Crystal, Keller, and Lee Lakes Nutrient Impairment Total Maximum Daily Load Implementation Plan and Earley Lake Protection Plan

Prepared for
Black Dog Watershed Management Organization and the Minnesota Pollution Control Agency

October 2011

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Executive Summary

Originally listed on the 303(d) Impaired Waters List for nutrient impairments, the *Crystal, Keller, and Lee Lakes Nutrient Impairment Total Maximum Daily Load Report and Earley Lake Water Quality Assessment (TMDL Report)* (Barr, 2010) established Total Maximum Daily Loads (TMDLs) for Crystal, Keller, and Lee Lakes to achieve the eutrophication standards established by the Minnesota Pollution Control Agency (MPCA). Because Earley Lake is currently meeting the MPCA eutrophication standards, it is in the process of being removed from the 303(d) Impaired Waters List, and a TMDL was not established for the lake. Table EX-1 summarizes the existing conditions total phosphorus loads, the annual TMDL load capacity as well as the required load reduction for Crystal, Keller, and Lee Lakes.

Table EX-1 Crystal, Keller, and Lee Lakes' Existing Conditions Total Phosphorus Loads, TMDL Load Capacity, and Required Phosphorus Reduction

Lake	Existing Conditions (lbs/yr)[1]	TMDL Load Capacity (lbs/yr)	Percent Reduction from Existing Conditions (%)
Crystal	1,243[2]	862	30.7
Keller	722[2]	272	62.2
Lee Lake	144	84	42

1 – Existing conditions assuming average (2006) climatic conditions and existing (2008) watershed conditions
2 – Assumes the ferric chloride system is not operating

The sources of phosphorus to Crystal, Keller, and Lee Lakes include both external loads from their watersheds, atmospheric deposition, and upstream lakes, as well as from internal sources such as release from the bottom sediments as well as the senescence of the macrophyte Curlyleaf pondweed. The *Crystal, Keller, and Lee Lakes Nutrient Impairment Total Maximum Daily Load Implementation Plan and Earley Lake Protection Plan* (*Implementation Plan)* outlines an adaptive management approach for a variety of restorative measures that address both external and internal sources of phosphorus for each lake to help achieve the loading capacity to meet the required MPCA water quality standards.

1.0 Introduction

The federal Clean Water Act requires states to adopt water quality standards to protect waters from pollution. The Minnesota Pollution Control Agency (MPCA) has developed water quality standards, and these standards are outlined in Minnesota Rules, Chapter 7050 (Standards for the Protection of Waters of the State). When water bodies fail to meet the standards established by the MPCA, they become listed on the 303(d) Impaired Waters List, requiring the completion of a Total Maximum Daily Load (TMDL) study that established the pollutant reduction goal needed to restore waters. In addition to the TMDL report, an implementation plan setting forth the activities and projects that will be implemented to achieve the required phosphorus reduction needs to be developed.

In addition to requiring the establishment of water quality standards, the Clean Water Act established the National Pollution Discharge Elimination System (NPDES), which currently regulates point sources of pollution, including the regulation of stormwater runoff from municipal separate storm sewer systems (MS4s). Those entities with an NPDES permit that have an established wasteload allocation required by an approved TMDL will need to demonstrate the progress being made toward achieving the TMDL.

This *Implementation Plan* describes potential activities planned over the next 20 years in order to achieve the wasteload and load allocations defined in the *Crystal, Keller, and Lee Lakes Nutrient Impairment Total Maximum Daily Load Report and Earley Lake Water Quality Assessment* (*TMDL Report*), completed by the Black Dog Watershed Management Organization (BDWMO) and the MPCA (Barr, 2010). The BDWMO is a local watershed management organization originally founded in 1985 that assists member communities with intercommunity water management issues, the monitoring and evaluation of select water bodies within the watershed, and the development of policies to be implemented by the member cities to protect the water resources within the watershed.

Each of the water bodies, the pollutant of concern, and the pollutant sources are summarized in the following section.

1.1 Crystal Lake

1.1.1 General Basin and Watershed Characteristics

Crystal Lake (DNR ID: 19-0027-00) is a 292-acre lake located in the cities of Burnsville and Lakeville in Dakota County, MN and within the BDWMO. The lake outlet is located at the northwest end of the lake in Buckhill Bay, and consists of a box weir with an overflow elevation of

933.5 feet above mean sea level (MSL). Overall, the lake has 5.3 miles of shoreline, a mean depth of 10 feet, and a maximum depth of 35 feet. The area of the lake shallow enough for aquatic plants to grow (the littoral zone) is approximately 208 acres. Crystal Lake is a dimictic lake; it mixes two times each year (during the spring and fall turnover events).

The Crystal Lake watershed consists of 3667 acres (including the lake surface area). Several other lakes are also located within the Crystal Lake watershed, including Keller Lake, and Lee Lake. Although Lee Lake has an outlet, it often acts as a landlocked portion of the Crystal Lake watershed and rarely discharges to Crystal Lake. The Crystal Lake watershed is almost fully-developed, with only a few small parcels available for new development. Low density residential land use is the dominant land use within the watershed. Figure 1-1 shows the *TMDL Study* location as well as the drainage areas and patterns of the watershed.

1.1.2 Pollutant of Concern & Pollutant Sources

Crystal Lake is located in the North Central Hardwood Forests (NCHF) ecoregion, and by MPCA definition, Crystal Lake is considered to be a deep lake (a maximum depth of greater than 15 feet). The lake's historical growing season water quality (10-year average) compared to the MPCA's deep lake eutrophication standards for this ecoregion are shown below.

Table 1-1 Crystal Lake 10-Year Average Water Quality Parameters

Water Quality Parameter	MPCA Deep Lake Eutrophication Standards (NCHF)	Crystal Lake 10-Year (1999-2008) Growing Season Average
Total Phosphorus (µg/L)	≤ 40	41.8
Chlorophyll *a* (µg/L)	≤ 14	24.5
Secchi disc (m)	≥ 1.4	1.7

Crystal Lake is currently listed on the MPCA's 2010 303(d) Impaired Waters List due to excess nutrients (phosphorus) and requires a Total Maximum Daily Load (TMDL) report. The BDWMO and MPCA will complete the *TMDL Report* for Crystal Lake in 2011.

During the growing season (i.e., representative average of concentrations or measurements of nutrient enrichment factors, taken over one summer growing season from June 1 through September 30), the largest source of phosphorous to Crystal Lake appears to be from internal sources, including phosphorus release from the lake sediment and senescing macrophytes (Curlyleaf pondweed). Another significant source of phosphorus is stormwater runoff from its tributary watershed.

1.2 Keller Lake

1.2.1 General Basin and Watershed Characteristics

Keller Lake (DNR ID: 19-0025-00) is a 52-acre lake (at normal water level) located in the cities of Burnsville and Apple Valley in Dakota County, MN. Keller Lake currently discharges to the northeast side of Crystal Lake over a weir structure, at an elevation of 934.3 feet MSL, through a 72-inch reinforced concrete pipe (RCP) arch. Keller Lake has an average depth of 4.8 feet and a maximum depth of about 8 feet. Because the lake is so shallow, aquatic plants can grow over the entire lake bed and a summer thermocline is not usually present (i.e., the lake does not thermally stratify). The lake may also be subject to intermittent wind mixing, meaning the lake is polymictic (mixes several times per year).

The Keller Lake watershed is 1447 acres (including the lake surface area). The Keller Lake watershed is almost fully-developed with low density residential as the major land use. Figure 1-1 shows the *TMDL Study* location as well as the drainage areas and patterns of the watershed.

1.2.2 Pollutant of Concern & Pollutant Sources

Keller Lake is located in the NCHF ecoregion, and by MPCA definition, Keller Lake is considered a shallow lake (a maximum depth of 15 feet or less or with at least 80 percent of the lake shallow enough to support emergent and submerged rooted aquatic plants (littoral area)). The lake's historical growing season water quality (10-year average) compared to the MPCA's shallow lake eutrophication standards for this ecoregion are shown below.

Table 1-2 Keller Lake 10-Year Average Water Quality Parameters

Water Quality Parameter	MPCA Shallow Lake Eutrophication Standards (NCHF)	Keller Lake 10-Year (1999-2008) Growing Season Average
Total Phosphorus (µg/L)	≤ 60	83.9
Chlorophyll *a* (µg/L)	≤ 20	28.5
Secchi disc (m)	≥ 1.0	1.2

Keller Lake is currently listed on the MPCA's 2010 303(d) Impaired Waters List due to excess nutrients (phosphorus) and requires a Total Maximum Daily Load (TMDL) report. The BDWMO and MPCA will complete the *TMDL Report* for Keller Lake in 2011.

During the growing season, the largest sources of phosphorus to Keller Lake include stormwater runoff from its tributary watershed, as well as internal phosphorus sources (e.g. from the lake sediment, senescing macrophytes (Curlyleaf pondweed), etc.).

1.3 Lee Lake

1.3.1 General Basin and Watershed Characteristics

Lee Lake (DNR ID: 19-0029-00) is an 18.6-acre water body (at water elevation 946.1 feet MSL (Lakeville, 2008)) located entirely within the City of Lakeville in Dakota County, MN. The lake is surrounded by privately owned property and has no public swimming beaches or public access. The Lee Lake outlet is located on the east side of the lake and is a stop log weir (at elevation 948.5 feet MSL) followed by a 36 inch gated structure (at elevation 947 feet MSL). Water level monitoring shows that the lake levels are typically below the outlet. Therefore, the lake often acts as a landlocked basin. The average depth of the lake is approximately 7 feet and the maximum depth is about 15 feet. Lee Lake is a dimictic lake; it mixes two times each year (during the spring and fall turnover events).

The Lee Lake watershed is 206 acres (including the lake surface area). The Lee Lake watershed is nearly fully-developed with low density residential as the major land use. Figure 1-1 shows the *TMDL Study* location as well as the drainage areas and patterns of the watershed.

1.3.2 Pollutant of Concern & Pollutant Sources

Lee Lake is located in the NCHF ecoregion, and by MPCA definition, Lee Lake is considered a shallow lake (a maximum depth of 15 feet or less or with at least 80 percent of the lake shallow enough to support emergent and submerged rooted aquatic plants (littoral area)). The lake's historical growing season water quality (10-year average) compared to the MPCA's shallow lake eutrophication standards for this ecoregion are shown below.

Table 1-3 Lee Lake 10-Year Average Water Quality Parameters

Water Quality Parameter	MPCA Shallow Lake Eutrophication Standards (NCHF)	Lee Lake 10-Year (1999-2008) Growing Season Average
Total Phosphorus (µg/L)	≤ 60	66.4
Chlorophyll *a* (µg/L)	≤ 20	24.3
Secchi disc (m)	≥ 1.0	1.3

Lee Lake is currently listed on the MPCA’s 2010 303(d) Impaired Waters List due to excess nutrients (phosphorus) and requires a Total Maximum Daily Load (TMDL) report. The BDWMO and MPCA will complete the *TMDL Report* for Lee Lake in 2011. Since the start of the TMDL study, two additional years of water quality monitoring data have been collected for Lee Lake (2009 and 2010), and based on this more recent data, the City of Lakeville is requesting the MPCA to delist Lee Lake from the 303(d) Impaired Waters List.

During the growing season, the largest sources of phosphorus to Lee Lake include internal phosphorus loading as well as stormwater runoff from its tributary watershed.

1.4 Earley Lake

1.4.1 General Basin and Watershed Characteristics

Earley Lake (DNR ID: 19-0033-00) is a 23-acre water body located entirely within the City of Burnsville in Dakota County, MN. The lake has no public swimming beaches or public access, and is used primarily for aesthetic viewing and wildlife observation. The Earley Lake outlet is located on the southwest side of the lake and is a 12-foot, three-sided box weir (at elevation 905.0 feet MSL) followed by a 36 inch RCP pipe. The average depth of the lake is 3.8 feet and the maximum depth is about 7.8 feet. Earley Lake is a polymictic lake, mixing several times each year. Figure 1-2 shows the bathymetry of Earley Lake.

The Earley Lake directly tributary watershed is 757 acres (including the lake surface area) and it also receives flows from Twin, Crystal, Keller, and Lee Lakes located upstream. The Earley Lake watershed is predominantly covered with commercial and highway land use and is almost fully developed.

1.4.2 Pollutant of Concern & Pollutant Sources

Earley Lake is located in the NCHF ecoregion, and by MPCA definition, Earley Lake is considered a shallow lake. The lake’s historical growing season water quality (10-year average) compared to the MPCA’s shallow lake eutrophication standards for this ecoregion are shown below.

Table 1-4 Earley Lake 10-Year Average Water Quality Parameters

Water Quality Parameter	MPCA Shallow Lake Eutrophication Standards (NCHF)	Earley Lake 10-Year (1999-2008) Growing Season Average
Total Phosphorus (µg/L)	≤ 60	51.4
Chlorophyll *a* (µg/L)	≤ 20	12.7
Secchi disc (m)	≥ 1.0	1.5

Earley Lake was originally listed on the MPCA's 2002 303(d) Impaired Waters List due to excess nutrients (phosphorus). However, because Early Lake is meeting the MPCA shallow lake standard for all three water quality parameters, the MPCA is in the process of removing it from the 303(d) Impaired Waters List. Because of this, the most recent water quality data for Earley Lake was compiled and reviewed to demonstrate that the lake is meeting the established MPCA water quality standards.

The City of Burnsville completed a study that resulted in the development of a Use Attainability Analysis (UAA[1]) for Twin and Earley Lakes. The UAA was entitled *Twin and Earley Lake Use Attainability Analysis Diagnostic-Feasibility Study: Water Quality Issues and Potential Restorative Measures* (Barr, 2007). This UAA was a scientific assessment similar to a diagnostic-feasibility study and outlined restorative measures to protect and improve water quality in these lakes. Although a TMDL was not developed and no phosphorus reductions are required for Earley Lake in terms of meeting the MPCA eutrophication standards, the restorative measures outlined as part of the UAA have been included in this *Implementation Plan* to help protect Earley Lake's water quality and prevent further degradation.

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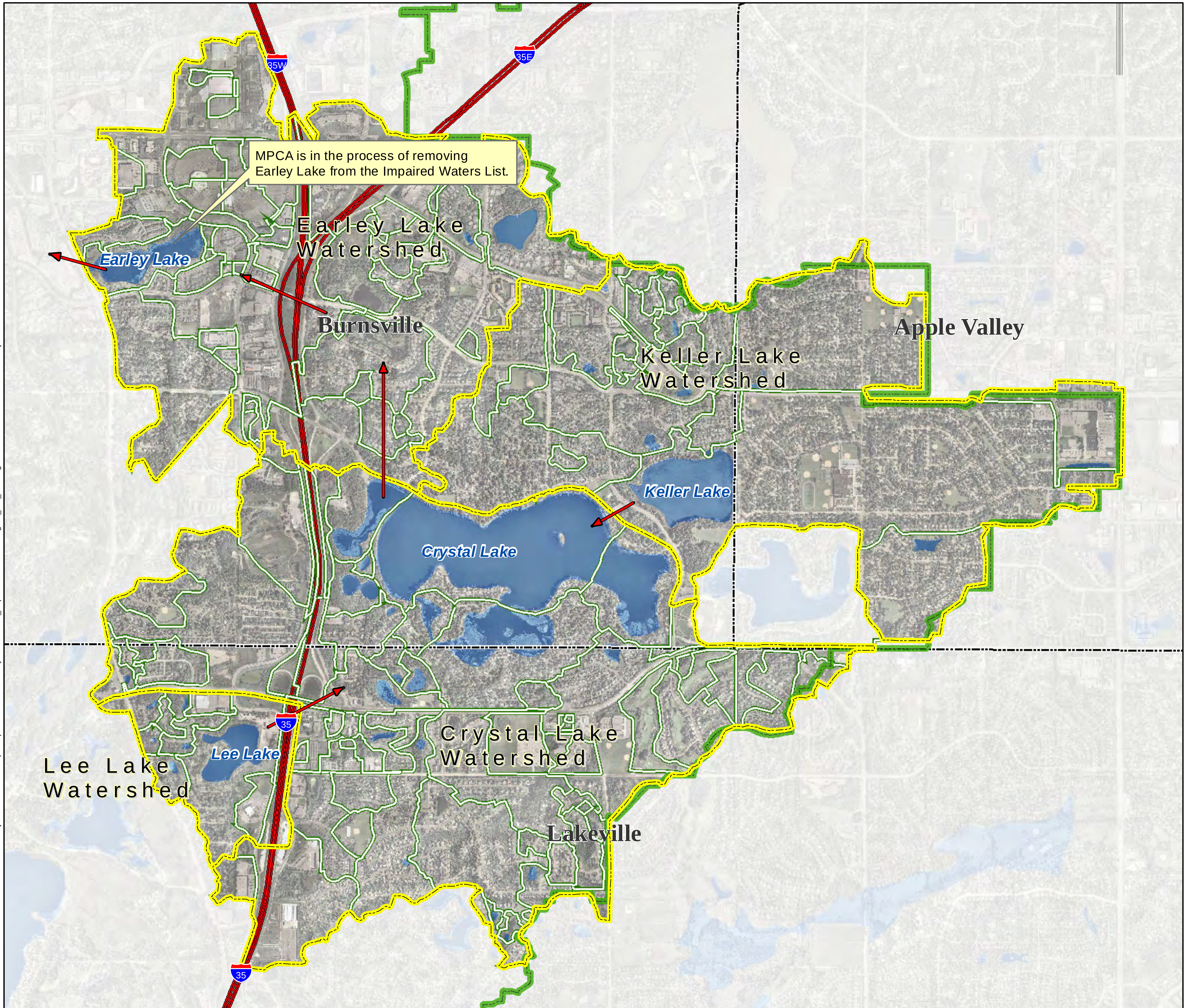
[1] For purposes of this report the term Use Attainability Analysis (UAA) means a scientific assessment similar to a diagnostic-feasibility study and not the more formal EPA report.



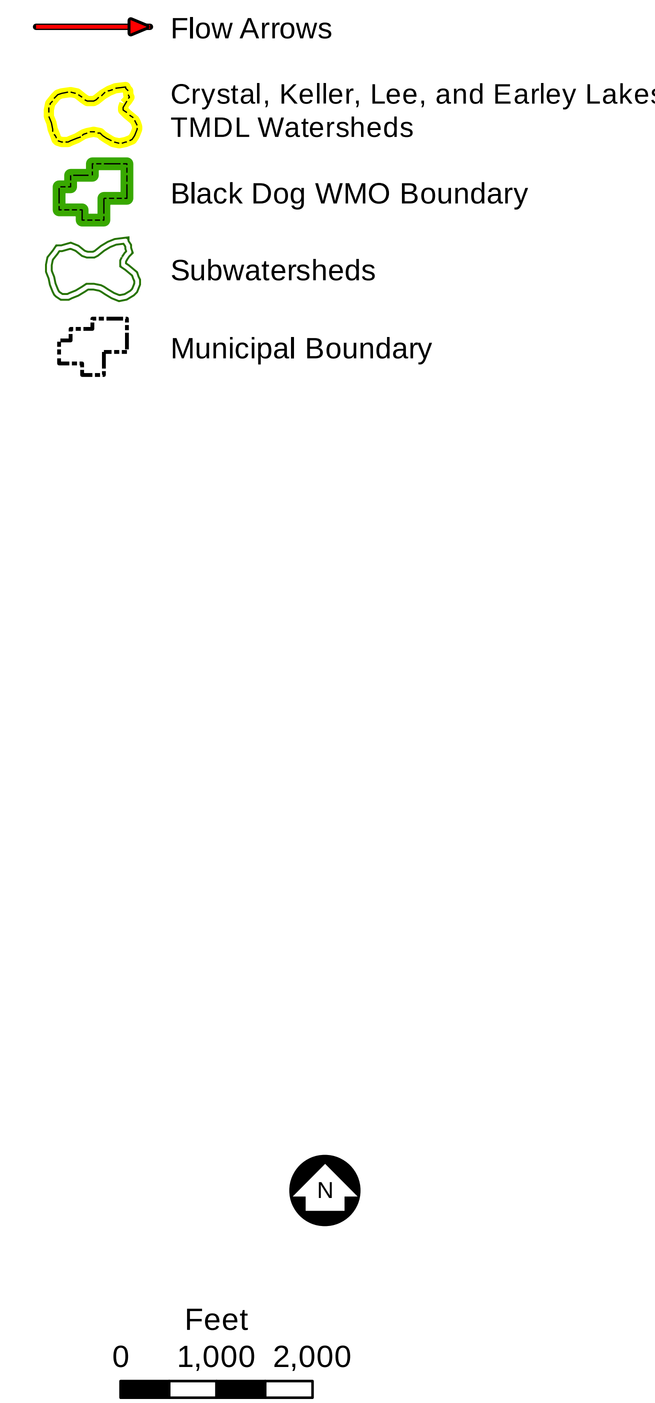
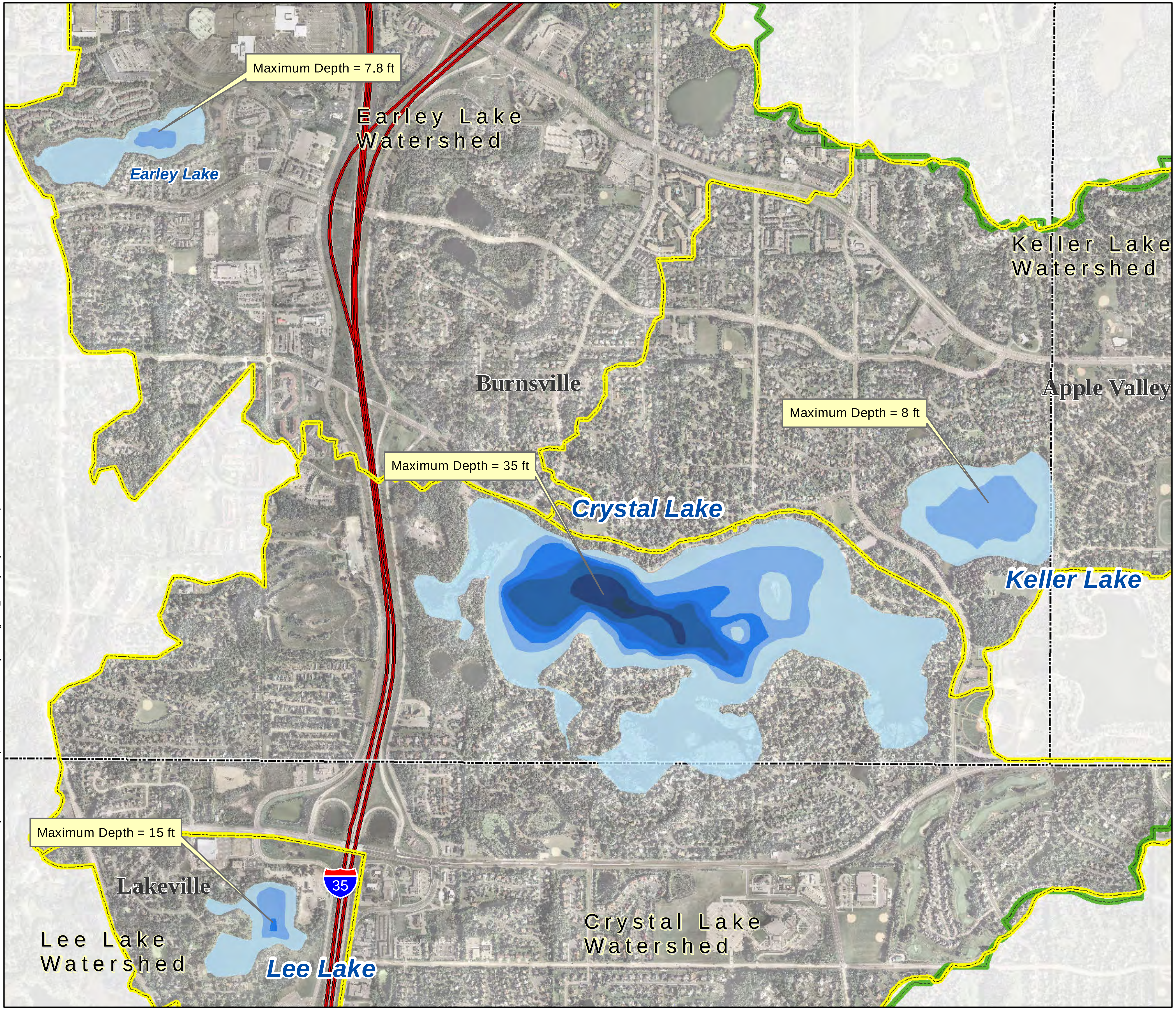


Figure 1-1
Site Location and Drainage Areas
for Crystal, Keller, Lee, and Earley Lakes

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA



Crystal, Keller, Lee, and Earley Lakes TMDL Watersheds

Black Dog WMO Boundary

Municipal Boundary

Bathymetry

Depth (ft)

0-5

5-10

10-15

15-20

20-25

25-30

30-35

N

Feet

0 625 1,250 2,500

Figure 1-2
Crystal, Keller, Lee, and Earley Lakes' Bathymetry

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

2.0 Summary of the Crystal, Keller, and Lee Lakes' TMDL Load Allocations

2.1 Crystal Lake TMDL Load Allocation

The TMDL is defined by the loading capacity for a given pollutant which is distributed among its components as follows (EPA 1999):

TMDL = WLA + LA + MOS + Reserve Capacity

Where:

WLA	=	Wasteload Allocation to Point (Permitted) Sources
LA	=	Load Allocation to NonPoint (Non-Permitted) Sources
MOS	=	Margin of Safety
Reserve Capacity	=	Load set aside for future allocations from growth or changes

For Crystal Lake, the Load Capacity is 862 pounds (lbs) of total phosphorus (TP) annually.

The TMDL equation used to distribute this Load Capacity for Crystal Lake is:

<u>Expressed as annual (October through September) totals:</u>

TMDL = 323 lbs TP (WLA) + 539 lbs TP (LA) + 0 lbs TP (MOS) + 0 lbs (Reserve Capacity)
= 862 lbs per year

<u>Expressed in daily terms (annual load/365)</u>

TMDL = 0.884 lbs (WLA) + 1.476 lbs (LA) + 0 lbs (MOS) + 0 lbs (Reserve Capacity)
= 2.361 lbs per day

The Wasteload Allocation (WLA), which is distributed among the individual permitted sources within the watershed, represents a 4% reduction in the external load from the tributary area to Crystal Lake. The external load reduction will be achieved through the implementation of various best management practices (BMPs) within the watershed. The Load Allocation (LA) represents a 41% total phosphorus reduction. This will be achieved through a reduction in the lake's internal phosphorus load. The establishment of the LA for Crystal Lake assumes the upstream water bodies (Keller and Lee Lakes) are meeting the MPCA water quality standards for the lakes. The Margin of Safety (MOS) is both implicitly and explicitly included in the equation as a result of calibrated modeling parameters, conservative modeling assumptions, and estimating the required reduction in phosphorus loading to achieve a summer average total phosphorus concentration 10% lower than the MPCA standard.

Table 2-1 summarizes the TMDL wasteload and load allocations for Crystal Lake under the critical conditions (average climatic conditions). Figure 2-1 shows the regulated Municipal Separate Storm Sewer Systems (MS4s) within the Crystal Lake watershed.

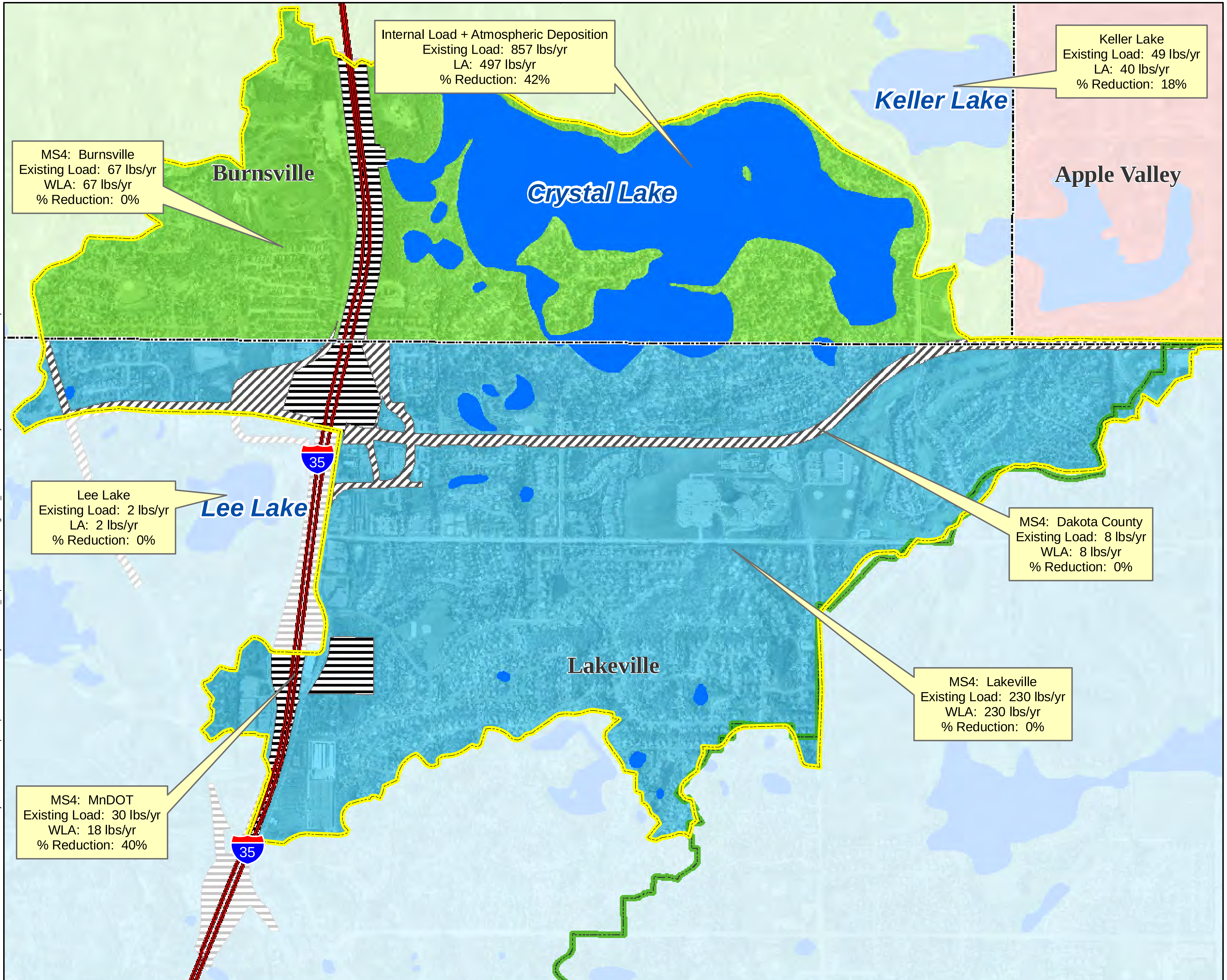
Table 2-1 Crystal Lake Annual[2] Total Phosphorus Load Allocations for Average (Critical) Climatic Conditions

TP Source	Existing Conditions without BMPs[1] (lbs/yr)	Existing Conditions with 2008 BMPs[1] (lbs/yr)	Percent Reduction by Existing BMPs (%)	TMDL Allocation (lbs/yr)	TMDL Allocation (lbs/day)	Required Load Reduction (lbs/yr)	Percent Reduction From Existing Load (%)
Wasteload Allocations (Permitted Sources)							
Burnsville (MS400076)	102	67	34	67	0.183	0	0
Lakeville (MS400099)	502	230	54	230	0.630	0	0
Dakota County (MS400132)	59	8	86	8	0.022	0	0
MnDOT (MS400170)	64	30	53	18	0.049	12	40
Total Wasteload Sources	**727**	**335**	**54**	**323**	**0.884**	**12**	**4**
Load Allocations (Non-Permitted Sources)							
Atmospheric Deposition		68		68	0.186	0	0
Keller Lake		49		40	0.110	9	18
Lee Lake		2		2	0.005	0	0
Internal Sources[3]		789		429	1.175	360	46
Total Load Sources		**908**		**539**	**1.476**	**369**	**41**
Margin of Safety							
--		--		Both Implicit and Explicit MOS		--	--
Reserve Capacity							
--		--		--	--	--	--
Overall Source Total		**1,243**		**862**	**2.361**	**381**	**30.7**

1 – Assumes the ferric chloride system is not operating

2 – Based on 2006 water year (October 1, 2005 – September 30, 2006)

3 – Reflects the sum of all internal sources of phosphorus (e.g. Curlyleaf pondweed, sediment release)



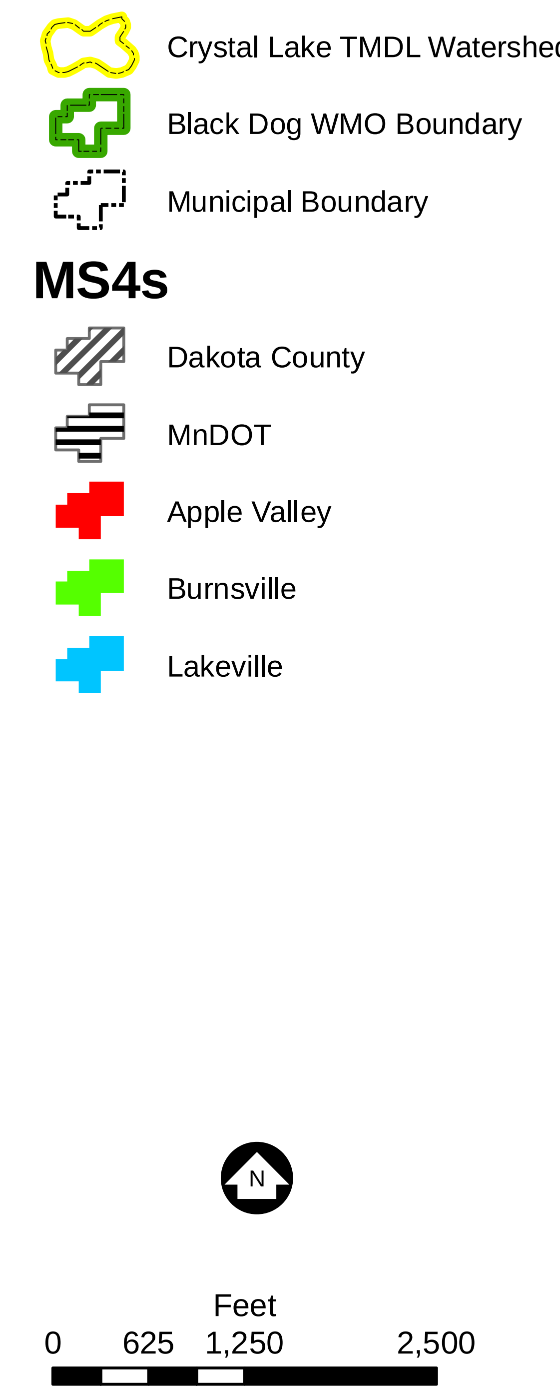


Figure 2-1
Crystal Lake Watershed:
MS4 Entities and TMDL Load
Allocation Summary

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation
Plan and Earley Lake Protection Plan
BDWMO & MPCA

2.2 Keller Lake TMDL Load Allocation

For Keller Lake, the Load Capacity is 272 pounds (lbs) of total phosphorus (TP) annually.

The TMDL equation used to distribute this Load Capacity for Keller Lake is:

Expressed as annual (October through September) totals:

TMDL = 202 lbs TP (WLA) + 70 lbs TP (LA) + 0 lbs TP (MOS) + 0 lbs (Reserve Capacity)
= 272 lbs per year

Expressed in daily terms (annual load/365)

TMDL = 0.553 lbs (WLA) + 0.192 lbs (LA) + 0 lbs (MOS) + 0 lbs (Reserve Capacity)
= 0.745 lbs per day

The Wasteload Allocation (WLA), which is distributed among the individual permitted sources within the watershed, represents a 52% reduction in the external load from the tributary area to Keller Lake. The external load reduction will be achieved through the implementation of various BMPs within the watershed. The Load Allocation (LA) represents a 77% total phosphorus reduction. This will be achieved through a reduction in the lake's internal phosphorus load. The Margin of Safety (MOS) is both implicitly and explicitly included in the equation.

Table 2-2 summarizes the TMDL wasteload and load allocations for Keller Lake under the critical conditions (average climatic conditions). Figure 2-2 shows the regulated MS4s within the Keller Lake watershed.

Table 2-2 Keller Lake Annual[2] Total Phosphorus Load Allocations for Average (Critical) Climatic Conditions

TP Source	Existing Conditions without BMPs[1] (lbs/yr)	Existing Conditions with 2008 BMPs[1] (lbs/yr)	Percent Reduction by Existing BMPs (%)	TMDL Allocation (lbs/yr)	TMDL Allocation (lbs/day)	Required Load Reduction (lbs/yr)	Percent Reduction of Existing Load (%)
Wasteload Allocations (Permitted Sources)							
Apple Valley (MS400074)	303	244	20	114	0.312	130	53
Burnsville (MS400076)	242	156	36	82	0.225	74	47
Dakota County (MS400132)	33	22	33	6	0.016	16	73
Total Wasteload Sources	**578**	**422**	**27**	**202**	**0.553**	**220**	**52**
Load Allocations (Non-Permitted Sources)							
Atmospheric Deposition		12		12	0.033	0	0
Internal Sources		288		58	0.159	230	80
Total Load Sources		**300**		**70**	**0.192**	**230**	**77**
Margin of Safety							
--		--		Both Implicit and Explicit MOS		--	--
Reserve Capacity							
--		--		--	--	--	--
Overall Source Total		**722**		**272**	**0.745**	**450**	**62.2**

1 – Assumes the ferric chloride system is not operating

2 – Based on 2006 water year (October 1, 2005 – September 30, 2006)

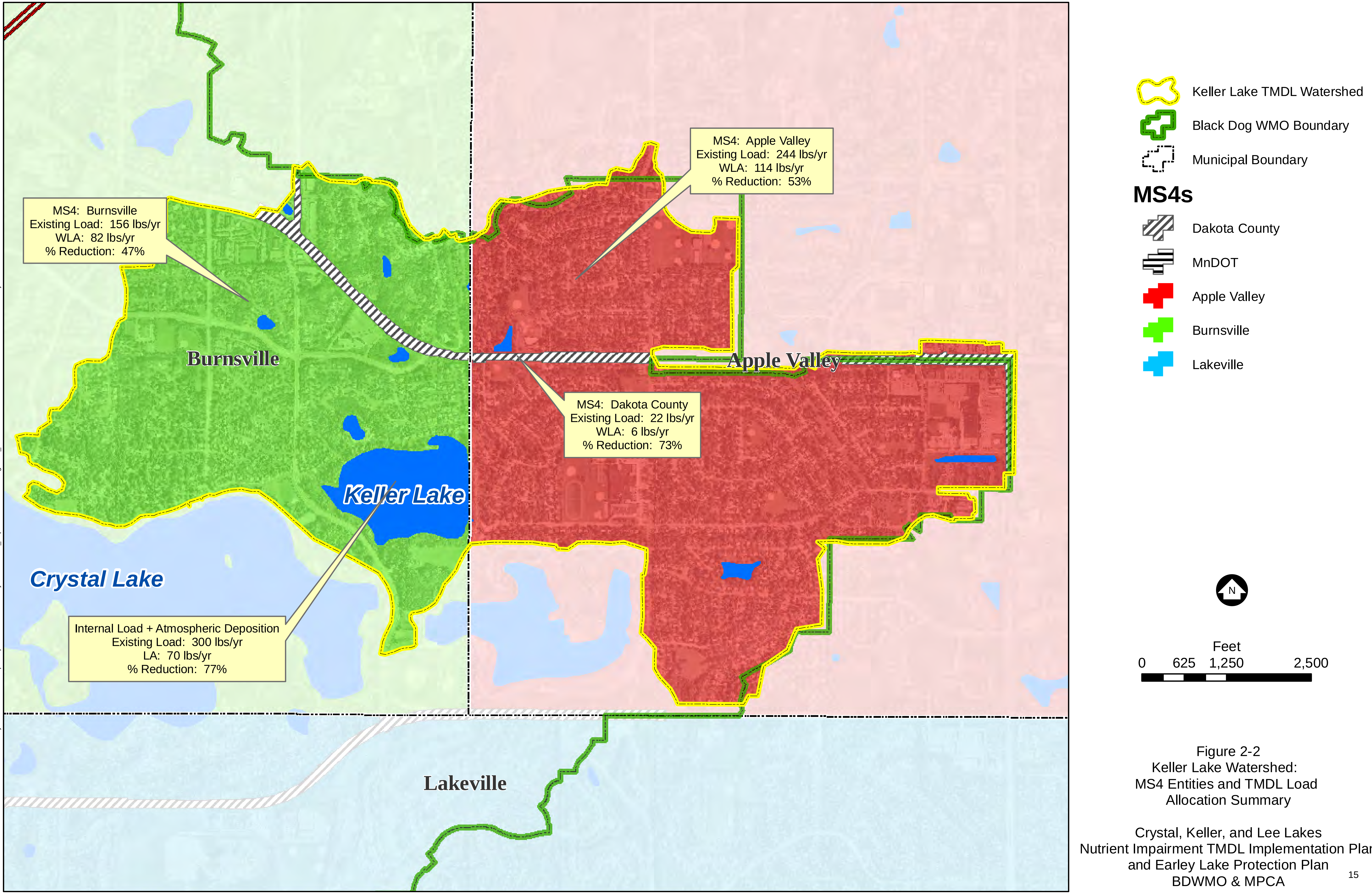


Figure 2-2
Keller Lake Watershed:
MS4 Entities and TMDL Load Allocation Summary

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

2.3 Lee Lake TMDL Load Allocation

The TMDL equation is defined as follows:

TMDL = Wasteload Allocation (WLA) + Load Allocation (LA) + Margin of Safety (MOS) + Reserve Capacity.

For Lee Lake, the Load Capacity is 84 pounds (lbs) of total phosphorus (TP) annually.

The TMDL equation used to distribute this Load Capacity for Lee Lake is:

<u>Expressed as annual (October through September) totals:</u>

TMDL = 45 lbs TP (WLA) + 39 lbs TP (LA) + 0 lbs TP (MOS) + 0 lbs (Reserve Capacity)
= 84 lbs per year

<u>Expressed in daily terms (annual load/365)</u>

TMDL = 0.122 lbs (WLA) + 0.107 lbs (LA) + 0 lbs (MOS) + 0 lbs (Reserve Capacity)
= 0.229 lbs per day

The Wasteload Allocation (WLA), which is distributed among the individual permitted sources within the watershed, represents a 31% reduction in the external load from the tributary area to Lee Lake. The external load reduction will be achieved through the implementation of various BMPs within the watershed. The Load Allocation (LA) represents a 51% total phosphorus reduction. This will be achieved through a reduction in the lake's internal phosphorus load. The Margin of Safety (MOS) is both implicitly and explicitly included in the equation.

Table 2-3 summarizes the TMDL wasteload and load allocations for Lee Lake under the critical conditions (average climatic conditions). Figure 2-3 shows the regulated MS4s within the Lee Lake watershed.

Table 2-3 Lee Lake Annual[1] Total Phosphorus Load Allocations for Average (Critical) Climatic Conditions

TP Source	Existing Conditions without BMPs (lbs/yr)	Existing Conditions with 2008 BMPs (lbs/yr)	Percent Reduction by Existing BMPs (%)	TMDL Allocation (lbs/yr)	TMDL Allocation (lbs/day)	Required Load Reduction (lbs/yr)	Percent Reduction of Existing Load (%)
Wasteload Allocations (Permitted Sources)							
Lakeville (MS400099)	75	43	43	37	0.101	6	14
Dakota County (MS400132)	9	4	56	2	0.005	2	50
MnDOT (MS400170)	20	18	10	6	0.016	12	67
Total Wasteload Sources	**104**	**65**	**37**	**45**	**0.122**	**20**	**31**
Load Allocations (Non-Permitted Sources)							
Atmospheric Deposition		5		5	0.014	0	0
Internal Sources		74		34	0.093	40	54
Total Load Sources		**79**		**39**	**0.107**	**40**	**51**
Margin of Safety							
--		--	--	Both Implicit and Explicit MOS		--	--
Reserve Capacity							
--		--	--	--	--	--	--
Overall Source Total		**144**		**84**	**0.229**	**60**	**42**

1 – Based on 2006 water year (October 1, 2005 – September 30, 2006)

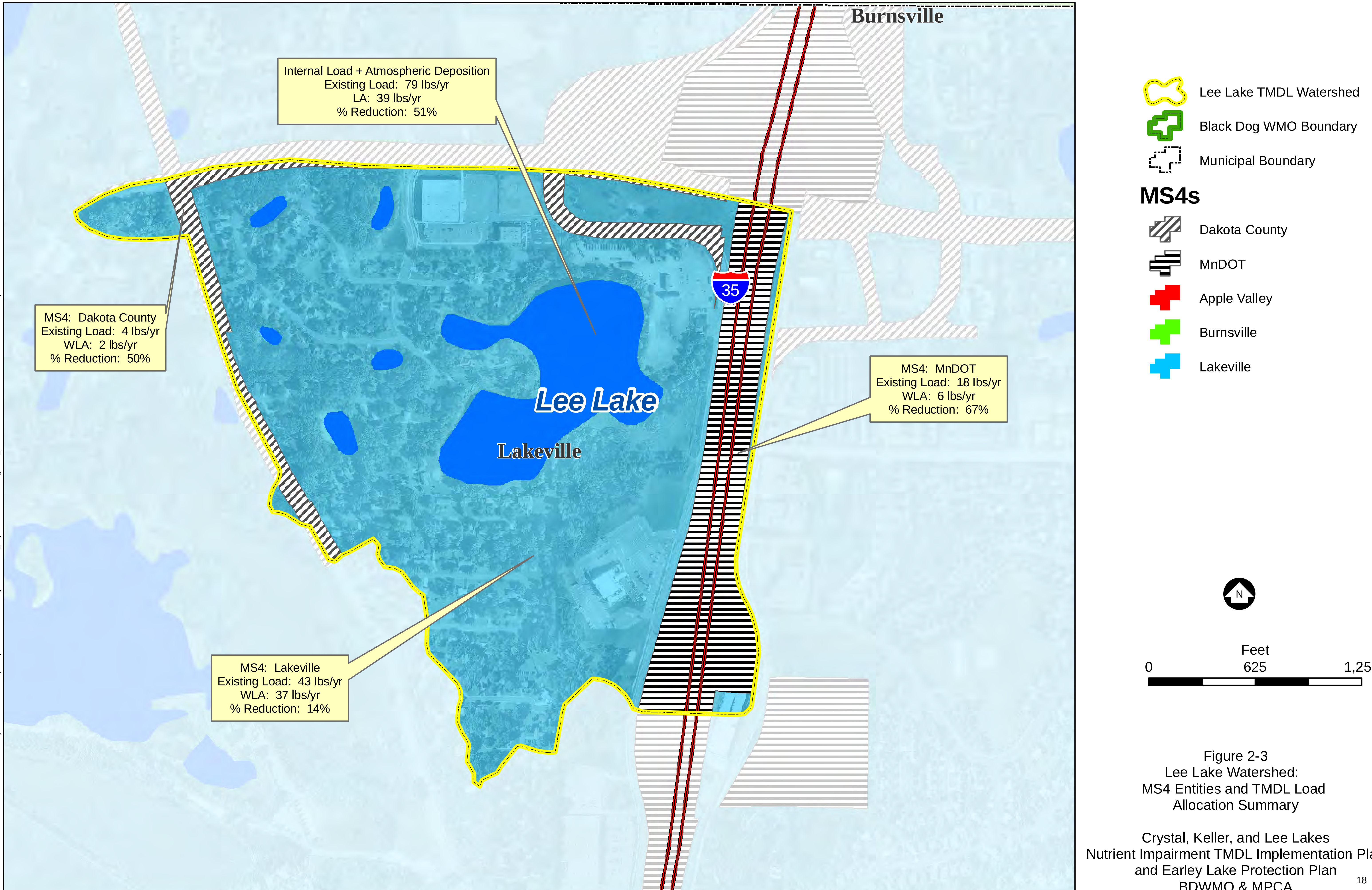


Figure 2-3
Lee Lake Watershed:
MS4 Entities and TMDL Load
Allocation Summary

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

3.0 TMDL Implementation Strategies

The following section outlines the implementation strategies developed for Crystal, Keller, and Lee Lakes. It describes the general approach and guidelines to the implementation strategies, a brief description of the process around the development of the *Implementation Plan*, as well as outlining a variety of projects that are expected to reduce phosphorus loads and improve water quality in the lakes. Additionally, the responsible parties and approximate timeline are included as well as the estimated costs and expected phosphorus reduction, if available.

3.1 TMDL Implementation Plan Process

The activities and BMPs outlined in this *Implementation Plan* are the result of a series of meetings with Technical Advisory Committee (TAC) and stakeholders led by the BDWMO. The TAC included representatives from the local cities (Apple Valley, Burnsville, Lakeville), Dakota County, Dakota County Soil and Water Conservation District (DCSWCD), the Minnesota Department of Transportation (MnDOT), the Minnesota Department of Natural Resources (MDNR), the Metropolitan Council, and the Minnesota Pollution Control Agency (MPCA). Meetings discussing the *TMDL Report* and the *Implementation Plan* were held on

- March 12, 2008,
- February 2, 2009,
- October 12, 2009,
- November 16, 2009
- December 16, 2009,
- March 1, 2010,
- March 31, 2010,
- April 22, 2010, and
- May 10, 2010.

The *Implementation Plan* was distributed to the stakeholders for review and comment.

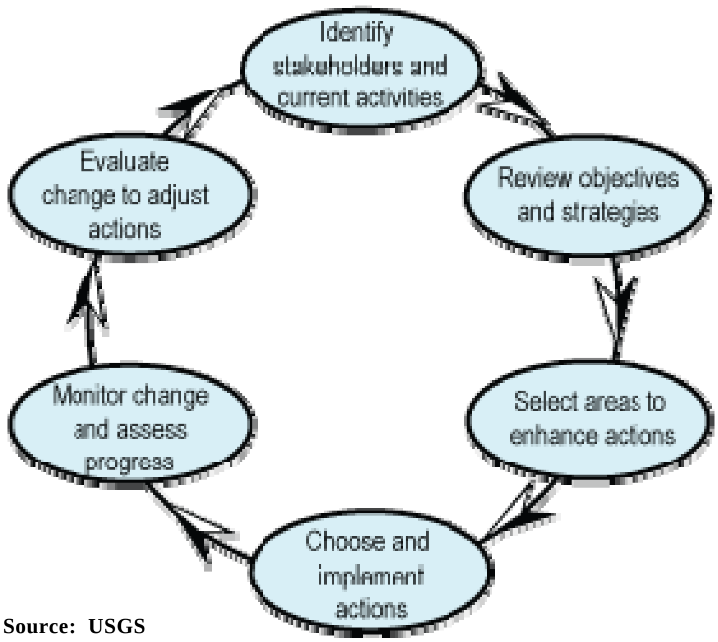
Additionally, from 2001 through 2003, the BDWMO completed a study that resulted in the development of a Use Attainability Analysis (UAA) for Crystal and Keller Lakes and their watersheds entitled *Crystal and Keller Lake Use Attainability Analysis Diagnostic-Feasibility Study: Water Quality Issues and Potential Restorative Measures* (Barr, 2003). Additionally, in 2007, the City of Burnsville completed a study that resulted in the development of a UAA for Twin and Earley

Lakes entitled *Twin and Earley Lake Use Attainability Analysis Diagnostic-Feasibility Study: Water Quality Issues and Potential Restorative Measures* (Barr, 2007). These studies helped establish priorities and BMPs to help achieve the established water quality goals, some of which were included as part of this *Implementation Plan*.

3.2 TMDL Implementation Plan Approach and Strategy

To achieve the TMDL wasteload and load allocations presented in the *TMDL Report*, significant phosphorus reductions will be required for Crystal, Keller, and Lee Lakes. The Crystal, Keller, and Lee Lake watershed areas are almost fully developed. As a result, there is limited space to retrofit BMPs and implementation of watershed BMPs will be costly. Additionally, internal phosphorus loading has been identified as an issue in all three lakes. Therefore, the stakeholders developing this *Implementation Plan* considered a variety of management opportunities to improve the water quality in Crystal, Keller, and Lee Lakes, including structural, nonstructural, and in-lake BMPs, addressing both external and internal sources of phosphorus. A general discussion of the various BMPs and management options considered in this TMDL can be found in Section 3.2.2 below and a more specific discussion of these restoration activities as applied to Crystal, Keller, and Lee Lakes can be found in Sections 3.3 through 3.5, respectively. The restorative actions included in this *Implementation Plan* provide examples of the types of projects that could be implemented by the various MS4s to demonstrate that the required phosphorus reductions can be achieved. However, the actual projects that will be implemented by the MS4s may vary from those included in this *Implementation Plan*.

The TMDL *Implementation Plan* follows an adaptive management approach which is an iterative approach to managing resources in light of uncertainties. In the case of this TMDL, it is difficult to predict exactly how each lake will respond to phosphorus load reductions. Proposed projects will be implemented in a phased manner, selecting specific projects for construction/implementation followed by a period of monitoring to evaluate the impact of the projects on the water quality in each respective lake. Depending on the resulting water quality, additional projects may be evaluated and selected for implementation, or it may be determined that the water quality in the lake meets the MPCA standards and the management approach may change from improvement to protection.



Adaptive Management Cycle

Additionally, the phasing of the projects in this *Implementation Plan* should first focus on addressing watershed loads to the maximum extent practicable followed by addressing the internal phosphorus loads within the lakes.

3.2.1 Implementation Plan Phasing

It is anticipated that it will take more than 20 years to implement all of the projects required to achieve the annual load reductions required by the TMDL. As previously mentioned, projects will be implemented in a phased manner, following the adaptive management approach.

To better outline the timeframe in which the proposed BMPs and activities will generally be implemented, the following phasing system was used as part of this *Implementation Plan*:

- **Completed:** Refers to projects fully implemented after the development of the TMDL began (2008), including the year in which the project was implemented. The responsible parties for these projects are identified and these completed projects may be counted towards the required wasteload reductions.

- **Ongoing:** Refers to activities that are ongoing practices that will be continued as the result of the implementation of the MS4s' Stormwater Pollution Prevention Programs (SWPPPs). The responsible parties for these projects have been identified.

- **As Opportunities Arise:** Refers to the implementation of projects and activities as opportunities (e.g. redevelopment, road reconstruction, etc.) arise, but the specific implementation projects have not yet been identified. The responsible parties for these projects have been identified.

- **Phase I:** Refers to projects and activities that have been identified as "first priority" projects with the goal of being implemented in the next permit cycle. The responsible parties for these projects have been identified.

- **Phase II:** Refers to projects and activities that have been identified as "second priority" projects. These projects will be reconsidered after implementation of those projects in Phase I and monitoring has been done to evaluate the impact of the Phase I projects on the water quality in the lakes, determining additional reductions as necessary.

- **Reserve:** Refers to projects and activities that may be considered if after the implementation of Phase I and Phase II tasks and sufficient monitoring has been performed, the lakes still do not meet the MPCA water quality goals.

The actual BMPs that will be implemented as the result of this TMDL study may vary from those listed in this *Implementation Plan*. Although this *Implementation Plan* is designed to act as a guide, the MS4s will ultimately select various BMPs to implement to achieve the required phosphorus load reductions.

3.2.2 Restorative Activities

3.2.2.1 Retrofit BMPs

The Crystal, Keller, and Lee Lakes' watersheds are almost fully-developed with only a few scattered parcels remaining for development. As a result, opportunities to implement BMPs within the watershed are limited to retrofits within the existing stormwater management system, redevelopment of parcels and along linear, transportation corridors.

Although much of the watershed runoff does receive some form of water quality treatment, there are areas within the Crystal, Keller, and Lee Lakes' watersheds that receive little or no treatment before discharging to the lake (see Figure 3-1). Efforts to retrofit BMPs into the existing system should first focus on the portions of the watershed that currently do not receive treatment by structural BMPs.

Additionally, retrofit opportunities that would create a series of BMPs within the watershed should also be considered. BMPs in series incorporate several stormwater treatment mechanisms in a sequence to enhance the treatment of runoff. Also called a “stormwater treatment train,” they consist of a series of BMPs and natural features, each designated to treat a different aspect of runoff, maximizing pollution removal. By combining structural and/or nonstructural treatment mechanisms in series rather than using a single method of treatment for stormwater runoff, the levels and reliability of pollutant removal can be improved (Metropolitan Council, 2001).

A variety of BMPs can be incorporated into the existing stormwater system such as wet detention, infiltration practices, filtration practices, hydrodynamic devices, and underground treatment systems. Also, as new BMPs and water quality improvement technologies are developed they will be evaluated to determine if they appropriate and practical and can provide a water quality benefit to the lakes.

Wet detention ponds (sometimes called “NURP” ponds when designed to the standards outlined by the Nationwide Urban Runoff Program) are impoundments that have a permanent pool of water and also have the capacity to hold runoff and release it at more controlled rates than the incoming flows. Wet detention ponds are one of the most effective methods available for treatment of stormwater runoff, trapping suspended solids and any of the pollutants associated with the sediment (e.g. heavy metals, nutrients, hydrocarbons). Detention ponds have also been credited with reducing the amount of bacteria and oxygen-demanding substances as runoff flows through the pond. When properly designed, wet detention ponds can remove approximately 80 to 95 percent of total suspended solids and 40 to 60 percent of total phosphorus (MPCA, 1989).

Infiltration practices are also an effective means of managing stormwater runoff, reducing peak discharges and volumes as well as improving water quality. These BMPs capture stormwater flows, gradually allowing the water to infiltrate into the soils below. For some practices, when stormwater flow exceeds the capacity of the infiltration system, only partial treatment will be possible because higher flows are bypassed around the system or discharged from an emergency overflow outlet. Pollutants are removed by adsorption, filtration, volatilization, ion exchange, and decomposition. As a result, infiltration practices are one of a few BMPs that can reduce the amount of dissolved pollutants in stormwater discharge. Infiltration BMPs can include a variety of practices, such as infiltration basins and trenches, bioretention areas and raingardens, vegetated swales, and porous surfaces such as permeable asphalt and concrete as well as permeable pavers. For infiltration practices to function as originally designed, pretreatment of the inflows to remove coarse particulates is recommended.

Filtration systems are typically designed to remove particulate matter and phosphorus from stormwater flows. These systems are typically constructed as offline systems, only providing partial treatment with higher flows being bypassed around the filter. Pretreatment of the stormwater flow is necessary to ensure that proper hydraulics and infiltration rates are maintained for phosphorus removal. As a result, filtration systems are often used in conjunction with another structural control. In some cases, infiltration practices can be designed to function more like filtration systems, collecting the infiltrated runoff in an underdrain system. Other filtration systems include surface and underground media filters, often using sand as the filter media. With the addition of steel fiber, steel wool blankets, or other types of iron amendments to sand filter media (iron-enhanced sand filtration), additional removal of soluble and non-settleable phosphorus is possible. Because aerobic conditions are required for these iron-enhanced systems to function properly, flow must be diverted from the filter to allow for drainage and drying and, thus, a parallel system or a system with a controlled bypass is recommended. Studies of iron enhanced sand filters have resulted in soluble phosphorus reductions ranging from 40 to 90 percent (City of Bellevue, Washington, 1999; Erickson et al. 2006; Erickson et al. 2009).

Hydrodynamic devices (aka. oil-grit separators) are concrete chambers designed to remove oil, sediments, and floatable debris from runoff, and are typically used in areas with heavy traffic or high potential for petroleum spills such as parking lots, gas stations, roads, and holding areas. They are good at removing coarse particulates, oil, and floatable debris and can be used as pre-treatment for an infiltration basin or pond. They can also be incorporated into an existing stormwater system or included in an underground vault detention system when no available land exists for a surface detention basin. In order to function properly, they must be properly sized and cleaned out regularly (at least once or twice a year).

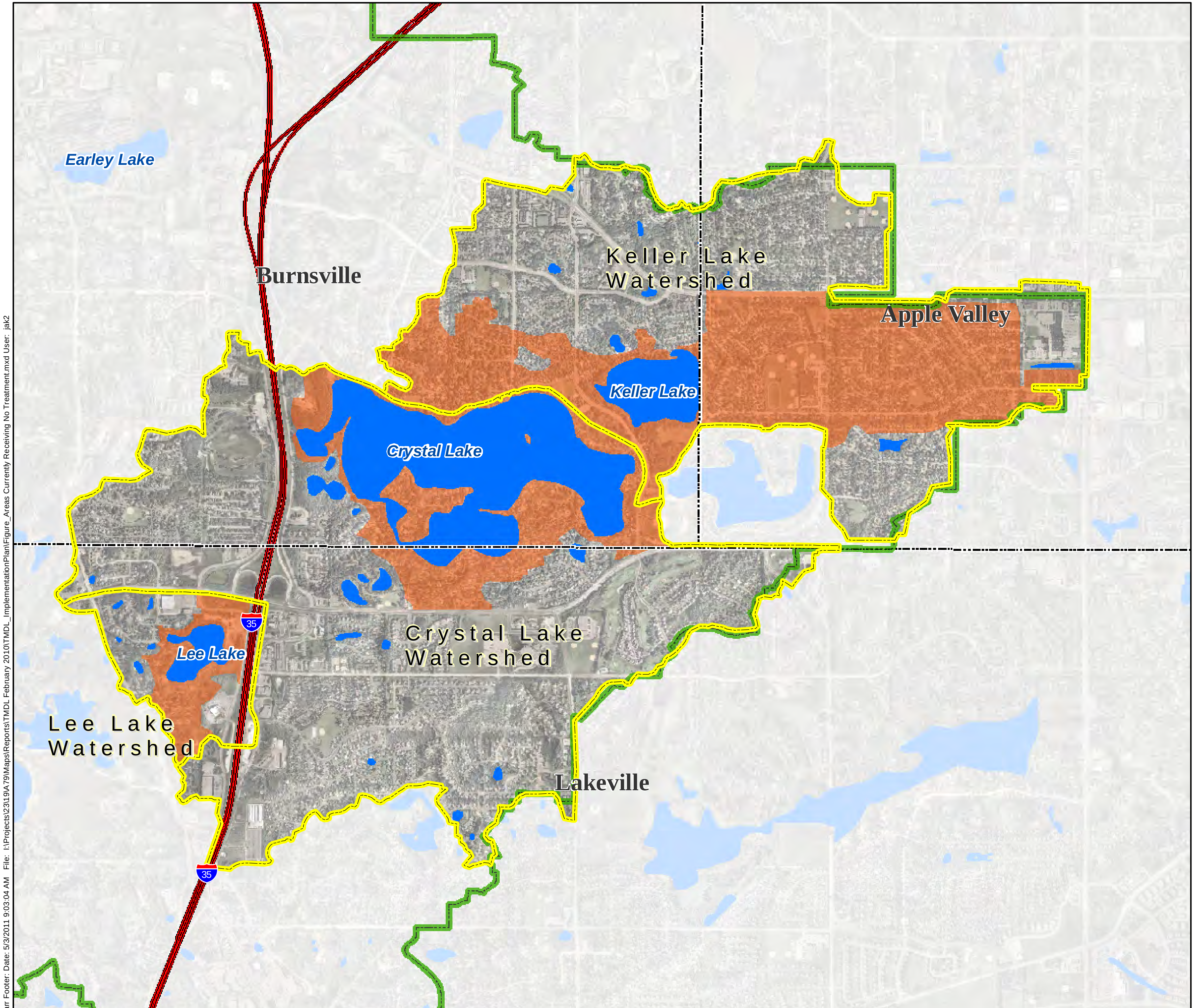
Underground treatment systems provide the opportunity to incorporate stormwater storage and treatment on highly-developed sites where space may be limited, maintaining a usable surface above. These underground systems can include subsurface vaults or interconnected pipes or storage chambers. In some systems, water may be allowed to infiltrate into the soil below while others act as detention/retention systems.

3.2.2.2 Redevelopment

In nearly fully-developed watersheds, as is the case with the Crystal, Keller, and Lee Lake watersheds, redevelopment provides the opportunity to improve stormwater runoff management from the redeveloping parcel as well as potentially providing an opportunity to incorporate both source and regional stormwater treatment to manage runoff and improve water quality.

In addition to allowing for improved stormwater treatment, redevelopment also provides the opportunity to incorporate Low Impact Development (LID) design techniques (better site design) into the redevelopment plans. LID is an approach to development which can include reductions in and disconnection of impervious surfaces, distribution of stormwater treatment across the site, and development, enhancement, or protection of natural areas on a site (MPCA, 2005).

The Cities of Apple Valley, Burnsville, and Lakeville currently have stormwater rules and standards in place for redevelopment activities. These standards are summarized in Table 3-1. The redevelopment standards may be reviewed periodically as required by updates to meet WMO requirements (e.g. BDWMO, VRWJPO) or as part of their SWPPP requirements. The BDWMO is currently in the process of updating its *Watershed Management Plan* and reviewing its standards.



Crystal, Keller, and Lee Lakes TMDL Watersheds

Black Dog WMO Boundary

Municipal Boundary

Subwatersheds Without Structural BMPs

N

Feet

0 1,000 2,000 4,000

Figure 3-1
Areas Currently Receiving No Treatment
in the Crystal, Keller, and Lee Lake Watersheds

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

Table 3-1   Redevelopment Standards by MS4

MS4	Redevelopment Standards
Apple Valley	- Redevelopment creating over 0.2 acres of new impervious surface shall be required to achieve no net increase in average annual TSS and TP loading compared to predevelopment conditions of the site or meet the post-construction runoff treatment section of the MPCA NPDES General Construction Permit, whichever is more restrictive. - Redevelopment creating over 0.2 acres of new impervious surface shall be required to achieve no net increase in average annual runoff volume compared to the 1990 nondegradation baseline loading condition.

Burnsville	- Any project resulting in 0.5 acre or more of disturbed area or 5,000 square feet or more of new impervious area:
	  - For all new impervious surfaces, a runoff volume of 1 inch must be treated in infiltration practices
	  - For all redevelopment impervious surfaces, a runoff volume of 0.5 inches must be treated in infiltration practices
	  - For new development portions of site, provide treatment to remove 90% TSS and 60% TP on an annual basis
	  - For redevelopment portions of a site, provide treatment to remove 70% TSS and 30% TP on an annual basis

Lakeville	- Redevelopment which creates less than 1 acre of new impervious surface and disturbs, replaces, or alters more than 1 acre of existing impervious surface is required to incorporate water quality BMPs to the extent practical.
	  - Meet the post-construction runoff treatment section of the MPCA NPDES General Construction Permit.
	  - Infiltration of 0.5 inches of runoff over the surface of all newly created impervious areas (where possible).
	- Development and redevelopment of commercial areas along the I-35 corridor are limited to less than 70 percent impervious coverage

TSS = Total Suspended Solids, TP = Total Phosphorus

Sources: Apple Valley *Surface Water Management Plan* (2007), Burnsville *Water Resources Management Plan* (2008), Lakeville *Water Resources Management Plan* (2008)

MnDOT has developed a 20-year *Statewide Transportation Policy Plan* as well as the MnDOT *Statewide 20-Year Highway Investment Plan* (both effective from 2009-2028). These plans outline the policies governing the development and maintenance of the state transportation system as well as outlining the future capital improvements projects to be implemented as part of the plan. Currently, the 20-year plan developed by MnDOT does not have any improvements identified for the stretch of Interstate 35 (I35) within the Crystal and Lee Lakes' watersheds although MnDOT may consider stormwater management projects to help achieve the established TMDL as part of the development of the next statewide highway investment plan. MnDOT may consider incorporating stormwater BMPs within their right of way as opportunities arise. Additionally, MnDOT does have the responsibility under their MS4 permit to meet the WLA, regardless of currently planned projects.

3.2.2.3 Street Sweeping

Most often, street sweeping is performed only in the spring and in the fall, after the leaves have fallen, to reduce this potential source of phosphorus from entering the storm sewer. For most urban areas, street sweeping has relatively low effectiveness from late-spring (after the streets are cleaned of accumulated loads) until early-fall (prior to the onset of leaf fall) (Bannerman, 1983). In addition, the use of vacuum sweepers is preferred over the use of mechanical, brush sweepers. The vacuum sweepers are more efficient at removing small phosphorus-bearing particles from impervious surfaces within the watershed. Fall street sweeping is particularly important in the watershed directly tributary to the lake, where treatment of stormwater is not available.

The Cities of Apple Valley, Burnsville, and Lakeville currently have street sweeping programs in place. Dakota County and MnDOT currently do not street sweep within their right of way but should consider street sweeping programs. The cities should continue to implement their street sweeping programs, targeting any future expansion of the street sweeping programs on areas where stormwater runoff currently receives little or no water quality treatment before discharging into a lake. Additionally, improved street sweeping technologies and techniques should be incorporated into the street sweeping programs as they are developed to increase removal of smaller particles, which carry the largest portion of the phosphorus to lakes.

3.2.2.4 Public Education and Outreach

Public education and outreach programs are directed efforts educating the public about urban nonpoint source pollution and at changing the behavior of property owners that can help reduce the nonpoint source pollution associated with activities such as lawn and garden care, car care, and disposal of yard wastes. Because the MS4s within the watershed are currently permitted, they are required to develop public education and outreach programs as part of their SWPPPs. However, the MS4s should continue to look for opportunities to expand the existing education and outreach programs specific to activities that will reduce phosphorus loading to the lakes.

3.2.2.5 Shoreline Buffers

Over the last decade, greater attention has been given to shoreland management and ecological restoration. Lake shore restoration programs encourage the establishment of a natural buffer using native plants that are less prone to erosion and provide quality fish and wildlife habitat. Vegetated buffer strips perform several pollutant attenuation functions, mitigating some of the impact of development. When natural vegetation is removed, pollutants are given a direct path to the lake—sediments cannot settle out; nutrients and other pollutants cannot be removed. Additional problems resulting from removal of natural vegetation include shoreline erosion and loss of valuable wildlife habitat (Rhode Island Department of Environmental Management, 1990).

The effectiveness of buffer strips is dependent on the width of the buffer, the slope of the site, and the type of vegetation present. Buffer strips should be 20-feet wide at a minimum, although wider buffer strips are recommended. Many attractive native plant species can be planted in buffer strips to create aesthetically pleasing landscapes, as well as providing habitat for wildlife and birds. When properly designed, buffer strips can remove 30 to 50 percent of total suspended solids from lawn runoff. In addition, well-designed buffer strips will discourage geese from nesting and feeding on shoreland lawns. Geese can be a significant source of phosphorus to ponds, by grazing turfed areas adjacent to the water and defecating in or near the water's edge where washoff into the pond is probable. Finally, native shoreline buffers can stabilize the shoreline. However, this practice typically does not have a high return on phosphorus reduction for the cost.

The MS4s should consider the development of shoreline restoration programs, including public education and outreach about shoreline buffers, to promote the restoration of the shoreline around Crystal, Keller, and Lee Lakes.

3.2.2.6 Management of Curlyleaf Pondweed

Curlyleaf pondweed has been identified as a significant source of phosphorous to Crystal, Keller, and Lee Lakes. Controlling and reducing the growth and spread of Curlyleaf pondweed within a lake system will require intensive management and monitoring efforts, but will help achieve the established TMDL load allocation. Several techniques have been relatively successful in the management of Curlyleaf pondweed including drawdown of lake water levels as well as herbicide treatments of the whole littoral area of the lake.

The management of Curlyleaf pondweed using a herbicide (Endothall) treatment typically takes 5-7 years and requires an aquatic plant control permit from the MDNR along with a letter of variance allowing for treatment of the entire lake. The MDNR also requires that a lake vegetation management plan be developed and approved prior to permit issuance. Permission from lakeshore residents will be required for treatment of the lake area within 150 feet of the shoreline. In addition to the herbicide application in the spring, the MDNR permit will require a variety of monitoring to be performed before and after the herbicide application for each year of the treatment. Monitoring required will include aquatic plant surveys, measurement of biomass, and collection and counting of Curlyleaf pondweed turions (i.e. winter buds). Annual reporting of the monitoring results to the MDNR is also required. Herbicide treatment is a multi-year management plan expected to significantly reduce the coverage and density of Curlyleaf pondweed. However, it is important to note that spot treatments will likely be required to help control this invasive macrophyte. A NPDES permit may also be required in the future for the treatment of Curlyleaf pondweed.

In some lakes, both Curlyleaf pondweed and Eurasian watermilfoil are present. Eurasian watermilfoil is another invasive macrophyte that can significantly interfere with the recreational uses of a lake by forming dense mats at the water surface. If this is the case, Curlyleaf pondweed and Eurasian watermilfoil should be managed concurrently to prevent Eurasian watermilfoil from colonizing areas vacated by Curlyleaf pondweed and to promote the reemergence of native plant communities. Eurasian watermilfoil management is typically a dual herbicide treatment (Endothall and 2,4-D). The majority of the requirements for the management of this macrophyte will be included as part of the lake vegetation management plan. However, additional herbicide residue monitoring will be necessary for the second herbicide (2,4-D).

3.2.2.7 Inactivation of Sediment Phosphorus

Both monitoring and modeling has indicated that phosphorus loading from the lake sediments is a significant source of phosphorus to all three lakes. The addition of aluminum sulfate (alum) has been proven to be effective in controlling phosphorus release from sediment, especially when an adequate dose has been delivered and where watershed sediment and phosphorus loads have been minimized (Moore and Thorton, 1988). Alum binds with phosphorus and removes phosphorus from the water column as it settles and then forms a layer on the lake bottom that covers the sediments and prevents release from the sediments as well. Alum application can decrease internal phosphorus loads by up to 80 percent (Welch and Cook, 1999) and can be effective for nearly 10 years, depending on the dose and watershed inputs. Similar to the management of Curlyleaf pondweed, alum treatments will help achieve the established TMDL load allocations. A NPDES permit may also be required in the future for alum treatments.

3.2.2.8 Emerging Technologies

As new BMPs and water quality improvement technologies are developed, they will be evaluated to determine if they can provide a water quality benefit to the lakes, and they will be considered for implementation if determined to be necessary, reasonable, practicable, and cost effective.

These technologies could also include lake water level drawdown, which can consolidate sediments potentially reducing the release of phosphorus from sediments. A winter drawdowns of lakes containing Curlyleaf pondweed can also freeze Curlyleaf pondweed turions in the sediment, reducing the viability of those turions.

3.2.2.9 Management of Aquatic Communities

The activity of benthivorous (bottom-feeding) fish (e.g. common carp and bullhead) can resuspend phosphorus into the water column and degrade water quality. Additionally, they can impact the long-term effectiveness of an alum treatment of lake bottom sediments. The methods typically used during the MDNR fishery surveys often underestimate the number of carp in a system (Sorensen, 2009).

In addition to benthivorous fish having a negative impact on water quality, significant populations of planktivorous fish (e.g., sunfish and minnows) can also increase turbidity and degrade water quality in a water body. Planktivorus fish feed on zooplankton, which in turn feed on phytoplankton (e.g., algae). However, when a system has high numbers of planktivorous fish, it can result in large reductions in the zooplankton population and can directly contribute to high abundances of algae (Zimmer et al., 2001).

If benthivorous or planktivorous fish are observed in high numbers as part of the next MDNR fishery surveys, additional study of the fishery may be required to better understand the impact of the fishery on the lake water quality and to develop a management plan for the lake.

Because phytoplankton and zooplankton form the base of the food web in lake systems and can be impacted by the fishery, phytoplankton and zooplankton surveys should be completed in conjunction with the fishery study. Understanding these aquatic communities can help better understand the overall lake ecosystem and potentially identify issues within the system that may be negatively impacting water quality. For example, phytoplankton and zooplankton communities within a lake system can impact the water clarity and affect the uses of a lake.

3.2.3 Engineer’s Opinion of Probable Costs

The engineer’s opinions of probable costs were developed for the various implementation items identified as part of this *Implementation Plan*. These costs were based on recent project costs, bid tabulation submittals, R.S Means, and communications with contractors. The costs assumed the engineering and design at 10 percent of the estimated cost and contingencies at 30 percent of the project total cost. The engineer’s opinion of probable costs do not include any land acquisition, easement acquisition, or wetland mitigation costs, and also assume that contaminated soils will not be encountered during excavation and construction. Additional details about the engineer's opinion of probable costs can be found in the following sections and Appendix A.

3.2.4 Interim Milestones

It can take many years for a lake to respond to phosphorus load reduction activities in the watershed and within the lakes. Interim measures will need to be implemented to assess the progress toward achieving the in-lake water quality standards. These activities could include:

- Tracking of new BMPs retrofit into the watershed, including the number, types, and estimated load reduction for each

- Tracking of redevelopment projects within the watershed that could incorporate new or oversized BMPs, including the types and estimated load reductions for each

- Documentation of expanded street sweeping efforts that target areas that currently receive little or no treatment before discharging to the lake, including the expanded extent, frequency, or improvements in technology

- Tracking of the participation of private property owners in existing programs to implement rainwater gardens, native shoreline buffers, etc. including their location and type of project implemented

- Documentation of new or modified educational materials and activities that address nutrient management

These milestones will provide information that documents the progress being made to achieve the TMDLs established for Crystal, Keller, and Lee Lakes even when water quality improvement is not yet observed in the lakes. The water quality monitoring program for the TMDL *Implementation Plan* is discussed in Section 4.0.

3.3 Crystal Lake Annual Load Reductions

The TMDL *Implementation Plan* focuses on reducing both external, or watershed, sources of phosphorus and internal, or in-lake, sources of phosphorus. For Crystal Lake, annual phosphorus reductions of 12 pounds (4%) from external loading and 369 pounds (41%) from internal loading sources are required to achieve the required TMDL standard of 40 µg/L for deep lakes (including a 10 percent MOS). Total phosphorus load reduction (both external and internal) to Crystal Lake will need to decrease overall loading by 381 pounds, or 30.7 percent annually in order to achieve the overall TMDL load capacity of 862 lbs.

3.3.1 External (Watershed) Sources-Reduction Goal of 12 Pounds Annually

Much of the runoff from the Crystal Lake watershed currently receives some form of water quality treatment (i.e. passes through a lake, pond, wetland, or infiltration basin), and as a result, the expected phosphorus reductions from the external sources of phosphorus to the lake are relatively small. However, there are some areas within the watershed that do not receive water quality treatment with structural BMPs. These areas are shown on Figure 3-1. The potential restorative measures for Crystal Lake are summarized in Table 3-2 and in Figure 3-2.

The following tasks describe activities that can be used to achieve the wasteload reductions defined in the *TMDL Report*. The modeling for the TMDL was completed through 2008, so projects that were fully implemented during the development of the TMDL are included in this list of implementation items.

Task C-1. Primrose School of Lakeville infiltration basins

Infiltration basins were incorporated into the site as part of the development of the Primrose School of Lakeville site (9711 163rd Street West, Lakeville, MN), which was constructed in 2008-2009. The infiltration basins currently collect and treat runoff from the impervious surfaces on the site.

1. Responsible Party — Lakeville
2. Timeline — Completed 2009
3. Estimated Phosphorus Reduction — 0.3 lbs/year

Task C-2. I-35 Transit Station infiltration basin

Infiltration basins were incorporated as part of the 2009 addition of the bus transit lanes and modifications to the existing park and ride area located east of Interstate Highway I-35 in Lakeville. Although originally constructed by MnDOT in its former right of way, ownership of the transit station and pond is planned to be transferred to the Metropolitan Council. Discharge from this basin flows into the City of Lakeville’s storm sewer system.

1. Responsible Party — MnDOT
2. Timeline — Completed 2009
3. Estimated Phosphorus Reduction — 0.6 lbs/year

Task C-3. Continued implementation of street sweeping in the Crystal Lake watershed

The Cities of Burnsville and Lakeville currently implement street-sweeping programs to help reduce phosphorus loads to the water bodies within each City. The City of Burnsville street sweeping program includes sweeping the entire city in the spring, targeted sweeping throughout the summer in areas around protected waters including Crystal Lake, and a final sweeping in the fall as weather permits. In Lakeville, the city sweeps streets twice annually.

Both cities should continue to implement their street sweeping programs, targeting any future expansion of the street sweeping programs in areas where stormwater runoff currently receives little or no water quality treatment before discharging into Crystal Lake. Additionally, improved street sweeping technologies and techniques should be incorporated into the street sweeping programs as they are developed.

1.	Responsible Party	Lakeville, Burnsville
2.	Timeline	Ongoing
3.	Estimated Capital Cost	Annual Cost

Task C-4. Retrofit BMPs within the Crystal Lake watershed

Although the majority of flows from the watershed to Crystal Lake receive water quality treatment before discharging to the lake, there are several areas in the watershed that receive no treatment before discharging to the lake (see Figure 3-1). Retrofitting BMPs within the Crystal Lake watershed as opportunities arise could have a significant impact on phosphorus load reductions to Crystal Lake. Again, focus of these efforts should first be placed on portions of the watershed that do not receive treatment by structural BMPs. Retrofit BMPs could include any of a variety of practices including water quality treatment ponds, infiltration practices, filtration systems including iron-enhanced filtration, hydrodynamic devices, as well as underground storage and treatment systems.

1.	Responsible Party	Lakeville, Burnsville, MnDOT, Dakota County
2.	Timeline	As Opportunities Arise
3.	Estimated Capital Cost	To Be Determined (TBD)

Task C-5. Infiltration/Filtration within the portion of the Crystal Lake watershed without structural BMPs

Implementation of an aggressive infiltration/filtration program within the areas of the Crystal Lake watershed that currently do not receive treatment by structural BMPs (infiltrating anywhere from 0.25 to 1.0 inches of runoff from impervious surfaces) as opportunities arise could have a significant impact on phosphorus load reductions to Crystal Lake. Infiltration of 0.25 to 1.0 inches of runoff from impervious surfaces in these areas would results in required treatment volumes of 0.5 to 1.7 acre-feet, respectively.

1.	Responsible Party	Lakeville, Burnsville, MnDOT, Dakota County
2.	Timeline	As Opportunities Arise
3.	Estimated Capital Cost	$450,000 to $2,900,000
4.	Estimated Phosphorus Reduction	12 to 26 lbs/year

Task C-6. Redevelopment within the Crystal Lake watershed

There are only a few small parcels in the Crystal Lake watershed that have not yet been developed. Redevelopment will provide the opportunity to incorporate better stormwater management and improve water quality, although no major redevelopment within the watershed is expected in the near future. The Cities of Burnsville and Lakeville currently have stormwater rules and standards in place for redevelopment activities, which will require treatment and therefore provide loading reductions from the redeveloped areas.

1.	Responsible Party	Lakeville, Burnsville, MnDOT, Dakota County
2.	Timeline	As Opportunity Arises
3.	Estimated Capital Cost	TBD

Task C-7. Promote the installation of native shoreline buffers along the lakeshore.

Crystal Lake has nearly 5.3 miles of shoreline. Because nearly the entire shoreline of Crystal Lake is private, residential development, the cities may consider targeting educational efforts about the importance of shoreline buffers and encourage shoreline restoration towards shoreline property owners. Additionally, the cities may consider developing shoreline management programs that can assist property owners with the creation of native shorelines along Crystal Lake.

1.	Responsible Party	Lakeville, Burnsville
2.	Timeline	Ongoing
3.	Estimated Capital Cost	$110,000 to $420,000

Task C-8. Continue to implement public education and outreach programs.

Because the MS4s within the watershed are currently permitted, they are required to develop public education and outreach programs as part of their SWPPPs. However, the MS4s should continue to look for opportunities to expand the existing education and outreach programs specific to nutrient reduction and management.

1.	Responsible Party	Lakeville, Burnsville, MnDOT, Dakota County
2.	Timeline	Ongoing
3.	Estimated Capital Cost	Annual Cost

3.3.1.1 Summary of External Phosphorus Source Reduction Tasks

Total cost for all external source phosphorus reduction tasks: \$560,000 to \$3,320,000.
The expected external source phosphorus reduction for the tasks outlined above: 13 to 27 lbs/yr, achieving more than the required reduction.

3.3.2 Internal Sources—Reduction Goal of 369 Pounds of Phosphorus Annually

There are several potential management strategies to control internal sources of phosphorus loading. Initially, macrophyte management of the invasive, nuisance species Curlyleaf pondweed should be conducted, reducing the internal phosphorus loading caused by this macrophyte. The reduction of Curlyleaf pondweed is needed for the successful application of aluminum sulfate (alum) to control the release of phosphorus from the lake-bottom sediments.

The following tasks describe activities that can be used to achieve the load reductions defined in the *TMDL Report*.

Task C-9. Reduction in TP load from Keller Lake

Keller Lake is located immediately upstream of Crystal Lake and is identified as a source of phosphorus to Crystal Lake. As part of the development of the *TMDL Report*, a load allocation was established for Keller Lake, resulting in a required reduction in the phosphorus load discharging from Keller Lake to Crystal Lake. The restorative measures identified for Keller Lake can be found in Section 3.4 of this *Implementation Plan* as well as Table 3-3. However, in terms of the phasing of implementation items, many of the restorative actions in Keller Lake should be implemented prior to the implementation of the internal phosphorus restorative measures in Crystal Lake. This will help reduce the external sediment loads to Crystal Lake from Keller Lake and increase the longevity of the treatments, most specifically the proposed alum treatment.

1.	Timeline	Phase I and Phase II

Task C-10. Macrophyte management to control Curlyleaf pondweed – 15% of Littoral Area

Curlyleaf pondweed has been identified as a significant source of phosphorous to Crystal Lake. The current MDNR aquatic plant management permit only allows for the treatment of up to 15% of a lake's littoral area without a special variance. Although this sort of treatment can reduce the coverage of Curlyleaf pondweed during any given year, this treatment may not control the growth or spread of Curlyleaf pondweed as it would likely not reduce the turion seedbank in the sediments. As a result, this treatment will need to be performed annually for an extended period of time.

1. Responsible Party	BDWMO & Member Cities
2. Timeline	Phase I
3. Estimated Capital Cost	\$41,000 to \$61,000
4. Estimated Phosphorus Reduction	25 lbs/year

Task C-11. Macrophyte management to control Curlyleaf pondweed – Whole Lake

Curlyleaf pondweed has been identified as a significant source of phosphorous to Crystal Lake. Controlling and reducing the growth and spread of Curlyleaf pondweed within a lake system will require intensive management efforts. The proposed Curlyleaf pondweed management plan includes the 5-year whole lake herbicide treatment to reduce this macrophyte to manageable levels. Because Eurasian watermilfoil is also present in Crystal Lake, it is recommended that this macrophyte be managed concurrently with Curlyleaf pondweed. Curlyleaf pondweed treatment may potentially fall under an NPDES permit in the near future.

1. Timeline	Reserve
2. Estimated Capital Cost	\$710,000 to \$1,070,000
3. Estimated Phosphorus Reduction	169 lbs/year

Task C-12. Inactivation of Sediment Phosphorus

The alum dosing estimate for Crystal Lake is based on lake sediment core analyses completed in 2008. A permit is currently not required for the application of alum in lakes; however, prior to the first application, the expected alum dosing and management plan should be submitted to the MPCA for review. However, alum treatment may potentially fall under an NPDES permit in the near future.

The alum dosing is included in Phase II to provide opportunity to reduce watershed loads to Crystal Lake. This would also provide time to begin implementing restorative measures to improve the water quality in Keller Lake prior to alum treatment in Crystal Lake.

1. Timeline Phase II
2. Estimated Capital Cost $500,000 to $700,000
3. Estimated Phosphorus Reduction 574 lbs/year

Task C-13. Fisheries Study of Crystal Lake

The most recent (2005) MDNR fishery survey does not indicate carp were present. Therefore, it appears that the fisheries currently do not have a negative impact on the water quality in Crystal Lake. If significant shifts in the fishery are observed during the completion of the next MDNR fishery survey, additional studies may be needed to better understand the fishery, its impact on water quality, and develop a management plan.

1. Timeline Reserve
2. Estimated Capital Cost $50,000 to $200,000

Task C-14. Conduct phytoplankton and zooplankton surveys

Because phytoplankton and zooplankton form the base of the food web in lake systems, phytoplankton and zooplankton surveys should be completed in conjunction with the fishery study. Surveys of phytoplankton and zooplankton have not recently been completed in Crystal Lake.

1. Timeline Reserve
2. Estimated Capital Cost $5,000

3.3.2.1 Summary of Internal Phosphorus Source Reduction Tasks

Total cost for all internal source phosphorus reduction tasks: $596,000 to $1,975,000.
The expected internal source phosphorus reduction for the tasks outlined above: 608 to 743 lbs/yr, achieving more than the required reduction.

3.3.3 Overall Cost Estimate and Phosphorus Reduction for Implementation

The expected cost of implementing the recommendations in this *Implementation Plan* including tasks that address both external and internal source phosphorus reductions is $1,156,000 to $5,295,000. The expected phosphorus load reduction is estimated to be 621 to 770 lbs/yr, achieving the required reduction.

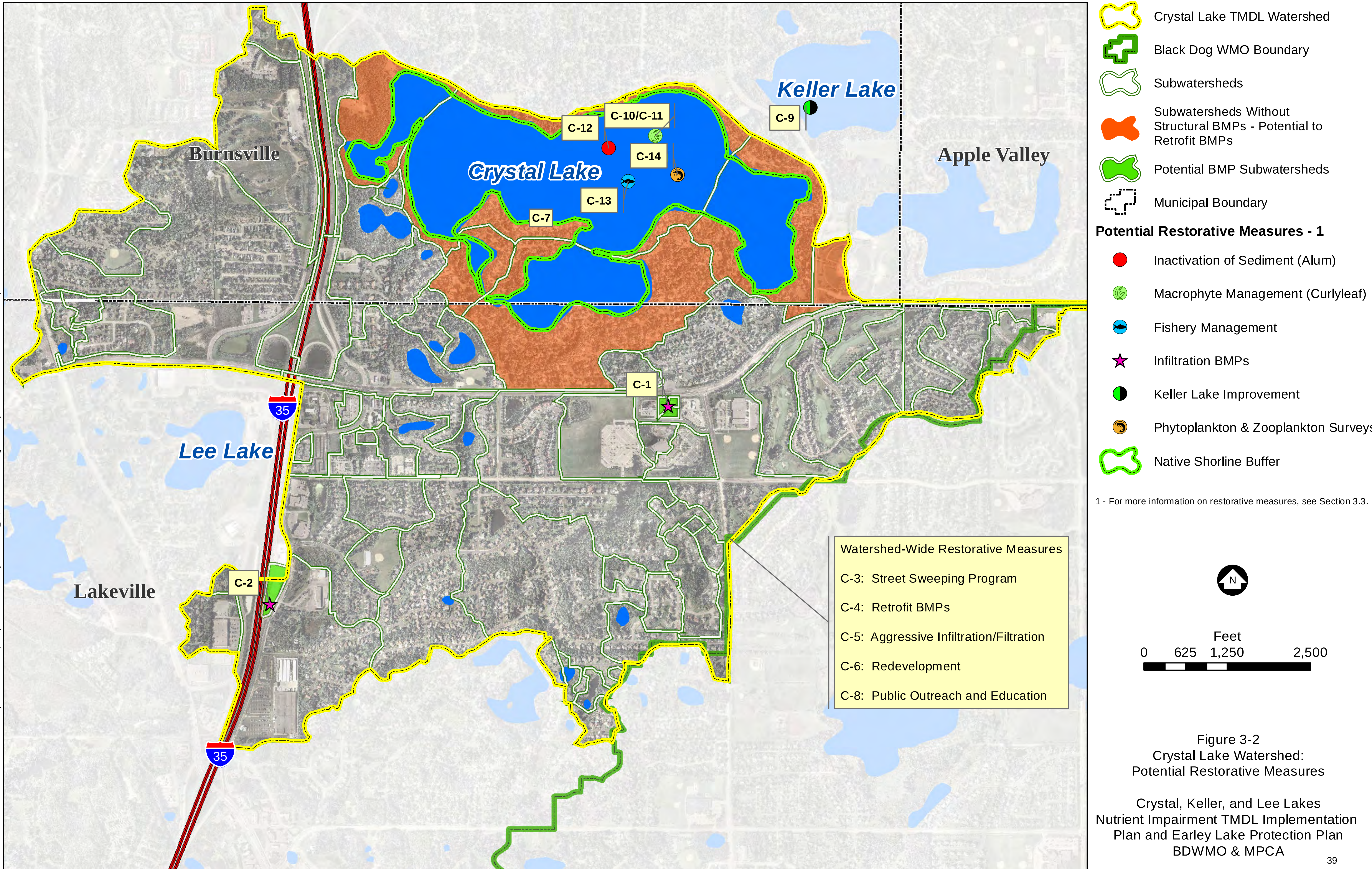


Figure 3-2
Crystal Lake Watershed:
Potential Restorative Measures

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation
Plan and Earley Lake Protection Plan
BDWMO & MPCA

Table 3-2 Summary of Potential Restorative Measures for Crystal Lake

Potential Restorative Measures[7]	Timeline[5]	Responsible Party[4]	TP Reduction (lbs/yr)	Cost ($)[6]	Comments
Crystal Lake (Total Required Load Reduction = 381 lbs/yr)					
External Projects and Activities (WLA) (Total Required WLA Reduction = 12 lbs/yr)					
C-1: Primrose School of Lakeville Infiltration Basins (2009)	Completed	Lakeville	0.3	N/A	
C-2: I35 Transit Station Infiltration Basin (2009)	Completed	MnDOT	0.6	N/A	
C-3: Continued implementation of street sweeping program	Ongoing	Lakeville, Burnsville	N/A	Annual Cost[1]	
C-4: Retrofit BMPs	As Opportunity Arises	Lakeville, Burnsville, MnDOT, Dakota County	TBD[2]	TBD[2]	
C-5: Infiltration/Filtration (Treat 0.25" - 1.0" of Runoff from Impervious Surfaces within the portion of the watershed without structural BMPs)	As Opportunity Arises	Lakeville, Burnsville, MnDOT, Dakota County	12 to 26	$450,000 - $2,900,000	Assumes approximately 200 sq ft per raingarden (67 - 243 raingardens within currently untreated watershed)
C-6: Redevelopment within the Watershed	As Opportunity Arises	Lakeville, Burnsville, MnDOT, Dakota County	TBD[2]	TBD[2]	
C-7: Native Shoreline Buffers	Ongoing	Lakeville, Burnsville	N/A	$110,000 - $420,000	
C-8: Public Outreach & Education	Ongoing	Lakeville, Burnsville, MnDOT, Dakota County	N/A	Annual Cost[1]	
Total WLA Reduction / Total Cost			***13 to 27[3]***	***$560,000 - $3,320,000[3]***	
Internal Projects and Activities (LA) (Total Required LA Reduction = 369 lbs/yr)					
C-9: Reduction in TP load from Keller Lake	Phase I/II	See Table 3-3 for Responsible Parties	9	See Table 3-3 for the Summary of Potential Restorative Measures for Keller Lake	This is the estimated reduction required for discharges from Keller Lake, based on the load allocation established assuming existing water load discharge at the MPCA total phosphorus standard (60 ug/L) for shallow lakes.
C-10: Annual Macrophyte Management to control Curlyleaf Pondweed & Eurasian Watermilfoil - 15% of Littoral Area	Phase I	BDWMO & Member Cities	25	$41,000-$61,000	Annual treatment cost including the aquatic plant management permit, herbicide application, and monitoring including aquatic plant surveys. This will likely require ongoing annual treatments for an extended duration because this only addresses plant biomass, not the source of the plants (turions); Assumed to be 15% of the estimated reduction for whole lake Curlyleaf pondweed
C-11: Macrophyte Management to control Curlyleaf Pondweed & Eurasian Watermilfoil - Whole Lake - Treatment over a 5-year period	Reserve		169	$710,000 - $1,070,000	Total cost for 5-year treatment plan including the aquatic plant management permit, MDNR letter of variance, lake vegetation management plan, lakeshore resident permission, herbicide application, monitoring including aquatic plant surveys, biomass measurement, herbicide residual, and turion counting, and annual reporting - intended to control Curlyleaf pondweed and Eurasian watermilfoil to manageable levels; Assumed 80% reduction in the internal load due to Curlyleaf Pondweed
C-12: Inactivation of Sediment Phosphorus (alum treatment)	Phase II		574	$500,000 - $700,000	Assumes 2 alum applications to achieve full dosage
C-13: Fisheries study and management plan	Reserve		N/A	$50,000 - $200,000	Only needed if MDNR fishery surveys or resident observations indicate a significant increase in benthivorous fish
C-14: Conduct Phytoplankton and Zooplankton Surveys	Reserve		N/A	$5,000	
Total LA Reduction / Total Cost			***608 -743***	***$596,000 - $1,975,000***	
Total Reduction / Total Cost			***621 to 770[3]***	***$1,156,000 - $5,295,000[3]***	

1 - Annual cost reflects ongoing activities included in the MS4s SWPPPs and will continue into the future

2 - TBD - Actual phosphorus reductions and costs to be determined at the time of retrofit or redevelopment.

3 - Does not include the estimated phosphorus reductions or costs for potential retrofit or redevelopment opportunities

4 - Responsible Parties identified for Completed, Ongoing, As Opportunity Arises, and Phase I projects

5 - Timeline definitions: Completed - projects fully implemented after the start of the TMDL (2008); Ongoing - ongoing practices implemented as part of SWPPP; As Opportunities Arise - projects and activities as opportunities arise but specific projects or locations have not yet been identified; Phase I - first priority projects to be implemented in next permit cycle; Phase II - second priority projects to be implemented after Phase I, if additional reductions are necessary; Reserve - Projects to be implemented if lake does not meet MPCA water quality goals after Phases I & II

6 - The engineer's opinion of probable cost assumed the engineering and design at 10 percent and contingencies at 30 percent of the project total cost. The costs do not include any land acquisition, easement acquisition, or wetland mitigation costs, and also assume that contaminated soils will not be encountered during excavation and construction. More detailed information on cost can be found in Appendix A.

7 - The restorative actions included in this Implementation Plan are examples of the types of projects that could be implemented by the various MS4s to achieve the required phosphorus reductions. The actual projects that will be implemented by the MS4s may vary from those included in this implementation plan.

3.4 Keller Lake Annual Load Reductions

The TMDL *Implementation Plan* focuses on reducing both external, watershed sources of phosphorus and internal, in-lake sources of phosphorus. Annual phosphorus reductions of 220 pounds (52%) from external loading and 230 pounds (77%) from internal loading sources are required to achieve the required TMDL standard of 60 µg/L for shallow lakes (including a 10 percent MOS). Total phosphorus load reduction (both external and internal) to Keller Lake will decrease overall loading by 450 pounds, or 62.2 percent annually in order to achieve the overall TMDL load capacity of 272 lbs.

3.4.1 External (Watershed) Sources-Reduction Goal of 220 Pounds Annually

Approximately half of the runoff from the Keller Lake watershed currently receives some form of water quality treatment (i.e. passes through a pond, wetland, or infiltration basin). However the remaining portion of the watershed was developed prior to current treatment requirements and therefore currently discharges to the lake without any structural BMP treatment. As a result, the expected reduction from the external sources of phosphorus to the lake is relatively significant. The areas within the Keller Lake watershed that currently do not receive water quality treatment with structural BMPs are shown on Figure 3-1. The potential restorative measures for Keller Lake are summarized in Table 3-3 and in Figure 3-3.

The following tasks describe activities that can be used to achieve the wasteload reductions defined in the *TMDL Report*.

Task K-1. Construction of Whitney Pond in Lac Lavon Park

Whitney Pond is a regional water quality treatment pond designed to NURP standards to treat a significant area that is currently not treated by structural BMPs in the Keller Lake watershed. The proposed pond is located in Lac Lavon Park within the City of Burnsville but will be primarily treating stormwater runoff from the City of Apple Valley. The proposed pond would have a surface area of about 1.5 acres and a water quality volume of 4.5 acre-ft. The size of the pond as currently proposed by the City of Apple Valley is based on an agreement between the Cities of Apple Valley and Burnsville. Construction of Whitney Pond is expected to begin in the near future.

1. Responsible Party	Apple Valley
2. Timeline	Phase I
3. Estimated Capital Cost	\$800,000 to \$1,200,000
4. Estimated Phosphorus Reduction	48 lbs/year

Task K-2. Construction of a water quality treatment pond in Crystal Beach Park

This pond would act as a regional water quality treatment pond designed to NURP standards to treat a significant area that does not receive treatment by structural BMPs in the Keller Lake watershed. This BMP would be treating runoff primarily from the City of Burnsville and the proposed pond is located in Crystal Beach Park within the City of Burnsville. This project was originally recommended in the 2003 UAA.

1.	Responsible Party	Burnsville
2.	Timeline	Phase I
3.	Estimated Capital Cost	$650,000 to $980,000
4.	Estimated Phosphorus Reduction	26 lbs/year

Task K-3. Redevelopment of Cedar Avenue

The City of Apple Valley is in the process of redevelopment along Cedar Ave in the eastern portion of the Keller Lake watershed. This redevelopment will result in modifications to the area draining to the pond in WVR-43a, which will result in the redirection of stormwater flows and reducing the tributary area discharging to Keller Lake. This construction should be completed by the end of the 2011.

1.	Responsible Party	Apple Valley
2.	Timeline	Phase I
3.	Estimated Phosphorus Reduction	TBD

Task K-4. Construction of a water quality treatment pond on the southwest corner of Keller Lake to treat runoff from Lac Lavon Drive.

This proposed water quality treatment pond designed to NURP standards is located on the southwest side of Keller Lake and is expected to treat runoff from Lac Lavon Drive (City of Burnsville), which does not currently receive treatment by structural BMPs. There are two potential locations for this water quality treatment pond including Lac Lavon Park near the existing stormwater discharge location or on a small parcel owned by the City of Burnsville located northwest of the intersection of Lac Lavon Drive and Crystal Lake Road. Construction of the pond within Lac Lavon Park may require wetland mitigation. The location of a sanitary lift station on the parcel owned by the City of Burnsville may limit the size of the proposed pond. Each location would need to be further investigated before final design.

1.	Timeline	Phase II
2.	Estimated Capital Cost	$260,000 to $390,000
3.	Estimated Phosphorus Reduction	11 lbs/year

Task K-5. Continued implementation of street sweeping in the Keller Lake watershed

The Cities of Apple Valley and Burnsville currently implement street-sweeping programs to help reduce phosphorus loads to the water bodies within each City. The City of Apple Valley sweeps streets twice annually and on an "as needed" basis. The City of Burnsville street sweeping program includes sweeping the entire city in the spring, targeted sweeping throughout the summer in areas around protected waters, and a final sweeping in the fall as weather permits.

Both cities should continue to implement their street sweeping programs, targeting any future expansion of the street sweeping programs in areas where stormwater runoff currently receives little or no water quality treatment before discharging into Keller Lake. Additionally, improved street sweeping technologies and techniques should be incorporated into the street sweeping programs as they are developed.

1.	Responsible Party	Burnsville, Apple Valley
2.	Timeline	Ongoing
3.	Estimated Capital Cost	Annual Cost

Task K-6. Retrofit BMPs within the untreated portions of the Keller Lake watershed

There are several areas in the Keller Lake watershed that currently receive little or no treatment before discharging to the lake (see Figure 3-1). Retrofitting BMPs within the Keller Lake watershed as opportunities arise could have a significant impact on phosphorus load reductions to Keller Lake. Again, focus of these efforts should first be placed on areas currently not treated by structural BMPs within the watershed. Retrofit BMPs could include any of a variety of practices including water quality treatment ponds, infiltration practices, filtration systems including iron-enhanced filtration, hydrodynamic devices, as well as underground storage and treatment systems.

1.	Responsible Party	Burnsville, Apple Valley, Dakota County
2.	Timeline	As Opportunity Arises
3.	Estimated Capital Cost	TBD

Task K-7. Implementation of infiltration/filtration within portions of the Keller Lake watershed without structural BMPs

The water balance models developed for Keller Lake as part of the TMDL study indicated that water levels in Keller Lake were significantly influenced by the operation of the ferric chloride treatment system in recent years (which pumped treated water from Crystal Lake to Keller Lake). During periods when the system is not operated, water levels in Keller Lake dropped, entirely changing the lake dynamics. Because the BDWMO had decided to cease operation of the system, there is concern that increasing infiltration of stormwater within the Keller Lake watershed will further reduce the water load to the lake, thus reducing Keller Lake water levels. It is unclear which direction the infiltrated water will travel, whether it will eventually reach Keller Lake or it will migrate outside of the watershed and away from Keller Lake.

Better understanding infiltration, the movement of infiltrated water within the watershed, and the overall impact on Keller Lake water levels and water quality, can better direct the watershed phosphorus reduction efforts, including the type and design of the treatment systems. This study will include the investigation of the surficial groundwater movement as well as develop an inventory of potential infiltration/filtration practices that could be implemented within the Keller Lake watershed.

Once the infiltration study is complete, implementation of an aggressive infiltration/filtration program within the areas of the Keller Lake watershed that currently are not treated by structural BMPs (infiltrating anywhere from 0.25 to 0.5 inches of runoff from impervious surfaces) as opportunities arise could have a significant impact on phosphorus load reductions to Keller Lake. Infiltration of 0.25 to 0.5 inches of runoff from impervious surfaces in these areas would result in required treatment volumes of 2.0 to 4.1 acre-feet, respectively.

1. Responsible Party	Burnsville, Apple Valley, Dakota County
2. Timeline	As Opportunity Arises
3. Estimated Capital Cost	$2,000,000 to $7,200,000
4. Estimated Phosphorus Reduction	61 to 95 lbs/year

Task K-8. Redevelopment within the Keller Lake watershed

There are no parcels within the Keller Lake watershed that have not yet been developed. Redevelopment will provide the opportunity to incorporate better stormwater management and improve water quality, although with the exception of redevelopment of Cedar Avenue and Whitney Drive, no major redevelopment within the watershed is expected in the near future. The Cities of Apple Valley and Burnsville currently have stormwater rules and standards in place for redevelopment activities, which will require treatment and therefore provide loading reductions from the redeveloped areas.

1.	Responsible Party	Burnsville, Apple Valley, Dakota County
2.	Timeline	As Opportunity Arises
3.	Estimated Capital Cost	TBD

Task K-9. Promote the installation of native shoreline buffers along the lakeshore.

Keller Lake has nearly 1.2 miles of shoreline. Because a significant portion of the Keller Lake shoreline is private, residential development, the cities may consider targeting educational efforts about the importance of shoreline buffers and encourage shoreline restoration towards shoreline property owners. Additionally, the cities may consider developing shoreline management programs that can assist property owners with the creation of native shorelines along Keller Lake.

1.	Responsible Party	Burnsville, Apple Valley
2.	Timeline	Ongoing
3.	Estimated Capital Cost	$26,000 to $96,000

Task K-10. Continue to implement public education and outreach programs.

Because the MS4s within the watershed are currently permitted, they are required to develop public education and outreach programs as part of their SWPPPs. However, the MS4s should continue to look for opportunities to expand the existing education and outreach programs specific to nutrient reduction and management.

1.	Responsible Party	Burnsville, Apple Valley, Dakota County
2.	Timeline	Ongoing
3.	Estimated Capital Cost	Annual Cost

Task K-11. Iron-enhanced sand filter retrofits to existing BMPs.

To enhance the phosphorus removal efficiency of existing BMPs and ponds, an iron-enhanced filter could be constructed to treat discharges from these systems or the systems could be modified to incorporate iron-enhanced filter media. These systems would remove additional soluble (non-settlable) phosphorus before reaching Keller Lake. Similar systems have had soluble phosphorus removal efficiencies ranging from 40 to 90 percent (City of Bellevue, WA, 1999; Erickson et al., 2006; Barr, 2009; Erickson et al., 2009). The size of the filter determines the allowable loading rate and ultimately the amount of phosphorus removal. The potential expected phosphorus reductions and associated costs for enhanced sand filters ranging from 0.25 acres to 0.75 acres were evaluated at up to three potential locations within the Keller Lake watershed, treating discharge from Redwood Pond, the pond in subwatershed A46a, and the potential pond in Crystal Beach Park. The locations evaluated were to estimate the potential phosphorus reductions and costs associated with the implementation of iron-enhanced filtration, although the actual implementation of iron enhanced sand filtration could be incorporated in a variety of locations throughout the watershed, not just those evaluated as part of this study. The low end of the range provided below reflects implementation of a single sand filtration system (with a filter area of 0.25 acres) while the upper range includes all three locations evaluated (with a filter area of 0.75 acres each).

1. Responsible Party	Burnsville, Apple Valley, Dakota County
2. Timeline	As Opportunities Arise
3. Estimated Capital Cost	$330,000 to $3,000,000
4. Estimated Phosphorus Reduction	9 to 49 lbs/year

3.4.1.1 Summary of External Phosphorus Source Reduction Tasks

Total cost for all external source phosphorus reduction tasks: $4,066,000 to $12,866,000.
The expected external source phosphorus reduction for the tasks outlined above: 155 to 229 lbs/yr, achieving more than the required reduction.

3.4.2 Internal Sources—Reduction Goal of 230 Pounds of Phosphorus Annually

There are several potential management strategies to control internal sources of phosphorus loading. Initially, macrophyte management of the invasive, non-native species Curlyleaf pondweed will be conducted, reducing the internal phosphorus loading caused by this macrophyte. The reduction of Curlyleaf pondweed is needed for the successful application of aluminum sulfate (alum) to control the release of phosphorus from the lake bottom sediments.

The following tasks describe activities that can be used to achieve the load reductions defined in the *TMDL Report*.

Task K-12. Macrophyte Management to control Curlyleaf pondweed – 15% of Lake Area

Curlyleaf pondweed has been identified as a significant source of phosphorous to Crystal Lake. The current MDNR aquatic plant management permit only allows for the treatment of up to 15% of a lake's littoral area without a variance. Although this sort of treatment can reduce the coverage of Curlyleaf pondweed during any given year, this treatment does not control the growth or spread of

Curlyleaf pondweed as it does not reduce the turion seedbank in the sediments. As a result, this treatment will need to be performed annually for an extended period of time.

1. Responsible Party	BDWMO and Member Cities
2. Timeline	Phase I
3. Estimated Capital Cost	$29,000 - $44,000
4. Estimated Phosphorus Reduction	7 lbs/year

Task K-13. Macrophyte Management to control Curlyleaf pondweed – Whole Lake

Curlyleaf pondweed has been identified as a significant source of phosphorus to Keller Lake. Controlling and reducing the growth and spread of Curlyleaf pondweed within a lake system will require intensive management efforts. The proposed Curlyleaf pondweed management plan includes the 5-year whole lake herbicide treatment. Because Eurasian watermilfoil is also present in Keller Lake, it is recommended that this macrophyte be managed concurrently with Curlyleaf pondweed. Curlyleaf pondweed treatment may potentially fall under an NPDES permit in the near future.

1. Timeline	Reserve
2. Estimated Capital Cost	$340,000 - $515,000
3. Estimated Phosphorus Reduction	43 lbs/year

Task K-14. Inactivation of Sediment Phosphorus

Both monitoring and modeling has indicated that phosphorus loading from the lake sediments is a significant source of phosphorus to Keller Lake. A multi-phased alum treatment of the lake bottom sediment will likely have a significant impact on lake water quality.

The alum dosing estimate for Keller Lake is based on lake sediment core analyses completed in 2008. A permit is currently not required for the application of alum in lakes; however, prior to the first application, the expected alum dosing and management plan should be submitted to the MPCA for review. However, alum treatment may potentially fall under an NPDES permit in the near future.

1. Timeline	Phase II
2. Estimated Capital Cost	$150,000 to $250,000
3. Estimated Phosphorus Reduction	186 lbs/year

Task K-15. Fisheries Study for Keller Lake

The most recent (1985) MDNR fishery survey did not indicate carp were present. Therefore, it appears that the fisheries currently do not have a negative impact on the water quality in Keller Lake.

If significant shifts in the fishery are observed during the completion of the next MDNR fishery survey, additional studies may be needed to better understand the fishery, its impact on water quality, and develop a management plan.

1. Timeline — Reserve
2. Estimated Capital Cost — $50,000 to $200,000

Task K-16. Conduct phytoplankton and zooplankton surveys

Because phytoplankton and zooplankton form the base of the food web in lake systems, phytoplankton and zooplankton surveys should be completed in conjunction with the fishery study. Surveys of phytoplankton and zooplankton have not recently been completed in Keller Lake.

1. Timeline — Reserve
2. Estimated Capital Cost — $5,000

3.4.2.1 Summary of Internal Phosphorus Source Reduction Tasks

Total cost for all internal source phosphorus reduction tasks: $234,000 to $1,014,000.

The expected internal source phosphorus reduction for the tasks outlined above: 193 to 229 lbs/yr.

3.4.3 Overall Cost Estimate and Phosphorus Reduction for Implementation

The expected cost of implementing the recommendations in this *Implementation Plan*, including tasks that address both external and internal source phosphorus reductions is $4,300,000 to $13,880,000. The expected phosphorus load reduction is estimated to be 348 to 458 lbs/year, which would achieve more than the required reduction.

Table 3-3 Summary of Potential Restorative Measures for Keller Lake

Potential Restorative Measures[7]	Timeline[5]	Responsible Party[4]	TP Reduction (lbs/yr)	Cost ($)[6]	Comments
Keller Lake (Total Required Load Reduction = 450 lbs/yr)					
External Projects and Activities (WLA) (Total Required WLA Reduction = 220 lbs/yr)					
K-1: Construction of Whitney Pond in Lac Lavon Park (current design)	Phase I	Apple Valley	48	$800,000 - $1,200,000	Assumes 4.46 acre-ft of water quality treatment volume
K-2: Construction of water quality pond in Crystal Beach Park (UAA design)	Phase I	Burnsville	26	$650,000 - $980,000	Assumes 4.8 acre-ft of water quality treatment volume
K-3: Redevelopement of Cedar Avenue	Phase I	Apple Valley	TBD[2]	TBD[2]	Construction to be complete in 2011
K-4: Water quality pond on southwest side of Keller Lake	Phase II		11	$260,000 - $390,000	Assumes 0.95 acre-ft of water quality treatment volume
K-5: Continued implementation of street sweeping program	Ongoing	Burnsville, Apple Valley	N/A	Annual Cost[1]	
K-6: Retrofit BMPs	As Opportunity Arises	Burnsville, Apple Valley, Dakota County	TBD[2]	TBD[2]	
K-7: Infiltration/Filtration (Treat 0.25" - 0.5" of Runoff from Impervious Surfaces within the portion of the watershed without structural BMPs)	As Opportunity Arises	Burnsville, Apple Valley, Dakota County	61 to 95	$2,000,000 - $7,200,000	Assumes approximately 200 sq ft per raingarden (288 - 598 raingardens within currently untreated watershed)
K-8: Redevelopment within the Watershed	As Opportunity Arises	Burnsville, Apple Valley, Dakota County	TBD[2]	TBD[2]	
K-9: Native Shoreline Buffers	Ongoing	Burnsville, Apple Valley	N/A	$26,000 - $96,000	
K-10: Public Outreach & Education	Ongoing	Burnsville, Apple Valley, Dakota County	N/A	Annual Cost[1]	
K-11: Iron-enhanced sand filter retrofits to existing BMPs	As Opportunity Arises	Burnsville, Apple Valley, Dakota County	9 to 49	$330,000 - $3,000,000	Assumed to treat outflow from one to three stormwater ponds in Keller Lake watershed (Redwood Pond, Pond in SWS A6a, (proposed) Crystal Beach Park Pond) to establish range of expected phosphorus reduction and costs. Actual locations to be determined. Assumes 70% removal of phosphorus in treated flows, including soluble phosphorus.
Total WLA Reduction / Total Cost			***155 to 229[3]***	***$4,066,000 - $12,866,000[3]***	
Internal Projects and Activities (LA) (Total Required LA Reduction = 230 lbs/yr)					
K-12: Annual Macrophyte Management to control Curlyleaf Pondweed & Eurasian Watermilfoil - 15% of Littoral Area	Phase I	BDWMO & Member Cities	7	$29,000 - $44,000	Annual treatment cost including the aquatic plant management permit, herbicide application, and monitoring including aquatic plant surveys. This will likely require ongoing annual treatments for an extended duration because this only addresses plant biomass, not the source of the plants (turions); Assumed to be 15% of the estimated reduction for whole lake Curlyleaf pondweed treatment.
K-13: Macrophyte Management to control Curlyleaf Pondweed & Eurasian Watermilfoil - Whole Lake - Treatment over 5-year period	Reserve		43	$340,000 - $515,000	Total cost for 5-year treatment plan including the aquatic plant management permit, MDNR letter of variance, lake vegetation management plan, lakeshore resident permission, herbicide application, monitoring including aquatic plant surveys, biomass measurement, herbicide residual, and turion counting, and annual reporting - intended to control Curlyleaf pondweed and Eurasian watermilfoil to manageable levels; Assumed 80% reduction in the internal load due to Curlyleaf Pondweed
K-14: Inactivation of Sediment Phosphorus (alum treatment)	Phase II		186	$150,000 - $250,000	Assumes 5 alum applications to achieve full dosage
K-15: Fisheries study and management plan	Reserve		N/A	$50,000 - $200,000	Only needed if MDNR fishery surveys or resident observations indicate a significant increase in benthivorous fish
K-16: Conduct Phytoplankton and Zooplankton Surveys	Reserve		N/A	$5,000	
Total LA Reduction / Total Cost			***236***	***$234,000 - $1,014,000***	
Total Reduction / Total Cost			***391 to 465[3]***	***$4,300,000 - $13,880,000[3]***	

1 - Annual cost reflects ongoing activities included in the MS4s SWPPPs and will continue into the future

2 - TBD - Actual phosphorus reductions and costs to be determined at the time of retrofit or redevelopment.

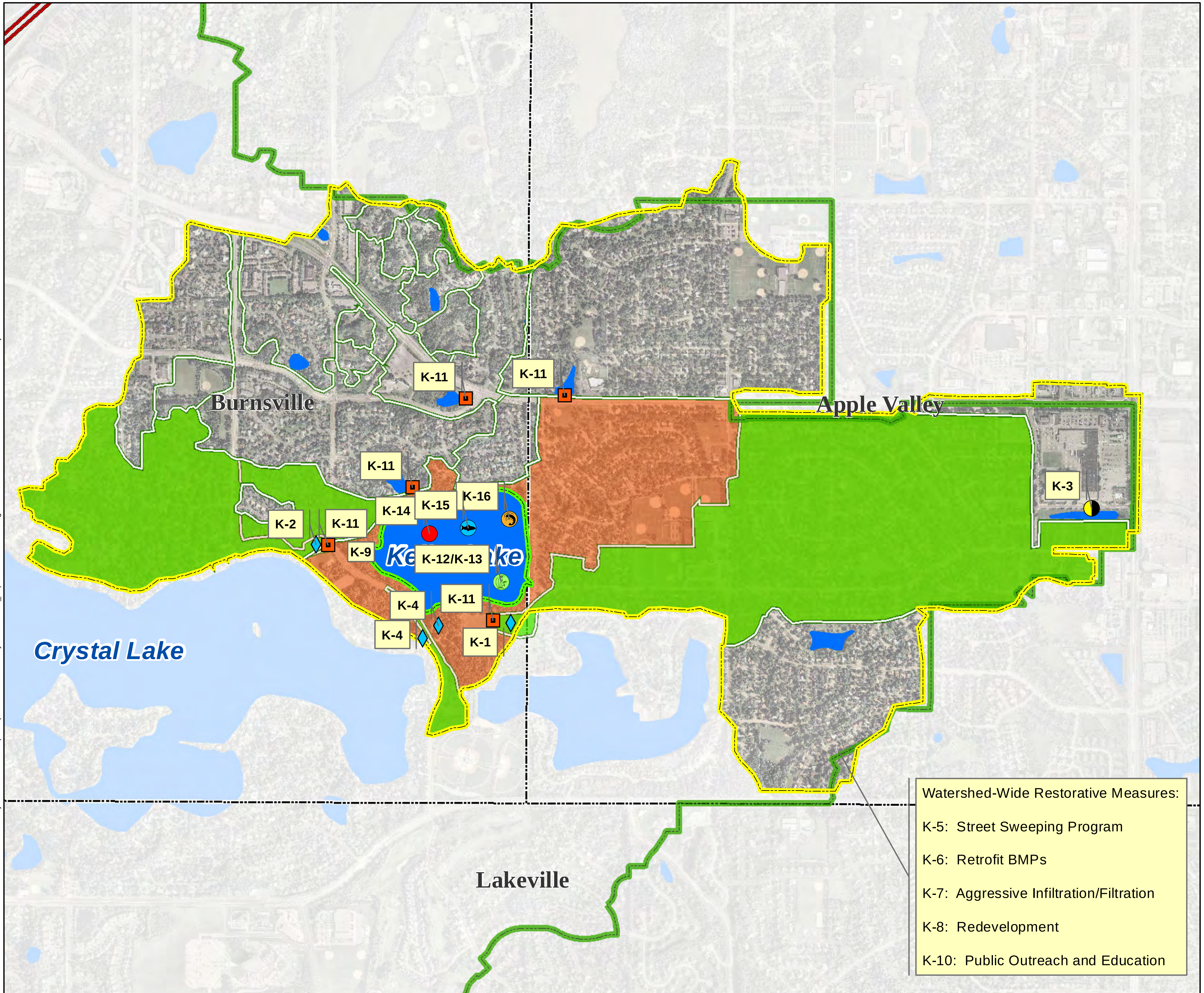
3 - Does not include the estimated phosphorus reductions or costs for potential retrofit or redevelopment opportunities

4 - Responsible Parties identified for Completed, Ongoing, As Opportunity Arises, and Phase I projects

5 - Timeline definitions: Completed - projects fully implemented after the start of the TMDL (2008); Ongoing - ongoing practices implemented as part of SWPPP; As Opportunities Arise - projects and activities as opportunities arise but specific projects or locations have not yet been identified; Phase I - first priority projects to be implemented in next permit cycle; Phase II - second priority projects to be implemented after Phase I, if additional reductions are necessary; Reserve - Projects to be implemented if lake does not meet MPCA water quality goals after Phases I & II

6 - The engineer's opinion of probable cost assumed the engineering and design at 10 percent and contingencies at 30 percent of the project total cost. The costs do not include any land acquisition, easement acquisition, or wetland mitigation costs, and also assume that contaminated soils will not be encountered during excavation and construction. More detailed information on cost can be found in Appendix A.

7 - The restorative actions included in this Implementation Plan are examples of the types of projects that could be implemented by the various MS4s to achieve the required phosphorus reductions. The actual projects that will be implemented by the MS4s may vary from those included in this implementation plan.



Keller Lake TMDL Watershed
Black Dog WMO Boundary
Subwatersheds
Potential BMP Subwatersheds
Municipal Boundary
Subwatersheds Without Structural BMPs - Potential to Retrofit BMPs

Potential Restorative Measures-1

Inactivation of Sediment (Alum)
Macrophyte Management (Curlyleaf)
FeCl3
Fishery Management
Infiltration BMPs
Iron Enhanced Sand Filter - 2
NURP Pond
Phytoplankton & Zooplankton Surveys
Redevelopment - Change in Watershed
Native Shoreline Buffer

1 - For more information on restorative measures, see Section 3.4.
2 - Actual locations for implementation subject to change based on retrofit opportunities

N

Feet
0 625 1,250 2,500

Figure 3-3
Keller Lake Watershed:
Potential Restorative Measures

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

Barr Footer: Date: 6/14/2010 10:59:00 AM File: I:\Projects\23\19\A79\Maps\Reports\TMDL February 2010\TMDL_ImplementationPlan\Figure 3-3 Keller Lake Watershed BMPs.mxd User: jak2

3.5 Lee Lake Annual Load Reductions

The TMDL *Implementation Plan* focuses on reducing both external, watershed sources of phosphorus and internal, in-lake sources of phosphorus. Annual phosphorus reductions of 20 pounds (31%) from external loading and 40 pounds (51%) from internal loading sources are required to achieve the required TMDL standard of 60 µg/L for shallow lakes (including a 10 percent MOS). Total phosphorus load reduction (both external and internal) to Lee Lake will decrease overall loading by 60 pounds, or 42 percent annually (Table 5-3) in order to achieve the overall TMDL load capacity of 84 lbs.

3.5.1 External (Watershed) Sources-Reduction Goal of 20 Pounds Annually

Approximately half of the runoff from the Lee Lake watershed currently receives some form of water quality treatment (i.e. passes through a pond, wetland, or infiltration basin). However, the remaining portion of the watershed currently discharges to the lake without any structural BMP treatment. As a result, the expected reduction from the external sources of phosphorus to the lake is relatively significant. The areas within the Lee Lake watershed that currently do not receive water quality treatment are shown on Figure 3-1. The potential restorative measures for Lee Lake are summarized in Table 3-4 and in Figure 3-4.

The following tasks describe activities that can be used to achieve the wasteload reductions defined in the *TMDL Report*. Additionally in 2009 and 2010, the City of Lakeville has performed some shoreline restoration and constructed a raingarden as part of its Blue Thumb projects.

Task L-1. I-35 Transit Station infiltration basin

Infiltration basins were incorporated as part of the 2009 addition of the bus transit lanes and modifications to the existing park and ride area located east of Interstate Highway I-35 in Lakeville. Although originally constructed by MnDOT in its former right of way, ownership of the transit station and pond is planned to be transferred to the Metropolitan Council. Discharge from this basin flows into MnDOT's drainage system before discharging to Lee Lake.

1. Responsible Party — MnDOT
2. Timeline — Completed 2009
3. Estimated Phosphorus Reduction — 3 lbs/year

Task L-2. Water Quality Pond as part of Redevelopment of former landscaping site (CL-12a-4)

The parcel in subwatershed CL-12a-4 was recently sold and redevelopment of the site will occur in the future. The City of Lakeville's current redevelopment standards will apply at that time and will include, at a minimum, water quality treatment to NURP standards.

1.	Timeline	Phase II
2.	Estimated Capital Cost	\$85,000 to \$125,000
3.	Estimated Phosphorus Reduction	6 lbs/year

Task L-3. Continued implementation of street sweeping in the Lee Lake watershed

The City of Lakeville currently implements a street-sweeping program to help reduce phosphorus loads to the water bodies within the city. In Lakeville, the city sweeps streets twice annually.

Lakeville should continue their street sweeping program, targeting any future expansion of the street sweeping program in areas where stormwater runoff currently receives little or no water quality treatment before discharging into Lee Lake. Additionally, improved street sweeping technologies should be incorporated into the street sweeping program.

1.	Responsible Party	Lakeville
2.	Timeline	Ongoing
3.	Estimated Capital Cost	Annual Cost

Task L-4. Retrofit BMPs within the untreated portions of the Lee Lake watershed

There are several areas in the Lee Lake watershed that currently receive little or no treatment by structural BMPs before discharging to the lake (see Figure 3-1). Retrofitting BMPs within the Lee Lake watershed as opportunities arise could have a significant impact on phosphorus load reductions to Lee Lake. Again, focus of these efforts should first be placed on portions of the watershed that are not treated by structural BMPs. Retrofit BMPs could include any of a variety of practices including water quality treatment ponds, infiltration practices, filtration systems, hydrodynamic devices, as well as underground storage and treatment systems.

1.	Responsible Party	Lakeville, MnDOT, Dakota County
2.	Timeline	As Opportunity Arises
3.	Estimated Capital Cost	TBD

Task L-5. Implementation of infiltration/filtration within the untreated portions of the Lee Lake watershed

Implementation of an aggressive infiltration/filtration program within the areas of the Lee Lake watershed that do not receive treatment by structural BMPs (infiltrating anywhere from 0.25 to 1.0 inches of runoff from impervious surfaces) as opportunities arise could have a significant impact on phosphorus load reductions to Lee Lake. Infiltration of 0.25 to 1.0 inches of runoff from impervious surfaces in these areas would results in required treatment volumes of 0.2 to 1.0 acre-feet, respectively.

1. Responsible Party	Lakeville, MnDOT, Dakota County
2. Timeline	As Opportunity Arises
3. Estimated Capital Cost	$230,000 to $1,700,000
4. Estimated Phosphorus Reduction	7 to 16 lbs/year

Task L-6. Redevelopment within the Lee Lake watershed

There are only a few small parcels within the Lee Lake watershed that have not yet been developed. Redevelopment will provide the opportunity to incorporate better stormwater management and improve water quality. With the exception of the former landscaping business site (see Task L-2 above), no major redevelopment within the watershed is expected in the near future. However, the City of Lakeville currently has stormwater rules and standards in place for redevelopment activities when they occur. The implementation of the redevelopment ordinances may result in phosphorus load reductions that can be applied to the required load reduction.

1. Responsible Party	Lakeville, MnDOT, Dakota County
2. Timeline	As Opportunity Arises
3. Estimated Capital Cost	TBD

Task L-7. Promote the installation of native shoreline buffers along the lakeshore

Lee Lake has nearly 1.2 miles of shoreline. Because nearly the entire shoreline of Lee Lake is private, residential development, the City of Lakeville may consider targeting educational efforts about the importance of shoreline buffers and encourage shoreline restoration towards shoreline property owners. Additionally, the City may consider developing shoreline management programs that can assist property owners with the creation of native shorelines along Lee Lake.

1. Responsible Party	Lakeville
2. Timeline	Ongoing
3. Estimated Capital Cost	$25,000 to $94,000

Task L-8. Continue to implement public education and outreach programs.

Public education and outreach programs are directed efforts educating the public about urban nonpoint source pollution and at changing the behavior of property owners that can help reduce the nonpoint source pollution associated with activities such as lawn and garden care, car care, and disposal of yard wastes. Because the MS4s within the watershed are currently permitted, they are required to develop public education and outreach programs as part of their SWPPPs. However, the MS4s should continue to look for opportunities to expand the existing education and outreach programs specific to nutrient reduction and management.

1. Responsible Party	Lakeville, MnDOT, Dakota County
2. Timeline	Ongoing
3. Estimated Capital Cost	Annual Cost

Task L-9. Infiltration basin in the neighborhood park on the southside of Lee Lake

The majority of the untreated portion of the Lee Lake watershed is located on the southside of the lake. There is a small neighborhood park owned by the City of Lakeville that is located off of Lower 167th Street that provides some open space to incorporate a small infiltration basin. This basin could be designed to treat local surface runoff from Lower 167th Street and the adjacent homes before reconnecting with the existing storm sewer system.

1. Timeline	Reserve
2. Estimated Capital Cost	\$100,000 to \$145,000
3. Estimated Phosphorus Reduction	2 lbs/yr

3.5.1.1 Summary of External Phosphorus Source Reduction Tasks

Total cost for all external source phosphorus reduction tasks: \$440,000 to \$2,064,000.
The expected external source phosphorus reduction for the tasks outlined above: 18 to 27 lbs/yr, achieving more than the required reduction.

3.5.2 Internal Sources—Reduction Goal of 40 Pounds of Phosphorus Annually

There are several potential management strategies to control internal sources of phosphorus loading. Initially, macrophyte management of the invasive, non-native species Curlyleaf pondweed should be conducted, reducing the internal phosphorus loading caused by this macrophyte. The reduction of Curlyleaf pondweed will improve the proposed application of aluminum sulfate (alum) to control the release of phosphorus from the lake bottom sediments. Additionally, since 2002, the City of Lakeville has removed 121 lbs of bluegill and bullheads from Lee Lake.

The following tasks describe activities that can be used to achieve the load reductions defined in the *TMDL Report*.

Task L-10. Inactivation of Sediment Phosphorus (2009)

In 2009, the City of Lakeville performed an alum treatment of Lee Lake, applying approximately 15% of the estimated alum dose based on the results of the lake sediment core analyses completed in 2008. The estimated load reduction was based on removal of 15% of the internal load from the sediments for the average (critical) climatic conditions.

1. Responsible Party	Lakeville
2. Timeline	Completed in 2009
3. Estimated Phosphorus Reduction	8 lbs/year

Task L-11. Inactivation of Sediment Phosphorus – Remaining Dose

In 2009, the City of Lakeville performed an alum treatment of Lee Lake, applying approximately 15% of the estimated alum dose (see Task L-10). For maximum effectiveness and longevity of the alum application, Lee Lake should be treated with the remaining alum dose (85%). The alum dosing estimate for Lee Lake is based on lake sediment core analyses completed in 2008. Four alum treatments need to be phased appropriately to apply the remaining alum dose without impacting water pH levels. A permit is currently not required for the application of alum in lakes; however, prior to the first application, the expected alum dosing and management plan should be submitted to the MPCA for review. However, alum treatment may potentially fall under an NPDES permit in the near future.

1. Timeline	Reserve
2. Estimated Capital Cost	\$100,000 to \$150,000
3. Estimated Phosphorus Reduction	47 lbs/year

Task L-12. Macrophyte Management to control Curlyleaf pondweed

Curlyleaf pondweed has been identified as a significant source of phosphorous to Lee Lake. Controlling and reducing the growth and spread of Curlyleaf pondweed within a lake system will require intensive management efforts. The proposed Curlyleaf pondweed management plan includes the 5-year whole lake herbicide treatment. Curlyleaf pondweed treatment may potentially fall under an NPDES permit in the near future.

1. Timeline Reserve
2. Estimated Capital Cost $260,000 - $390,000
3. Estimated Phosphorus Reduction 8 lbs/year

Task L-13. Fisheries Study for Lee Lake

The most recent (1991) MDNR fishery survey did not indicate carp were present. Therefore, it appears that benthivorous fish currently do not have a negative impact on the water quality in Lee Lake. In recent years, high numbers of small planktivorous fish were observed in Lee Lake and significant numbers of these small fish were removed from the lake during the four years prior to the 2009 alum treatment. If significant shifts in the fishery are observed during the completion of the next MDNR fishery survey, additional studies may be needed to better understand the fishery, its impact on water quality, and a management plan will need to be developed.

1. Timeline Reserve
2. Estimated Capital Cost $50,000 to $200,000

Task L-14. Conduct phytoplankton and zooplankton surveys

Because phytoplankton and zooplankton form the base of the food web in lake systems, phytoplankton and zooplankton surveys should be completed in conjunction with the fishery study. Surveys of phytoplankton and zooplankton have not recently been completed in Lee Lake.

1. Timeline Reserve
2. Estimated Capital Cost $5,000

3.5.2.1 Summary of Internal Phosphorus Source Reduction Tasks

Total cost for all internal source phosphorus reduction tasks: $415,000 to $745,000.
The expected internal source phosphorus reduction for the tasks outlined above: 63 lbs/yr.

3.5.3 Overall Cost Estimate and Phosphorus Reduction for Implementation

The expected cost of implementing the recommendations in this *Implementation Plan*, including tasks that address both external and internal source phosphorus reductions is $855,000 to $2,809,000. The expected phosphorus load reduction is estimated to be 81 to 90 lbs/year, achieving more than the required reduction.

Table 3-4 Summary of Potential Restorative Measures for Lee Lake

Potential Restorative Measures[7]	Timeline[5]	Responsible Party[4]	TP Reduction (lbs/yr)	Cost ($)[6]	Comments
Lee Lake (Total Required Load Reduction = 60 lbs/yr)					
External Projects and Activities (WLA) (Total Required WLA Reduction = 20 lbs/yr)					
L-1: I35 Transit Station Infiltration Basin (2009)	Completed	MnDOT	3	N/A	
L-2: Water Quality Pond as part of redevelopment of former landscaping site (CL-12a-4)	Phase II		6	$85,000 - $125,000	Assumes 0.67 acre-ft of water quality treatment volume
L-3: Continued implementation of street sweeping program	Ongoing	Lakeville	N/A	Annual Cost[1]	
L-4: Retrofit BMPs	As Opportunity Arises	Lakeville, MnDOT, Dakota County	TBD[2]	TBD[2]	
L-5: Infiltration/Filtration (Treat 0.25" - 1.0" of Runoff from Impervious Surfaces within the portion of the watershed without structural BMPs)	As Opportunity Arises	Lakeville, MnDOT, Dakota County	7 to 16	$230,000 - $1,700,000	Assumes approximately 200 sq ft per raingarden (34 - 143 raingardens within currently untreated watershed)
L-6: Redevelopment within the Watershed	As Opportunity Arises	Lakeville, MnDOT, Dakota County	TBD[2]	TBD[2]	
L-7: Native Shoreline Buffers	Ongoing	Lakeville	N/A	$25,000 - $94,000	
L-8: Public Outreach & Education	Ongoing	Lakeville, MnDOT, Dakota County	N/A	Annual Cost[1]	
L-9: Infiltration basin in CL-12a-2a	Reserve		2	$100,000 - $145,000	Assumes 0.115 acre-ft of storage volume in basin
Total WLA Reduction / Total Cost			***18 to 27[3]***	***$440,000 - $2,064,000[3]***	
Internal Projects and Activities (LA) (Total Requiired LA Reduction = 40 lbs/yr)					
L-10: Inactivation of Sediment Phosphorus (2009 alum treatment)	Completed	Lakeville	8	N/A	Alum applied was 15% of estimated dosage
L-11: Inactivation of Sediment Phosphorus (alum treatment)	Reserve		47	$100,000 - $150,000	Assumes 4 alum applications to achieve full dosage
L-12: Macrophyte Management to control Curlyleaf Pondweed - Treatment over a 5-year period	Reserve		8	$260,000 - $390,000	5-year treatment plan including the aquatic plant management permit, MDNR letter of variance, lake vegetation management plan, lakeshore resident permission, herbicide application, monitoring including aquatic plant surveys, biomass measurement, herbicide residual, and turion counting, and annual reporting - intended to control Curlyleaf pondweed and Eurasian watermilfoil to manageable levels; Assumed 80% reduction in the internal load due to Curlyleaf Pondweed
L-13: Fisheries study and management plan	Reserve		N/A	$50,000 - $200,000	Only needed if MDNR fishery surveys or resident observations indicate a significant increase in benthivorous fish
L-14: Conduct Phytoplankton and Zooplankton Surveys	Reserve		N/A	$5,000	
Total LA Reduction / Total Cost			***63***	***$415,000 - $745,000***	
Total Reduction / Total Cost			***81 to 90[3]***	***$855,000 - $2,809,000[3]***	

1 - Annual cost reflects ongoing activities included in the MS4s SWPPPs and will continue into the future

2 - TBD - Actual phosphorus reductions and costs to be determined at the time of retrofit or redevelopment.

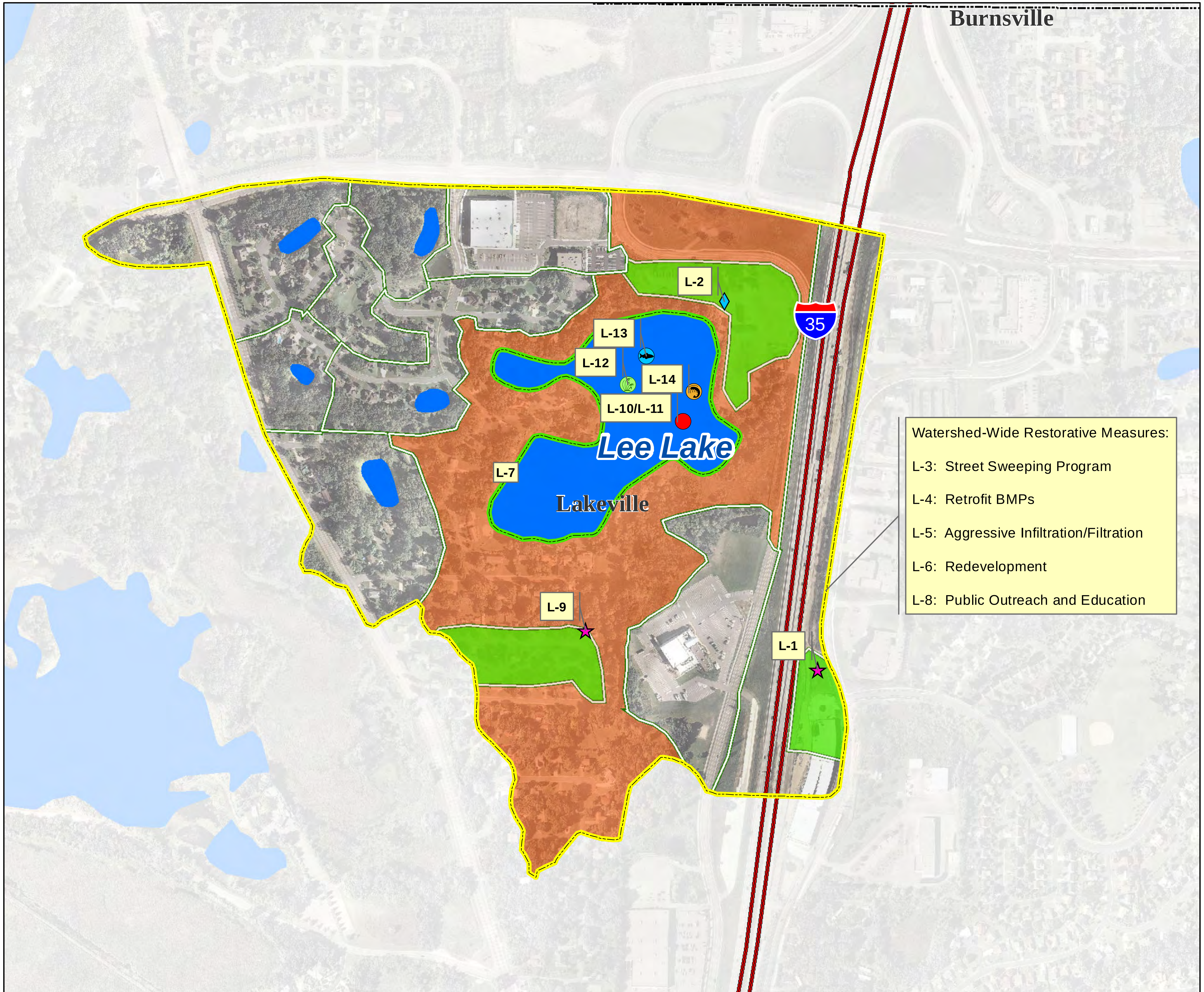
3 - Does not include the estimated phosphorus reductions or costs for potential retrofit or redevelopment opportunities

4 - Responsible Parties identified for Completed, Ongoing, As Opportunity Arises, and Phase I projects

5 - Timeline definitions: Completed - projects fully implemented after the start of the TMDL (2008); Ongoing - ongoing practices implemented as part of SWPPP; As Opportunities Arise - projects and activities as opportunities arise but specific projects or locations have not yet been identified; Phase I - first priority projects to be implemented in next permit cycle; Phase II - second priority projects to be implemented after Phase I, if additional reductions are necessary; Reserve - Projects to be implemented if lake does not meet MPCA water quality goals after Phases I & II

6 - The engineer's opinion of probable cost assumed the engineering and design at 10 percent and contingencies at 30 percent of the project total cost. The costs do not include any land acquisition, easement acquisition, or wetland mitigation costs, and also assume that contaminated soils will not be encountered during excavation and construction. More detailed information on cost can be found in Appendix A.

7 - The restorative actions included in this Implementation Plan are examples of the types of projects that could be implemented by the various MS4s to achieve the required phosphorus reductions. The actual projects that will be implemented by the MS4s may vary from those included in this implementation plan.



Lee Lake TMDL Watershed

Black Dog WMO Boundary

Subwatersheds

Potential BMP Subwatersheds

Subwatersheds Without Structural BMPs - Potential to Retrofit BMPs

Municipal Boundary

Potential Restorative Measures-1

Inactivation of Sediment (Alum)

Macrophyte Management (Curlyleaf)

Fishery Management

Infiltration BMPs

NURP Pond

Phytoplankton & Zooplankton Surveys

Native Shoreline Buffer

1 - For more information on restorative measures, see Section 3.5.

N

Feet

0 625 1,250

Figure 3-4
Lee Lake Watershed:
Potential Restorative Measures

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

Barr Footer: Date: 6/14/2010 11:03:12 AM File: I:\Projects\23\19\A79\Maps\Reports\TMDL February 2010\TMDL_ImplementationPlan\Figure 3-4 Lee Lake Watershed BMPs.mxd User: jak2

3.6 Earley Lake Protection Plan

Because Earley Lake currently is meeting the MPCA eutrophication standards, a TMDL load capacity was not developed for the lake and phosphorus reductions are not required. However, in 2007, the City of Burnsville completed a study that resulted in the development of a UAA for Twin and Earley Lakes. The UAA was entitled *Twin and Earley Lake Use Attainability Analysis Diagnostic-Feasibility Study: Water Quality Issues and Potential Restorative Measures* (Barr, 2007).

As part of that study, the sources of phosphorus to Earley Lake were quantified. The majority of phosphorus to Earley Lake is from runoff from its tributary watershed and from the outflow from North Twin Lake (located upstream from Earley Lake). Additionally, internal loading from Curlyleaf pondweed and release from sediments contributes a small portion of the phosphorus load to Earley Lake. The UAA identified several restorative measures for Earley Lake and its contributing watershed. The following section is a summary of the recommendations from the 2007 UAA that have not yet been implemented (see Table 3-5 and Figure 3-5).

Task E-1. Water Quality Pond in Subwatershed E-1B

This is a regional water quality pond designed to NURP criteria intended to treat primarily untreated flows from an entirely commercial drainage area within the Earley Lake watershed. The parcel was redeveloped and construction of a pond is expected to be complete in 2011.

1. Timeline — Phase I
2. Estimated Capital Cost — $2,050,000 to $3,010,000

Task E-2. Water Quality Pond Northwest of North Twin Lake (NT-1A and NT-1)

This is a proposed regional water quality pond designed to NURP criteria intended to treat primarily untreated flows to North Twin Lake from a drainage area that is primarily commercial and interstate highway usage. The parcel that this proposed pond would be located on is currently undeveloped, and it is expected that the pond would be constructed at the time development occurs.

1. Timeline — Reserve
2. Estimated Capital Cost — $2,250,000 to $3,360,000

Task E-3. Upgrade Existing Ponds to NURP Standards

Several of the detention basins in the Earley Lake watershed were constructed prior to the establishment of the NURP design criteria and the City of Burnsville's storm water quality treatment requirements. The phosphorus removal efficiencies of these ponds could be improved if the ponds were upgraded to meet the NURP criteria. These ponds should be upgraded to NURP standards as opportunities arise.

1.	Timeline	As Opportunities Arise
2.	Estimated Capital Cost	TBD

Task E-4. Retrofitting BMPs within the Earley Lake watershed focusing on infiltration

There are several areas in the Earley Lake watershed that currently receive little or no treatment by structural BMPs before discharging to the lake (see Figure 3-5). Retrofitting BMPs within the Early Lake watershed as opportunities arise could have a significant impact on phosphorus load reductions and the protection of water quality in Earley Lake. Retrofit BMPs could include any of a variety of practices including water quality treatment ponds, infiltration practices, filtration systems, hydrodynamic devices, as well as underground storage and treatment systems. Focus of these efforts should first be placed on portions of the watershed that are not treated by structural BMPs, with an emphasis on infiltration practices.

1.	Timeline	As Opportunities Arise
2.	Estimated Capital Cost	TBD

Task E-5. Curlyleaf Pondweed Management in South Twin and Earley Lakes

Curlyleaf pondweed was identified throughout Earley Lake in moderate to high densities. The invasive macrophyte Eurasian watermilfoil was also present. In South Twin Lake, both Curlyleaf pondweed and Eurasian watermilfoil have been present in some of the years surveyed. Mechanical harvesting of Curlyleaf pondweed and Eurasian watermilfoil was recommended in the early summer as well as again in mid to late summer. A permit from the MDNR is required for mechanical harvesting, which allows for up to 50 percent of the littoral area to be managed. Unlike herbicide treatments which can control some macrophytes (if applied as part of a long term management program), mechanical harvesting only provides temporary control and would have to occur annually.

1.	Timeline	Ongoing
2.	Estimated Capital Cost	$23,000 to $34,000/year

Table 3-5 Summary of Potential Protective Measures for Earley Lake

Potential Protective Measures	Timeline[2]	Cost ($)	Comments
Earley Lake			
External Projects and Activities			
E-1: Water Quality Pond in Subwatershed E-1B	Phase I	$2,050,000 - $3,010,000	Construction to be complete in 2011
E-2: Water Quality Pond Northwest of North Twin Lake	Reserve	$2,250,000 - $3,360,000	
E-3: Upgrade existing ponds to NURP standards	As Opportunity Arises	TBD[1]	
E-4: Retrofit BMPs focusing on Infiltration	As Opportunity Arises	TBD[1]	
Internal Projects and Activities			
E-5: Curlyleaf Pondweed Management in South Twin and Earley Lakes (mechanical harvesting)	Ongoing	$23,000 - $34,000	
Total Cost		***$4,323,000 - $6,370,000***	

1 - TBD - Actual costs to be determined

2 - Timeline definitions: Completed - projects fully implemented after the start of the TMDL (2008); Ongoing - ongoing practices implemented as part of SWPPP; As Opportunities Arise - projects and activities as opportunities arise but specific projects or locations have not yet been identified; Phase I - first priority projects to be implemented in next permit cycle; Phase II - second priority projects to be implemented after Phase I, if additional reductions are necessary; Reserve - Projects to be implemented if lake does not meet MPCA water quality goals after Phases I & II

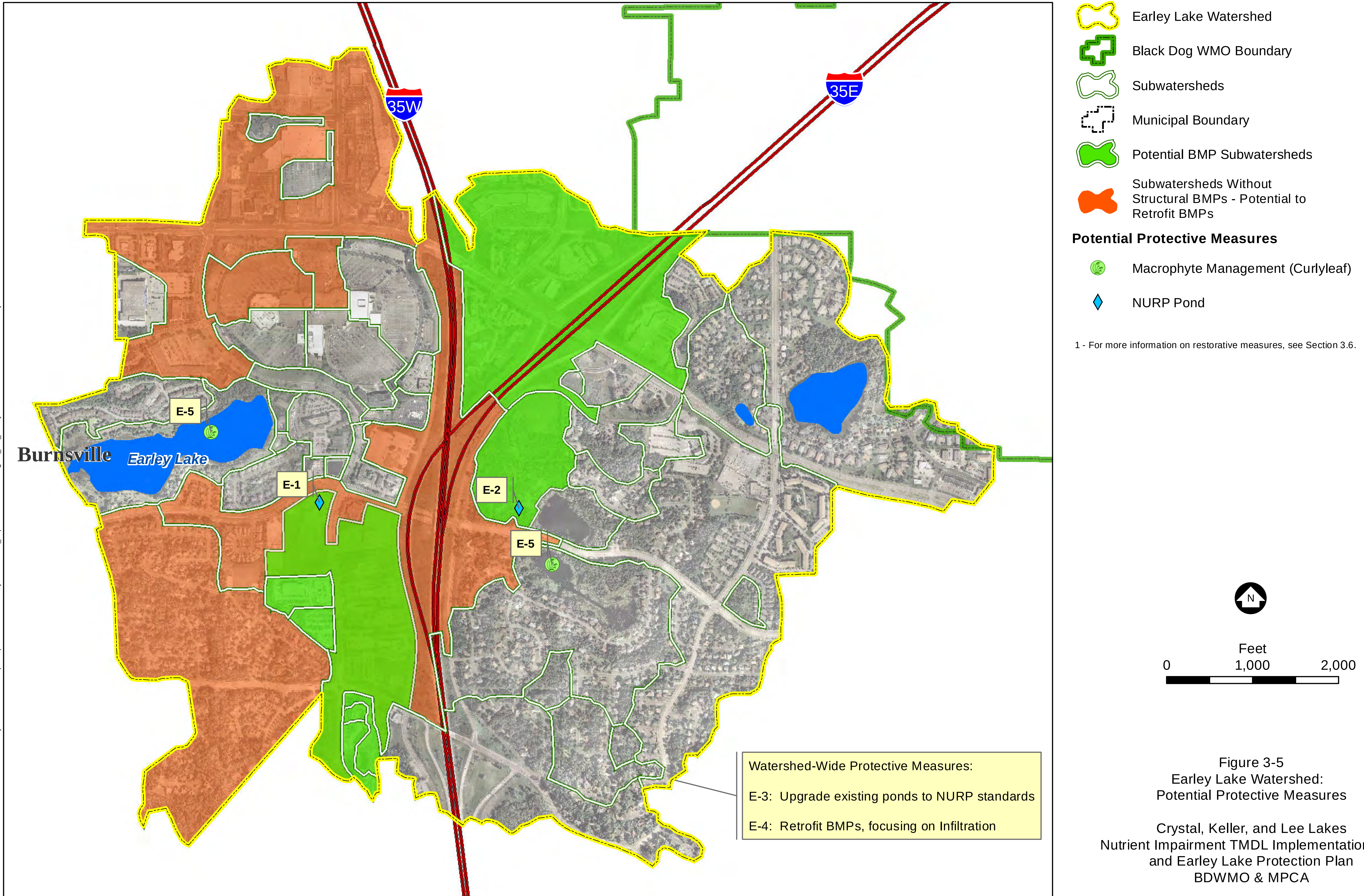


Figure 3-5
Earley Lake Watershed:
Potential Protective Measures

Crystal, Keller, and Lee Lakes
Nutrient Impairment TMDL Implementation Plan
and Earley Lake Protection Plan
BDWMO & MPCA

3.7 Implementation Responsibilities

3.7.1 Funding Opportunities

Funding for many of the potential projects may come from the MS4s, but other sources of funding such as the State Clean Water Partnership Funds, State Revolving Funds, Section 319 grants, Board of Water and Soil Resources Challenge Grants, and other relevant federal and state funds will likely be pursued to assist the MS4s in their efforts.

3.7.2 Roles and Responsibilities

The BDWMO is willing to take the lead role in coordinating the implementation projects to address the internal phosphorus loading, assuming the MS4s are willing to fund the projects. In general, the BDWMO relies on the member cities to fund capital improvements, although the BDWMO joint powers agreement allows the BDWMO to fund capital improvements as necessary. However, as a WMO, the BDWMO does not have any tax levying authority to generate additional funds beyond the BDWMO general fund, which comes directly from the annual contributions by cities within the WMO as outlined in the joint powers agreement.

The cities and other MS4s in the Crystal, Keller, and Lee Lake watersheds are expected to fulfill their existing responsibilities in storm water management to help meet the goals of this TMDL.

Specifically, cities and other MS4s in the watershed will:

- Implement phosphorus reduction measures that address external phosphorus loads, using the *Implementation Plan* to help guide the projects to be implemented. These projects may require the various MS4s to collaborate, to share costs, and distribute the phosphorus load reduction to the respective MS4s.

- Continue to implement stormwater management requirements on all City projects to comply with their established development and redevelopment rules.

- Look for opportunities to implement voluntary projects (other than those specifically outlined in the *Implementation Plan*) to reduce runoff and phosphorus load, wherever possible.

- Continue to implement their SWPPPs and to improve their public works maintenance practices, wherever possible.

4.0 Monitoring Plan to Track Implementation Plan Effectiveness

4.1 Lake Water Quality Monitoring

The water quality in Crystal Lake has been monitored for approximately 22 years, in Keller and Lee Lakes for approximately 13 years, and in Earley Lake for approximately 15 years, and will continue to be monitored for the foreseeable future, allowing the BDWMO and the member cities the ability to track changes in the lakes' water quality and assess the impact of implementing the various BMPs outlined in this *Implementation Plan*.

According to the BDWMO *Watershed Management Plan* (draft Barr, 2011), the BDWMO is responsible for the monitoring of all the water bodies within the watershed that were classified (according to the BDWMO classification system) as strategic water bodies (which includes Crystal and Keller Lakes). Member cities are encouraged to monitor the non-strategic water bodies (including Lee Lake). At a minimum, survey level water quality monitoring should be conducted at least once every three years for Crystal, Keller, and Lee Lakes, although it has been performed annually in recent years. Survey level water quality monitoring program as outlined by the BDWMO is equivalent to the Metropolitan Council's Citizen Assisted Lake Monitoring Program (CAMP). The monitoring typically includes the collection of basic surface water quality parameters (total phosphorus, total Kjeldahl nitrogen, chlorophyll-*a*, Secchi depth, and water temperature) on a biweekly basis from April through October.

For some of the more regionally important water bodies, such as Crystal Lake, the BDWMO monitoring program, as outlined in the BDWMO *Watershed Management Plan* (Barr, 2002), involves more detailed monitoring efforts, which includes collection of total phosphorus concentration data along the profile of the water column.

Intensive water quality monitoring can be performed, as needed. The program involves more sample collection dates and analyzing other water quality parameters besides total phosphorus along the profile of the water column. This monitoring method typically includes monitoring of the following parameters: total phosphorus, total dissolved phosphorus, orthophosphate, pH, chlorophyll-*a*, Secchi depth, turbidity, dissolved oxygen, water temperature, specific conductivity, and alkalinity.

Each year the BDWMO compiles an annual watershed report which includes a summary of the water quality of the strategic waterbodies monitored by the BDWMO in that year. This includes a trend analysis of the historic water quality in each water body, which evaluates statistically significant changes (improvement or degradation) in water quality.

4.2 BMP Monitoring

Although most projects implemented in the Crystal, Keller, and Lee Lakes' watersheds will be modeled to estimate the expected reduction in phosphorus loads, it will also be important to monitor the long-term effectiveness of the different BMPs that have been and will be implemented in the watersheds to determine if the BMPs are performing as designed.

4.3 Monitoring Major Inflows to Keller Lake

Because the TMDL WLA for Keller Lake requires a phosphorus load reduction from the watershed that may be difficult to attain using typical stormwater management practices, monitoring of the major surface inflows to Keller Lake may provide the information needed to verify the modeled watershed loads to the lake, as there is currently no stormwater runoff water quality data available within the Keller Lake watershed.

5.0 References

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Appendix A

Engineer’s Opinion of Probable Costs for Restorative Measures

Appendix A

Table of Contents

Table No.	Table Title

Appendix A

List of Acronyms

Ac.	Acres
BMPs	Best Management Practices
C.Y.	Cubic Yard
EWMF	Eurasian Water Milfoil
Gal	Gallon
L.S.	Lump Sum
L.F.	Linear Feet
MDNR	Minnesota Department of Natural Resources
S.F	Square Feet
SY	Square Yard
CLPW	Curlyleaf Pondweed

C-5: Infiltration throughout the Portions of the Crystal Lake Watershed not Treated by Structural BMPs

C-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.25 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$29,604	$29,604
Excavation (assumes 18" depth)	C.Y.	742	$8	$5,937
Disposal of Excavated Material	C.Y.	742	$15	$11,132
Diversion to Rainwater Gardens	each	67	$1,500	$100,500
Planting Rainwater Gardens	S.F.	13,358	$13	$176,941
Pond Restoration	Ac.	0.31	$5,000	$1,533
Subtotal				$325,647
Contingencies (30%)				$97,694
Engineering & Design (10%)				$32,565
Total				$455,906

C-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.25 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$51,985	$51,985
Excavation (assumes 18" depth)	C.Y.	742	$8	$5,937
Disposal of Excavated Material	C.Y.	742	$15	$11,132
Diversion to Rainwater Gardens	each	67	$1,500	$100,500
Planting Rainwater Gardens	S.F.	13,358	$30	$400,752
Pond Restoration	Ac.	0.31	$5,000	$1,533
Subtotal				$571,840
Contingencies (30%)				$171,552
Engineering & Design (10%)				$57,184
Total				$800,576

C-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.5 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$55,883	$55,883
Excavation (assumes 18" depth)	C.Y.	1404	$8	$11,229
Disposal of Excavated Material	C.Y.	1404	$15	$21,054
Diversion to Rainwater Gardens	each	126	$1,500	$189,000
Planting Rainwater Gardens	S.F.	25,265	$13	$334,648
Pond Restoration	Ac.	0.58	$5,000	$2,900
Subtotal				$614,714
Contingencies (30%)				$184,414
Engineering & Design (10%)				$61,471
Total				$860,600

C-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.5 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$98,213	$98,213
Excavation (assumes 18" depth)	C.Y.	1404	$8	$11,229
Disposal of Excavated Material	C.Y.	1404	$15	$21,054
Diversion to Rainwater Gardens	each	126	$1,500	$189,000
Planting Rainwater Gardens	S.F.	25,265	$30	$757,944
Pond Restoration	Ac.	0.58	$5,000	$2,900
Subtotal				$1,080,339
Contingencies (30%)				$324,102
Engineering & Design (10%)				$108,034
Total				$1,512,475

C-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 1.0 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$107,291	$107,291
Excavation (assumes 18" depth)	C.Y.	2694	$8	$21,554
Disposal of Excavated Material	C.Y.	2694	$15	$40,414
Diversion to Rainwater Gardens	each	242	$1,500	$363,000
Planting Rainwater Gardens	S.F.	48,497	$13	$642,371
Pond Restoration	Ac.	1.11	$5,000	$5,567
Subtotal				$1,180,197
Contingencies (30%)				$354,059
Engineering & Design (10%)				$118,020
Total				$1,652,275

C-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 1.0 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$188,544	$188,544
Excavation (assumes 18" depth)	C.Y.	2694	$8	$21,554
Disposal of Excavated Material	C.Y.	2694	$15	$40,414
Diversion to Rainwater Gardens	each	242	$1,500	$363,000
Planting Rainwater Gardens	S.F.	48,497	$30	$1,454,904
Pond Restoration	Ac.	1.11	$5,000	$5,567
Subtotal				$2,073,983
Contingencies (30%)				$622,195
Engineering & Design (10%)				$207,398
Total				$2,903,576

C-7: Native Shoreline Buffers along Crystal Lake

C-7: Engineer's Opinion of Probable Costs -- Native Shoreline Buffers (50 ft)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Native Seed Mix Installation	Ac.	32	$2,450	$78,697	Shoreline = 5.3 miles; assume 50 ft buffer
Erosion Control Blanket	SY	155467	$1.10	$171,013	
Subtotal				$249,710	
Contingencies (30%)				$74,913	
Engineering & Design (10%)				$24,971	
Total				$349,594	

C-7: Engineer's Opinion of Probable Costs -- Native Shoreline Buffers (20 ft)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Native Seed Mix Installation	Ac.	13	$2,450	$31,479	Shoreline = 5.3 miles; assume 20 ft buffer
Erosion Control Blanket	SY	62187	$1.10	$68,405	
Subtotal				$99,884	
Contingencies (30%)				$29,965	
Engineering & Design (10%)				$9,988	
Total				$139,838	

C-10: Curlyleaf Pondweed Management - 15% of Littoral Area - for Crystal Lake

C-10: Engineer's Opinion of Probable Costs – Endothall & 2, 4-D Treatments in Crystal Lake to Control Curlyleaf Pondweed & Eurasian Watermilfoil

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Comment
Obtain Permit For Endothall & 2,4-D Application	L.S	1	$2,500	$2,500	
Mobilization (10%)	L.S.	1	$1,065	$1,065	
Endothall Application (CLPW & EWMF)	Gal	101	$105	$10,647	Treatment of 15% of littoral area
2,4-D Application (EWMF)	ac	33	$59	$1,947	Treatment of 15% of littoral area
Subtotal				$16,159	
Contingencies (30%)				$4,848	
Engineering & Administration (10%) (One Time Cost)				$1,616	
Total				$22,622	

*2010 dollars

C-10: Engineer's Opinion of Probable Costs - Monitoring Cost Estimate – Aquatic Plant

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Comment
Aquatic Plant Monitoring	L.S.	1	$20,193	$20,193	3 survey events per year (April, June, August) per MDNR requirements; 125 survey points per survey
Subtotal				$20,193	
Contingencies (30%)				$6,058	
Engineering & Design (10%)				$2,019	
Total				$28,270	

*2010 dollars

TOTAL $50,892

C-11: Curlyleaf Pondweed Management - Whole Lake - for Crystal Lake

C-11: Engineer's Opinion of Probable Costs – Endothall & 2, 4-D Treatments in Crystal Lake to Control Curlyleaf Pondweed & Eurasian Watermilfoil

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Mobilization (10%)	L.S.	1	$7,098	$7,098	$35,490	
Endothall Application (CLPW & EWMF)	Gal	676	$105	$70,980	$354,900	Treatment of entire littoral area
2,4-D Application (EWMF)	ac	33	$59	$1,947	$9,735	Treatment of entire littoral area
Subtotal				$80,025	$400,125	
Contingencies (30%)				$24,008	$120,038	
Engineering & Administration (10%) (One Time Cost)				$8,003	$8,003	
Total				$112,035	$528,165	

*2010 dollars

C-11: Engineer's Opinion of Probable Costs – Develop Lake Vegetation Management Plan and Obtain MDNR Treatment Permit and Letter of Variance and Letters of Permission to Treat Within 150 Feet of Riparian Property Boundaries

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Obtain Letter of Variance	L.S.	1	$500	$500	$2,500	
Obtain Permit For Endothall & 2,4-D Application	L.S	1	$2,500	$2,500	$12,500	
Obtain Permission Letters From Riparian Owners	L.S	1	$2,500	$2,500	$12,500	
Lake Vegetation Management Plan (One Time Cost)	L.S.	1	$15,000	$15,000	$15,000	
Total				$20,500	$42,500	

*2010 dollars

C-11: Engineer's Opinion of Probable Costs - Monitoring, Analysis, and Reporting Cost Estimate – Aquatic Plant, Biomass, Turion, and Herbicide Residue

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Aquatic Plant Monitoring	L.S.	1	$20,193	$20,193	$100,965	3 survey events per year (April, June, August) per MDNR requirements; 125 survey points per survey
Biomass Monitoring	L.S	1	$4,168	$4,168	$20,842	3 survey events per year (April, June, August) per MDNR requirements
Turion Monitoring	L.S	1	$3,590	$3,590	$17,950	1 survey event per year; 78 survey points
Herbicide Residue Monitoring	L.S.	1	$17,675	$17,675	$88,375	5 survey events at 1, 2, 7, 14, 21 days after treatment @ 5 survey locations
Subtotal				$45,626	$228,132	
Contingencies (30%)				$13,688	$68,440	
Engineering & Design (10%)				$4,563	$22,813	
Total				$63,877	$319,385	

*2010 dollars

TOTAL $890,050

C-12: In-Lake Alum Treatment to Crystal Lake

C-12: Engineer's Opinion of Probable Costs -- In-Lake Alum Treatment to Crystal Lake

Item	Unit	Estimated Quantity	Unit Price	Extention	Comments
Alum Treatment Cost[1]	L.S.	1	$526,964	$526,964	2 doses; Assumed $1.38/gallon for alum
Mobilization per Treatment	L.S.	2	$5,000	$10,000	
Subtotal				$536,964	
Contingencies (30%)				$161,089	
Engineering & Design (10%)				$53,696	
Total				$751,750	

1 - Based on results of 2008 sediment core analysis and calculated Alum Dose for Crystal Lake, assuming 2 applications

K-1: Add Water Quality Pond into A7a-1 (Whitney Pond)

K-1: Engineer's Opinion of Probable Costs -- Add Pond into A7a-1 (Whitney Pond)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Mobilization (10%)	L.S.	1	$65,943	$65,943	
Flow Diversion Structures	L.S.	1	$20,000	$20,000	
Clearing & Grubbing	Ac.	2	$5,690	$11,380	
Basin Excavation	C.Y.	21578	$8	$172,627	Assumes 4.5 acre-ft permanent pool, 8.9 acre-ft flood pool
Disposal of Excavated Material	C.Y.	21578	$15	$323,675	
60" Piping	L.F.	275	$282	$77,550	
Weir Outlet/Overflow Sturcture	L.S.	1	$20,000	$20,000	
Erosion Control Blanket	SY	9680	$2.50	$24,200	
Pond Restoration	Ac.	2	$5,000	$10,000	
Subtotal				$725,375	
Contingencies (30%)				$217,612	
Engineering & Design (10%)				$72,537	
Total				$1,015,525	

K-2: Add Pond into A7b-2 in Crystal Beach Park

K-2: Engineer's Opinion of Probable Costs -- Add Pond into A7b-2 in Crystal Beach Park

Item	Unit	Estimated Quantity	Unit Price	Extention	Comments
Mobilization (10%)	L.S.	1	$52,838	$52,838	
Flow Diversion Structures	L.S.	1	$20,000	$20,000	
Clearing & Grubbing	Ac.	2	$5,690	$11,380	
Basin Excavation	C.Y.	17424	$8	$139,392	Assumes 4.8 acre-ft permanent pool, 6 acre-ft flood pool
Disposal of Excavated Material	C.Y.	17424	$15	$261,360	
66" Piping	L.F.	175	$338	$59,150	
Weir Outlet/Overflow Sturcture	L.S.	1	$20,000	$20,000	
Erosion Control Blanket	SY	4840	$2.50	$12,100	
Pond Restoration	Ac.	1	$5,000	$5,000	
Subtotal				$581,220	
Contingencies (30%)				$174,366	
Engineering & Design (10%)				$58,122	
Total				$813,708	

K-4: Add Pond into A7a-3a on Southwest Side of Keller

K-4: Engineer's Opinion of Probable Costs -- Add Pond into A7a-3a on Southwest Side of Keller

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Mobilization (10%)	L.S.	1	$21,039	$21,039	
Flow Diversion Structures	L.S.	1	$20,000	$20,000	
Clearing & Grubbing	Ac.	0.24	$5,690	$1,366	
Basin Excavation	C.Y.	1855	$8	$14,843	Assumes 0.95 acre-ft permanent pool, 0.2 acre-ft flood pool
Disposal of Excavated Material	C.Y.	1855	$15	$27,830	
30" Piping	L.F.	200	$84	$16,800	
Weir Outlet/Overflow Sturcture	L.S.	1	$20,000	$20,000	
Road Excavation & Reconstruction	L.S.	1	$65,000	$65,000	
Wetland Permitting & Mitigation	Ac.	0.48	$75,000	$36,000	
Erosion Control Blanket	SY	2420	$2.50	$6,050	
Pond Restoration	Ac.	0.5	$5,000	$2,500	
Subtotal				$231,427	
Contingencies (30%)				$69,428	
Engineering & Design (10%)				$23,143	
Total				$323,998	

K-7: Infiltration throughout the Portions of the Keller Lake Watershed not Treated by Structural BMPs

K-7: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.25 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$127,218	$127,218
Excavation (assumes 18" depth)	C.Y.	3194	$8	$25,555
Disposal of Excavated Material	C.Y.	3194	$15	$47,916
Diversion to Rainwater Gardens	each	287	$1,500	$430,500
Planting Rainwater Gardens	S.F.	57,499	$13	$761,614
Pond Restoration	Ac.	1.32	$5,000	$6,600
Subtotal				$1,399,403
Contingencies (30%)				$419,821
Engineering & Design (10%)				$139,940
Total				$1,959,165

K-7: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.25 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$223,555	$223,555
Excavation (assumes 18" depth)	C.Y.	3194	$8	$25,555
Disposal of Excavated Material	C.Y.	3194	$15	$47,916
Diversion to Rainwater Gardens	each	287	$1,500	$430,500
Planting Rainwater Gardens	S.F.	57,499	$30	$1,724,976
Pond Restoration	Ac.	1.32	$5,000	$6,600
Subtotal				$2,459,102
Contingencies (30%)				$737,731
Engineering & Design (10%)				$245,910
Total				$3,442,743

K-7: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.5 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$264,881	$264,881
Excavation (assumes 18" depth)	C.Y.	6649	$8	$53,188
Disposal of Excavated Material	C.Y.	6649	$15	$99,728
Diversion to Rainwater Gardens	each	598	$1,500	$897,000
Planting Rainwater Gardens	S.F.	119,674	$13	$1,585,157
Pond Restoration	Ac.	2.75	$5,000	$13,737
Subtotal				$2,913,691
Contingencies (30%)				$874,107
Engineering & Design (10%)				$291,369
Total				$4,079,167

K-7: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.5 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$465,387	$465,387
Excavation (assumes 18" depth)	C.Y.	6649	$8	$53,188
Disposal of Excavated Material	C.Y.	6649	$15	$99,728
Diversion to Rainwater Gardens	each	598	$1,500	$897,000
Planting Rainwater Gardens	S.F.	119,674	$30	$3,590,215
Pond Restoration	Ac.	2.75	$5,000	$13,737
Subtotal				$5,119,255
Contingencies (30%)				$1,535,777
Engineering & Design (10%)				$511,926
Total				$7,166,957

K-9: Native Shoreline Buffers Along Keller Lake

K-9: Engineer's Opinion of Probable Costs -- Native Shoreline Buffers (50 ft)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Native Seed Mix Installation	Ac.	7	$2,450	$18,115	Shoreline = 1.22 miles; assume 50 ft buffer
Erosion Control Blanket	SY	35787	$1.10	$39,365	
Subtotal				$57,480	
Contingencies (30%)				$17,244	
Engineering & Design (10%)				$5,748	
Total				$80,473	

K-9: Engineer's Opinion of Probable Costs -- Native Shoreline Buffers (20 ft)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Native Seed Mix Installation	Ac.	3	$2,450	$7,246	Shoreline = 1.22 miles; assume 20 ft buffer
Erosion Control Blanket	SY	14315	$1.10	$15,746	
Subtotal				$22,992	
Contingencies (30%)				$6,898	
Engineering & Design (10%)				$2,299	
Total				$32,189	

K-11: Iron-Enhanced Sand Filtration in the Keller Lake Watershed

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at Redwood Pond (0.25 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.25	$ 936,941	$234,235
Subtotal				$234,235
Contingencies (30%)				$70,271
Engineering & Design (10%)				$23,424
Total				$327,929

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at Redwood Pond (0.5 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.5	$ 936,941	$468,471
Subtotal				$468,471
Contingencies (30%)				$140,541
Engineering & Design (10%)				$46,847
Total				$655,859

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at Redwood Pond (0.75 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.75	$ 936,941	$702,706
Subtotal				$702,706
Contingencies (30%)				$210,812
Engineering & Design (10%)				$70,271
Total				$983,788

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at Pond in SWS A6a (0.25 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.25	$ 936,941	$234,235
Subtotal				$234,235
Contingencies (30%)				$70,271
Engineering & Design (10%)				$23,424
Total				$327,929

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at Pond in SWS A6a (0.5 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.5	$ 936,941	$468,471
Subtotal				$468,471
Contingencies (30%)				$140,541
Engineering & Design (10%)				$46,847
Total				$655,859

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at Pond in SWS A6a (0.75 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.75	$ 936,941	$702,706
Subtotal				$702,706
Contingencies (30%)				$210,812
Engineering & Design (10%)				$70,271
Total				$983,788

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Iron-Enhanced Sand Filtration in the Keller Lake Watershed

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at proposed Crystal Beach Park Pond (0.25 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.25	$ 936,941	$234,235
Subtotal				$234,235
Contingencies (30%)				$70,271
Engineering & Design (10%)				$23,424
Total				$327,929

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

TOTAL ESF COST	Lower end (1 filter at 0.25 acres)	Upper End (3 filters @ 0.75 acres each)
Total	$327,929	$2,951,365

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at proposed Crystal Beach Park Pond (0.5 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.5	$ 936,941	$468,471
Subtotal				$468,471
Contingencies (30%)				$140,541
Engineering & Design (10%)				$46,847
Total				$655,859

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-11: Engineer's Opinion of Probable Costs -- Construct an Iron-Enhanced Sand Filter at proposed Crystal Beach Park Pond (0.75 acres)

Item	Unit	Estimated Quantity	Unit Price	Extention
Construction Costs[1]	acre	0.75	$ 936,941	$702,706
Subtotal				$702,706
Contingencies (30%)				$210,812
Engineering & Design (10%)				$70,271
Total				$983,788

1 - Costs based on Kohlman basin iron-enhanced sand filter bid tab information from Ramsey Washington Metro Watershed District, adjust to 2010 $ using the Engineering News Record Construction Cost Index

K-12: Curlyleaf Pondweed Management - 15% of Littoral Area - for Keller Lake

K-12: Engineer's Opinion of Probable Costs – Endothall & 2, 4-D Treatments in Keller Lake to Control Curlyleaf Pondweed & Eurasian Watermilfoil - 15% of Lake Area & Obtaining Aquatic Plant Management Permit

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Comments
Obtain Permit For Endothall & 2,4-D Application	L.S	1	$2,500	$2,500	
Mobilization (10%)	L.S.	1	$257	$257	
Endothall Application (CLPW & EWMF)	Gal	24.50	$105	$2,572	Treatment of 15% littoral area
2,4-D Application (EWMF)	ac	7.8	$32	$250	Treatment of 15% littoral area
Subtotal				$5,579	
Contingencies (30%)				$1,674	
Engineering & Administration (10%) (One Time Cost)				$558	
Total				$7,811	

*2010 dollars

K-12: Engineer's Opinion of Probable Costs - MonitoringCost Estimate – Aquatic Plant

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Comments
Aquatic Plant Monitoring	L.S.	1	$23,448	$20,193	3 survey events per year (April, June, August) per MDNR requirements; 125 survey points per survey
Subtotal				$20,193	
Contingencies (30%)				$6,058	
Engineering & Design (10%)				$2,019	
Total				$28,270	

*2010 dollars

TOTAL $36,081

K-13: Curlyleaf Pondweek Management - Whole Lake - for Keller Lake

K-13: Engineer's Opinion of Probable Costs – Endothall & 2, 4-D Treatments in Keller Lake to Control Curlyleaf Pondweed & Eurasian Watermilfoil

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Mobilization (10%)	L.S.	1	$1,715	$1,715	$8,574	
Endothall Application (CLPW & EWMF)	Gal	163.31172	$105	$17,148	$85,739	Treatment of entire littoral area
2,4-D Application (EWMF)	ac	52	$32	$1,664	$8,320	Treatment of entire littoral area
Subtotal				$20,527	$102,633	
Contingencies (30%)				$6,158	$30,790	
Engineering & Administration (10%) (One Time Cost)				$2,053	$2,053	
Total				$28,737	$135,475	

*2010 dollars

K-13: Engineer's Opinion of Probable Costs – Develop Lake Vegetation Management Plan and Obtain MDNR Treatment Permit and Letter of Variance and Letters of Permission to Treat Within 150 Feet of Riparian Property

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Obtain Letter of Variance	L.S.	1	$500	$500	$2,500	
Obtain Permit For Endothall & 2,4-D Application	L.S	1	$2,500	$2,500	$12,500	
Obtain Permission Letters From Riparian Owners	L.S	1	$2,500	$2,500	$12,500	
Lake Vegetation Management Plan (One Time Cost)	L.S.	1	$15,000	$15,000	$15,000	
Total				$20,500	$42,500	

*2010 dollars

K-13: Engineer's Opinion of Probable Costs - Monitoring, Analysis, and Reporting Cost Estimate – Aquatic Plant, Biomass, Turion, and Herbicide Residue

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Aquatic Plant Monitoring	L.S.	1	$23,448	$20,193	$117,238	3 survey events per year (April, June, August) per MDNR requirements; 125 survey points per survey
Biomass Monitoring	L.S	1	$4,168	$4,168	$20,842	3 survey events per year (April, June, August) per MDNR requirements
Turion Monitoring	L.S	1	$1,355	$1,270	$6,774	1 survey event per year; 20 survey points
Herbicide Residue Monitoring	L.S.	1	$6,675	$6,675	$33,375	5 survey events at 1, 2, 7, 14, 21 days after treatment @ 2 survey locations
Subtotal				$32,306	$178,229	
Contingencies (30%)				$9,692	$53,469	
Engineering & Design (10%)				$3,231	$17,823	
Total				$45,229	$249,521	

*2010 dollars

TOTAL $427,496

K-14: In-Lake Alum Treatment to Keller Lake

K-14: Engineer's Opinion of Probable Costs -- In-Lake Alum Treatment to Keller Lake

Item	Unit	Estimated Quantity	Unit Price	Extention	Comments
Alum Treatment Cost[1]	L.S.	1	$122,144	$122,144	5 doses; Assumed $1.38/gallon for alum
Mobilization per Treatment	L.S.	5	$5,000	$25,000	
Subtotal				$147,144	
Contingencies (30%)				$44,143	
Engineering & Design (10%)				$14,714	
Total				$206,001	

1 - Based on results of 2008 sediment core analysis and calculated Alum Dose for Keller Lake, assuming 5 applications

L-2: Water Quality Pond at former Landcape Center Site in CL12a4

L-2: Engineer's Opinion of Probable Costs – Water Quality Pond at former Landscape Center Site in CL12a4

Item	Unit	Estimated Quantity	Unit Price	Extention	Comments
Mobilization (10%)	L.S.	1	$6,765	$6,765	
Clearing & Grubbing	Ac.	1	$5,690	$5,690	
Basin Excavation	C.Y.	1081	$8	$8,647	Assumes 0.67 acre-ft permanent pool
Disposal of Excavated Material	C.Y.	1081	$15	$16,214	
Weir Outlet/Overflow Sturcture	L.S.	1	$20,000	$20,000	
Erosion Control Blanket	SY	4840	$2.50	$12,100	
Pond Restoration	Ac.	1	$5,000	$5,000	
Subtotal				$74,417	
Contingencies (30%)				$22,325	
Engineering & Design (10%)				$7,442	
Total				$104,183	

L-5: Infiltration throughout the Portions of the Lee Lake Watershed not Treated by Structural BMPs

L-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.25 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$14,920	$14,920
Excavation (assumes 18" depth)	C.Y.	373	$8	$2,981
Disposal of Excavated Material	C.Y.	373	$15	$5,590
Diversion to Rainwater Gardens	each	34	$1,500	$51,000
Planting Rainwater Gardens	S.F.	6,708	$13	$88,855
Pond Restoration	Ac.	0.2	$5,000	$770
Subtotal				$164,116
Contingencies (30%)				$49,235
Engineering & Design (10%)				$16,412
Total				$229,763

L-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.25 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$26,159	$26,159
Excavation (assumes 18" depth)	C.Y.	373	$8	$2,981
Disposal of Excavated Material	C.Y.	373	$15	$5,590
Diversion to Rainwater Gardens	each	34	$1,500	$51,000
Planting Rainwater Gardens	S.F.	6,708	$30	$201,247
Pond Restoration	Ac.	0.2	$5,000	$770
Subtotal				$287,748
Contingencies (30%)				$86,324
Engineering & Design (10%)				$28,775
Total				$402,847

L-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.5 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$30,990	$30,990
Excavation (assumes 18" depth)	C.Y.	778	$8	$6,221
Disposal of Excavated Material	C.Y.	778	$15	$11,664
Diversion to Rainwater Gardens	each	70	$1,500	$105,000
Planting Rainwater Gardens	S.F.	13,997	$13	$185,403
Pond Restoration	Ac.	0.32	$5,000	$1,607
Subtotal				$340,885
Contingencies (30%)				$102,265
Engineering & Design (10%)				$34,088
Total				$477,238

L-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 0.5 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$54,441	$54,441
Excavation (assumes 18" depth)	C.Y.	778	$8	$6,221
Disposal of Excavated Material	C.Y.	778	$15	$11,664
Diversion to Rainwater Gardens	each	70	$1,500	$105,000
Planting Rainwater Gardens	S.F.	13,997	$30	$419,918
Pond Restoration	Ac.	0.32	$5,000	$1,607
Subtotal				$598,852
Contingencies (30%)				$179,655
Engineering & Design (10%)				$59,885
Total				$838,392

L-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 1.0 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $13/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$63,237	$63,237
Excavation (assumes 18" depth)	C.Y.	1586	$8	$12,687
Disposal of Excavated Material	C.Y.	1586	$15	$23,789
Diversion to Rainwater Gardens	each	143	$1,500	$214,500
Planting Rainwater Gardens	S.F.	28,546	$13	$378,114
Pond Restoration	Ac.	0.66	$5,000	$3,277
Subtotal				$695,604
Contingencies (30%)				$208,681
Engineering & Design (10%)				$69,560
Total				$973,845

L-5: Engineer's Opinion of Probable Costs -- Infiltration (Rainwater Gardens) to treated 1.0 inch of Runoff from Impervious Areas in the Currently Untreated Portions of the Watershed - Planting Cost $30/Sq Ft

Item	Unit	Estimated Quantity	Unit Price	Extention
Mobilization (10%)	L.S.	1	$111,064	$111,064
Excavation (assumes 18" depth)	C.Y.	1586	$8	$12,687
Disposal of Excavated Material	C.Y.	1586	$15	$23,789
Diversion to Rainwater Gardens	each	143	$1,500	$214,500
Planting Rainwater Gardens	S.F.	28,546	$30	$856,390
Pond Restoration	Ac.	0.66	$5,000	$3,277
Subtotal				$1,221,706
Contingencies (30%)				$366,512
Engineering & Design (10%)				$122,171
Total				$1,710,389

L-7: Native Shoreline Buffers along Lee Lake

L-7: Engineer's Opinion of Probable Costs -- Native Shoreline Buffers (50 ft)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Native Seed Mix Installation	Ac.	7	$2,450	$17,670	Shoreline = 1.2 miles; assume 50 ft buffer
Erosion Control Blanket	SY	34907	$1.10	$38,397	
Subtotal				$56,067	
Contingencies (30%)				$16,820	
Engineering & Design (10%)				$5,607	
Total				$78,494	

L-7: Engineer's Opinion of Probable Costs -- Native Shoreline Buffers (20 ft)

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Native Seed Mix Installation	Ac.	3	$2,450	$7,068	Shoreline = 1.2 miles; assume 20 ft buffer
Erosion Control Blanket	SY	13963	$1.10	$15,359	
Subtotal				$22,427	
Contingencies (30%)				$6,728	
Engineering & Design (10%)				$2,243	
Total				$31,398	

L-9: Infiltration Area within CL-12a-2a

L-9: Engineer's Opinion of Probable Costs -- Infiltration Area within CL-12a-2a

Item	Unit	Estimated Quantity	Unit Price	Extention	Comment
Mobilization (10%)	L.S.	1	$7,814	$7,814	
Excavation	C.Y.	185	$8	$1,482	Assumes 0.115 acre-ft
Weir Outlet/Overflow Sturcture	each	1	$20,000	$20,000	
Disposal of Excavated Material	C.Y.	185	$15	$2,779	
Diversion to Infiltration Area	each	1	$1,500	$1,500	
Planting Rainwater Gardens	S.F.	3,920	$13	$51,928	
Pond Restoration	Ac.	0.1	$5,000	$450	
Subtotal				$85,953	
Contingencies (30%)				$25,786	
Engineering & Design (10%)				$8,595	
Total				$120,334	

L-11: In-Lake Alum Treatment to Lee Lake

L-11: Engineer's Opinion of Probable Costs -- In-Lake Alum Treatment to Lee Lake

Item	Unit	Estimated Quantity	Unit Price	Extention	Comments
Alum Treatment Cost[1]	L.S.	1	$65,567	$65,567	Estimated alum quantity reduced by 15% to account for 2009 alum treatment (4 doses instead of 5); Assumed $1.38/gallon for alum
Mobilization per Treatment	L.S.	5	$5,000	$25,000	
Subtotal				$90,567	
Contingencies (30%)				$27,170	
Engineering & Design (10%)				$9,057	
Total				$126,794	

1 - Based on results of 2008 sediment core analysis and calculated Alum Dose for Lee Lake, assuming 5 applications

L-12: Curlyleaf Pondweed Treatments - Whole Lake - for Lee Lake

L-12: Engineer's Opinion of Probable Costs – Endothall Treatments in Lee Lake to Control Curlyleaf Pondweed

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Mobilization (10%)	L.S.	1	$956	$956	$4,778	
Endothall Application (CLPW)	Gal	91	$105	$9,555	$47,775	Treatment of entire littoral area
Subtotal				$10,511	$52,553	
Contingencies (30%)				$3,153	$15,766	
Engineering & Administration (10%) (One Time Cost)				$1,051	$1,051	
Total				$14,715	$69,369	

*2010 dollars

L-12: Engineer's Opinion of Probable Costs – Develop Lake Vegetation Management Plan and Obtain MDNR Treatment Permit and Letter of Variance and Letters of Permission to

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Obtain Letter of Variance	L.S.	1	$500	$500	$2,500	
Obtain Permit For Endothall Application	L.S	1	$2,500	$2,500	$12,500	
Obtain Permission Letters From Riparian Owners	L.S	1	$2,500	$2,500	$12,500	
Lake Vegetation Management Plan (One Time Cost)	L.S.	1	$15,000	$15,000	$15,000	
Total				$20,500	$42,500	

*2010 dollars

L-12: Engineer's Opinion of Probable Costs - Monitoring, Analysis, and Reporting Cost Estimate – Aquatic Plant, Biomass, Turion, and Herbicide Residue

Item	Unit	Estimated Quantity	Unit Price*	Extension Per Year*	Extension 5 Years*	Comments
Aquatic Plant Monitoring	L.S.	1	$20,193	$20,193	$100,965	3 survey events per year (April, June, August) per MDNR requirements; 125 survey points per survey
Biomass Monitoring	L.S	1	$4,168	$4,168	$20,842	3 survey events per year (April, June, August) per MDNR requirements
Turion Monitoring	L.S	1	$790	$790	$3,950	1 survey event per year; 8 survey points
Herbicide Residue Monitoring	L.S.	1	$4,975	$4,975	$24,875	5 survey events at 1, 2, 7, 14, 21 days after treatment @ 2 survey locations
Subtotal				$30,126	$150,632	
Contingencies (30%)				$9,038	$45,190	
Engineering & Design (10%)				$3,013	$15,063	
Total				$42,177	$210,885	

*2010 dollars

TOTAL $322,755