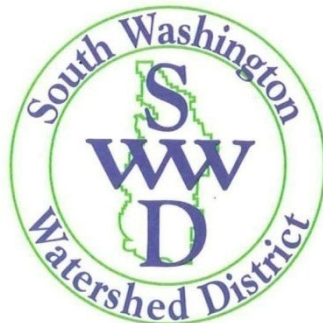


SWWD Northern Subwatershed; Colby Lake

4B Demonstration Report



Preface

This is a third party 4b demonstration prepared by the South Washington Watershed District (SWWD) in collaboration with the Minnesota Pollution Control Agency (MPCA) following USEPA's *Recommended Structure for Category 4b Demonstrations* (2006) and MPCA's *Guidance for Category 4b Requests Developed by Third Parties* (2011). It provides the supporting information necessary to reclassify Colby Lake as a Category 4b impaired water and remove it from the State's 303(d) List. The reclassification is based on the expectation that existing and scheduled SWWD programs and controls will result in Colby Lake meeting water quality standards in a reasonable period of time. However, the State retains the authority to relist Colby Lake as a Category 5 impaired water and establish a total maximum daily load (TMDL) should SWWD fail to implement or the lake fail to show improvement as expected.

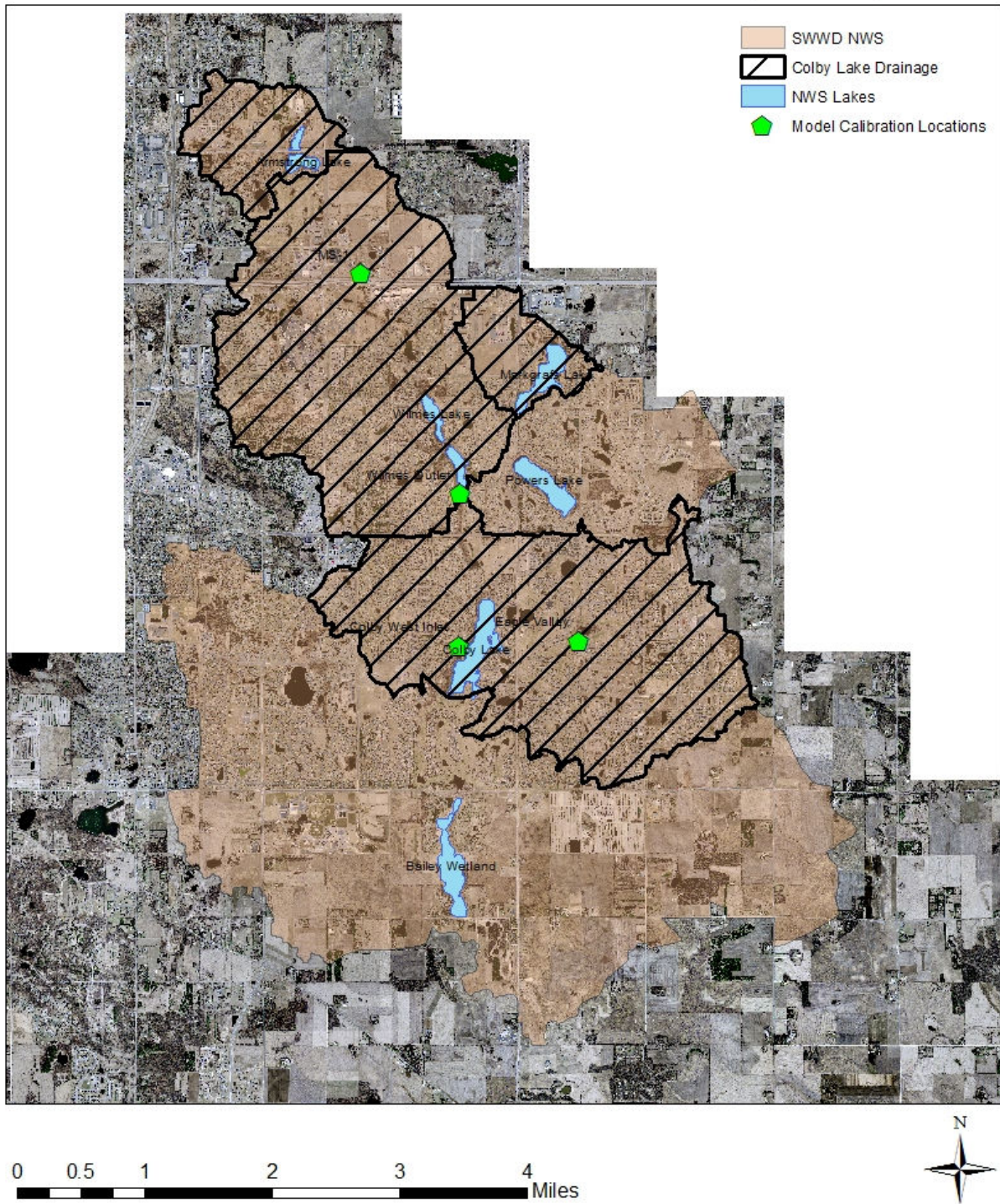
1.0 Introduction

Established in 1993, SWWD manages approximately 65,000 acres near the confluence of the Mississippi and St. Croix Rivers. The District encompasses 12 lakes, 5 of which are impaired, and 120 miles of public waters streams (piped and open channel), of which 2 reaches are impaired. SWWD actively manages surface waters in the District and places a strong emphasis on implementation through enforcement of development and redevelopment standards, collaboration with municipalities and agencies, and pursuit of public/private partnerships.

Colby Lake is part of system of lakes that drains the SWWD Northern Watershed (NWS; **Figure 1**) which is dominated by dense suburban development. Colby Lake receives runoff from the central portion of the NWS in addition to runoff from the northern portion of the NWS via Armstrong, Markgrafs, and Wilmes Lakes. All water flowing through Colby Lake ultimately drains to the Bailey wetland in the southern portion of the NWS. In all, 4 lakes (Armstrong, Markgrafs, Wilmes, and Colby) and one stream reach within the NWS are listed as impaired. A small portion of the NWS drains to Powers Lake. While there is a pump station to allow Powers Lake to drain to Wilmes and Colby Lakes, it has never been used and Powers Lake remains disconnected from the rest of the NWS. The NWS is currently landlocked for all but the rarest precipitation events, terminating at two regional infiltration basins south of Bailey wetland. However, plans are underway to provide a controlled emergency outlet for the NWS to the Mississippi River, which will activate during rare events to protect northern portions of Cottage Grove that would otherwise be inundated.

The NWS lake system is highly prized by the City of Woodbury and Washington County and heavily used by its residents for both active and passive recreation. Because of the high importance of water quality in these lakes, SWWD has undertaken efforts to protect and improve these resources. Utilizing authorities granted by Minnesota State Statutes and Rules (see section 3.4), SWWD has developed a comprehensive water quality management program that systematically assesses District water resources against both local and state standards, identifies strategies and specific projects to protect or restore those resources, and implements those strategies and projects using a variety of voluntary and mandatory controls. SWWD's comprehensive program as it applies to Colby Lake is described in detail below. This Colby Lake 4b Demonstration represents the first effort in what is ultimately expected to be a SWWD NWS 4b Demonstration. The proposed schedule for completion of that effort is included in section 5 of this report, as management of the entire NWS is necessary to ultimately meet water quality standards at Colby Lake. This approach is consistent with the Minnesota Pollution Control Agency's (MPCA) emphasis on managing resources at the watershed level.

Figure 1: SWWD Northern Watershed (NWS)



2.0 Description of Water Body and Problem Causing Impairment

2.1 Water Body Description

Colby Lake is an approximately 70-acre lake located in the City of Woodbury within southern Washington County. Washington County is located within the Minneapolis-St. Paul metropolitan area of eastern Minnesota. The Colby Lake watershed is situated in the North Central Hardwood Forests ecoregion, though the lake itself is in close proximity to the boundary with the Western Corn Belt Plains ecoregion. Colby Lake is part of a multi-lake system; receiving water from Wilmes Lakes to its north and contributing water downstream to the Bailey wetland (**Figure 1**). The total cumulative drainage area into Colby Lake is 10.6 square miles, 6.3 of which come through Wilmes Lake. The remaining 4.3 square miles of the drainage area contributes water directly into Colby Lake either through direct runoff or through a series of stormwater infrastructure. Collectively, these lakes make up the majority of SWWD's NWS which is dominated by newer suburban development.

Colby Lake is identified by the Minnesota Department of Natural Resources (MnDNR) as Public Water No. 82-0094-00. The fishery within the lake is managed by the Fishing in the Neighborhood (FiN) program with the goal of providing shorefishing opportunities in the City of Woodbury. The outlet of Colby Lake is controlled by a 10-foot long weir with a crest elevation at 890.30 MSL (NGVD 29) and an ordinary high water level has been established at 891.8 MSL. Since 1980, lake levels have fluctuated by a maximum of 5 feet, averaging to within a foot and a half of the weir elevation (URL: <http://www.dnr.state.mn.us/lakefind/showlevel.html?id=82009400> , accessed April 1, 2011).

The fisheries report for Colby Lake prepared by the MnDNR in 2007 indicates the vast majority of fish in Colby Lake are black bullhead (*Ameiurus melas*). Additional species present include: black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), hybrid sunfish (*Lepomis sp.*), largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), and white sucker (*Catostomus commersonii*). Colby Lake has been managed through FiN since 2002 and was stocked in 2002-2003 with black crappie and bluegill, in 2005 with northern pike, bluegill and yellow perch, and in 2008 with northern pike and yellow perch. Fish consumption guidelines of once per week have been placed on crappie and northern pike due to mercury. Also according to the 2007 MnDNR report, Colby Lake's submergent plant community has a number of species, including curly-leaf pondweed.

2.2 Impairment and Pollutant Causing Impairment

In 2006, Colby Lake was placed on the Environmental Protection Agency's (EPA) List of Impaired Waters (i.e., 303(d) List) for Nutrient Eutrophication / Biological Indicators. It is currently listed in Category 5C with no TMDL plan having been approved.

Colby Lake's water quality has been monitored by various agencies and volunteers since 1994 and that monitoring continues through support from the SWWD. **Figure 2** illustrates the historic (regulated) summer season (June 1-September 30) total phosphorus (TP) concentrations monitored in Colby Lake. All samples were collected in the upper three feet of the lake. Although there is variability from season to season, phosphorus concentrations have remained relatively constant and are consistently over the

state water quality standard. **Figures 3 and 4** show the chlorophyll-*a* (chl-*a*) and Secchi disk depth (SD) data that have been collected in the lake. Similar to TP concentrations, chl-*a* concentrations and SD values have consistently not met state water quality standards.

Figure 2: Summer Season (June through September) TP Concentrations in Colby Lake

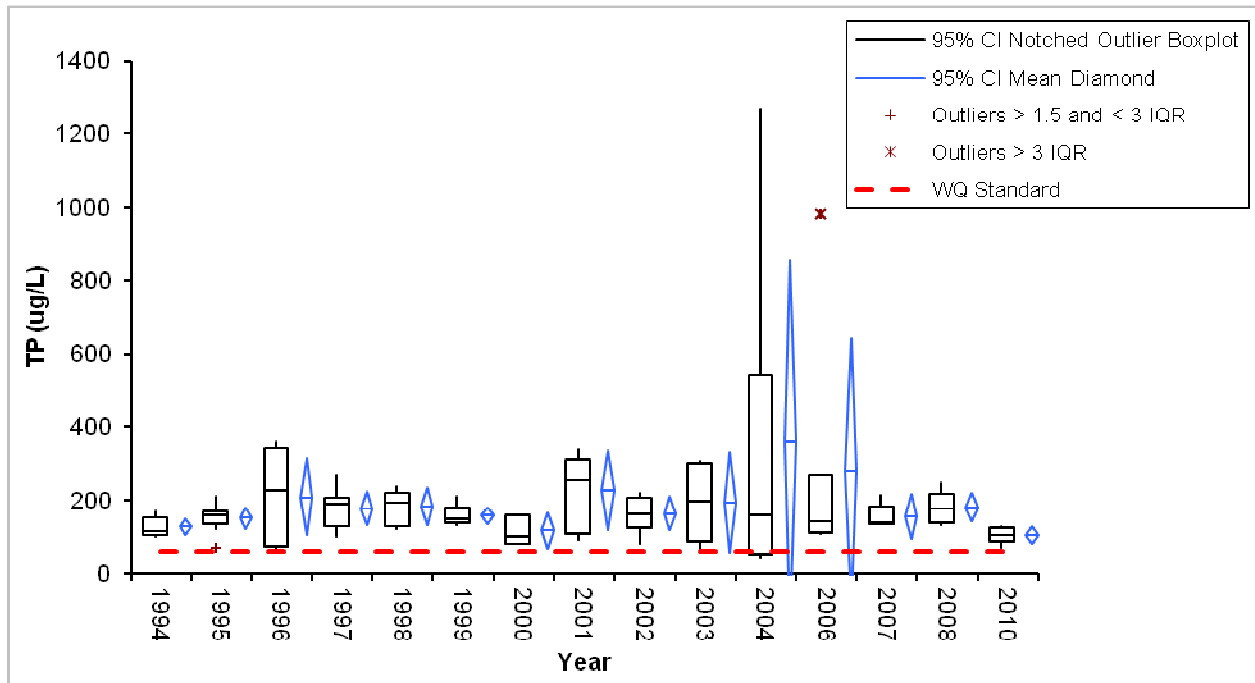


Figure 3: Summer Season (June through September) Chl-*a* Concentrations in Colby Lake

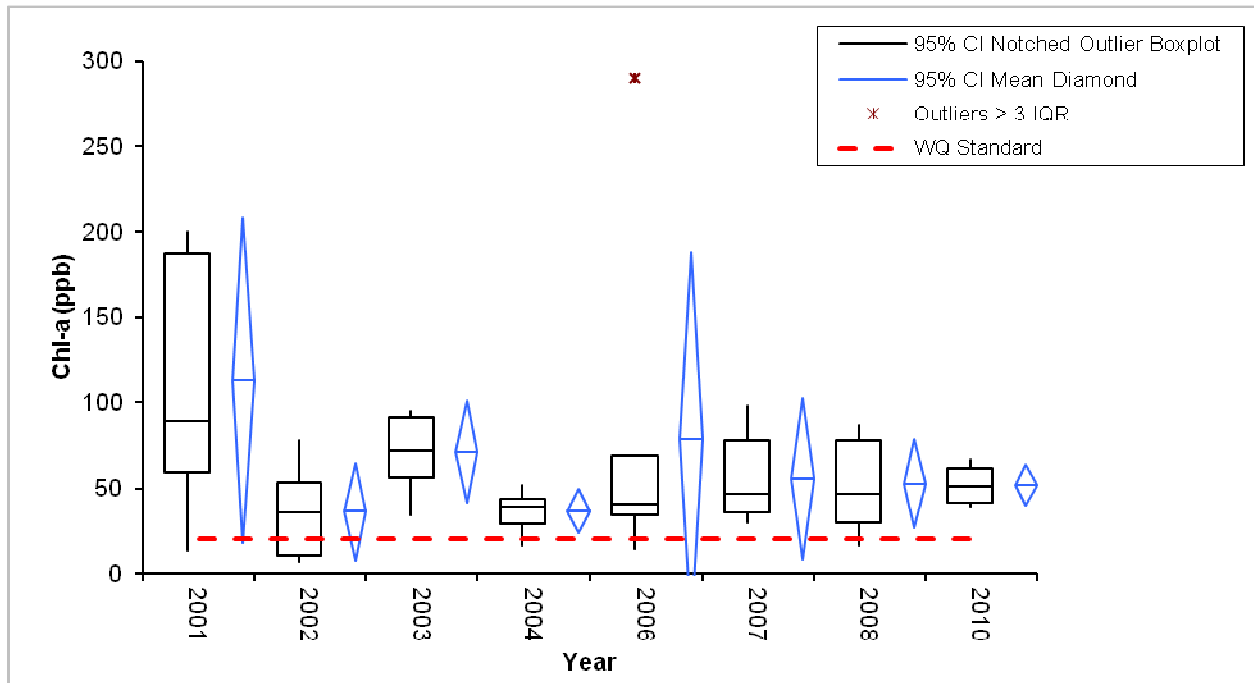
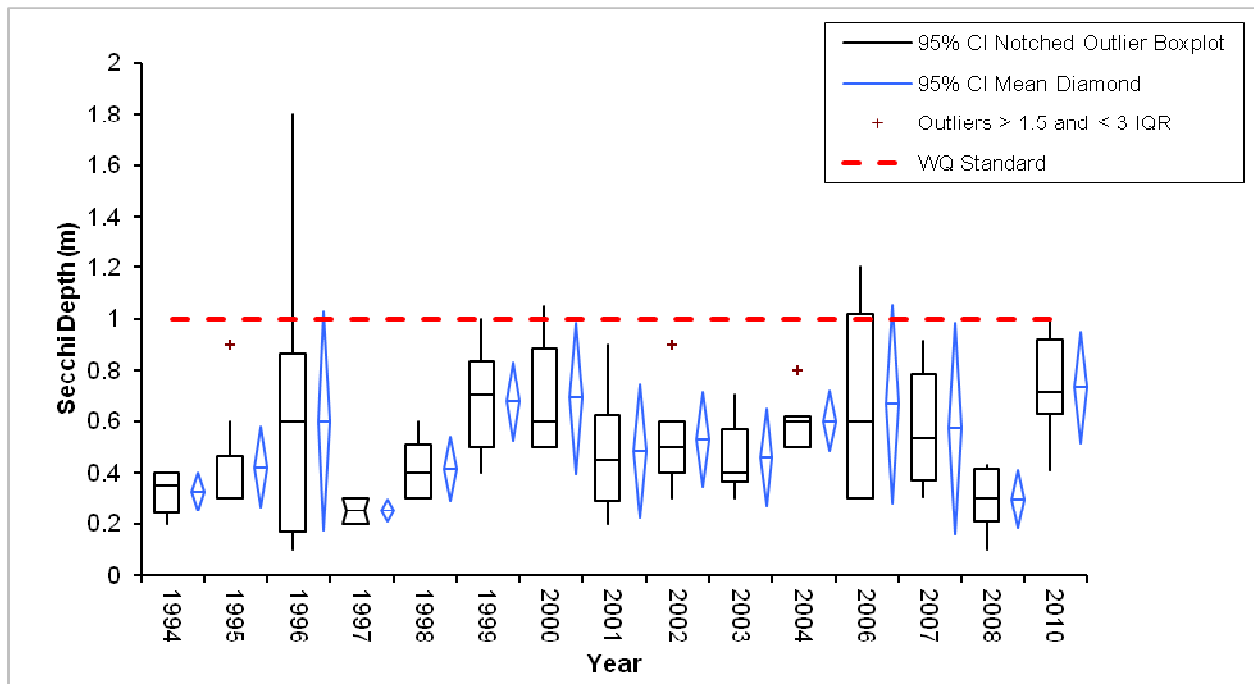


Figure 4: Summer Season (June through September) Secchi Disk Depths in Colby Lake



2.3 Sources of Pollutant causing Impairment

Hydrologic and TP budgets for Colby Lake under current conditions (2008-2010) were developed as part of the *Colby Lake Water Quality Modeling Project (Appendix A)*. The budgets are based on observed

data during the 2008-2010 summer seasons. Specific methods used in developing the budgets are discussed in detail in the report (**Appendix A**). Flow volumes are expressed in acre-feet and TP loads are expressed in units of mass per time (e.g., kg/season) and estimated by considering the concentration of a substance in the water and the amount of water over a time period. The completed hydrologic and TP budgets for Colby Lake are shown in **Figures 5 and 6**. Results of this empirical analysis show that the largest TP input to Colby Lake is from stormwater runoff throughout the watershed (gauged and ungauged).

Figure 5: Colby Lake Summer Season (June through September) Hydrologic Budget: 2008, 2009, and 2010

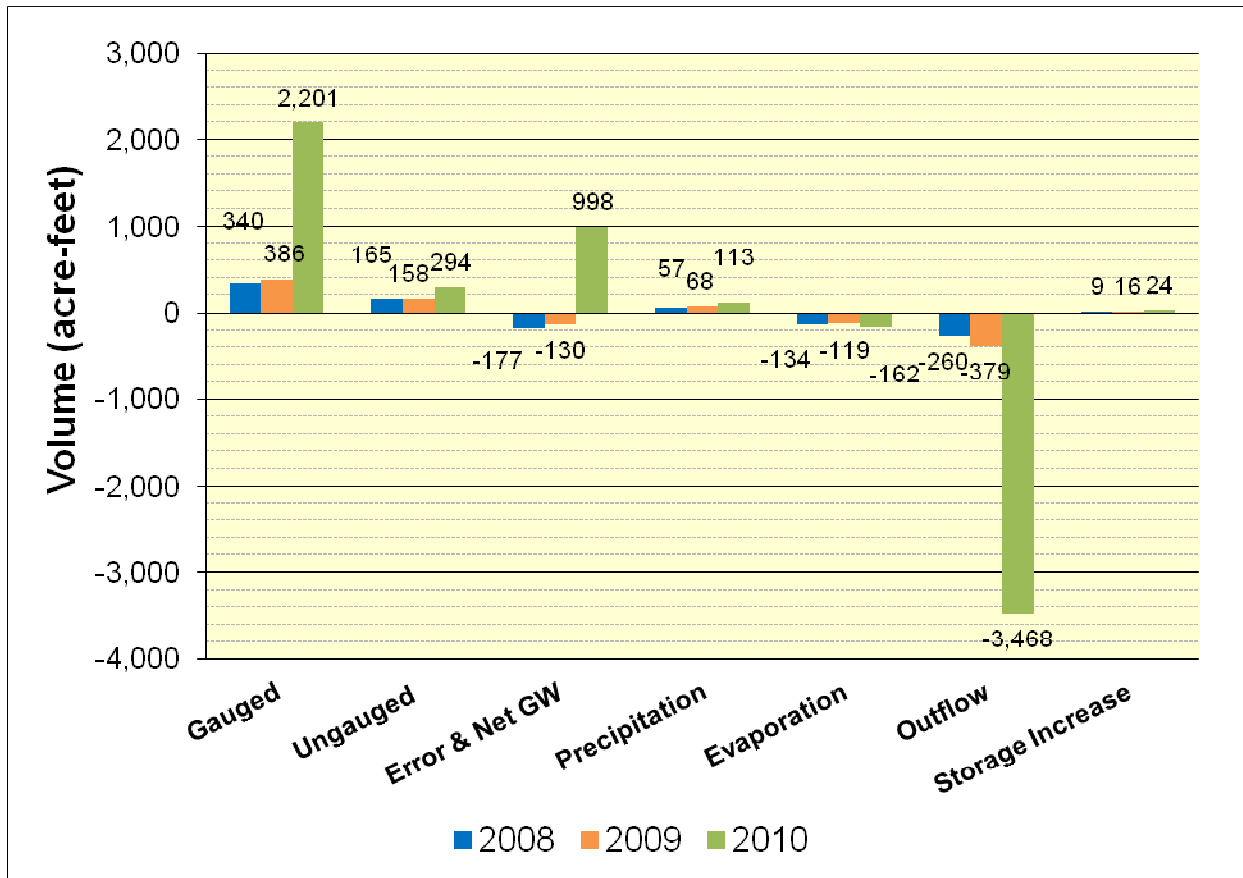
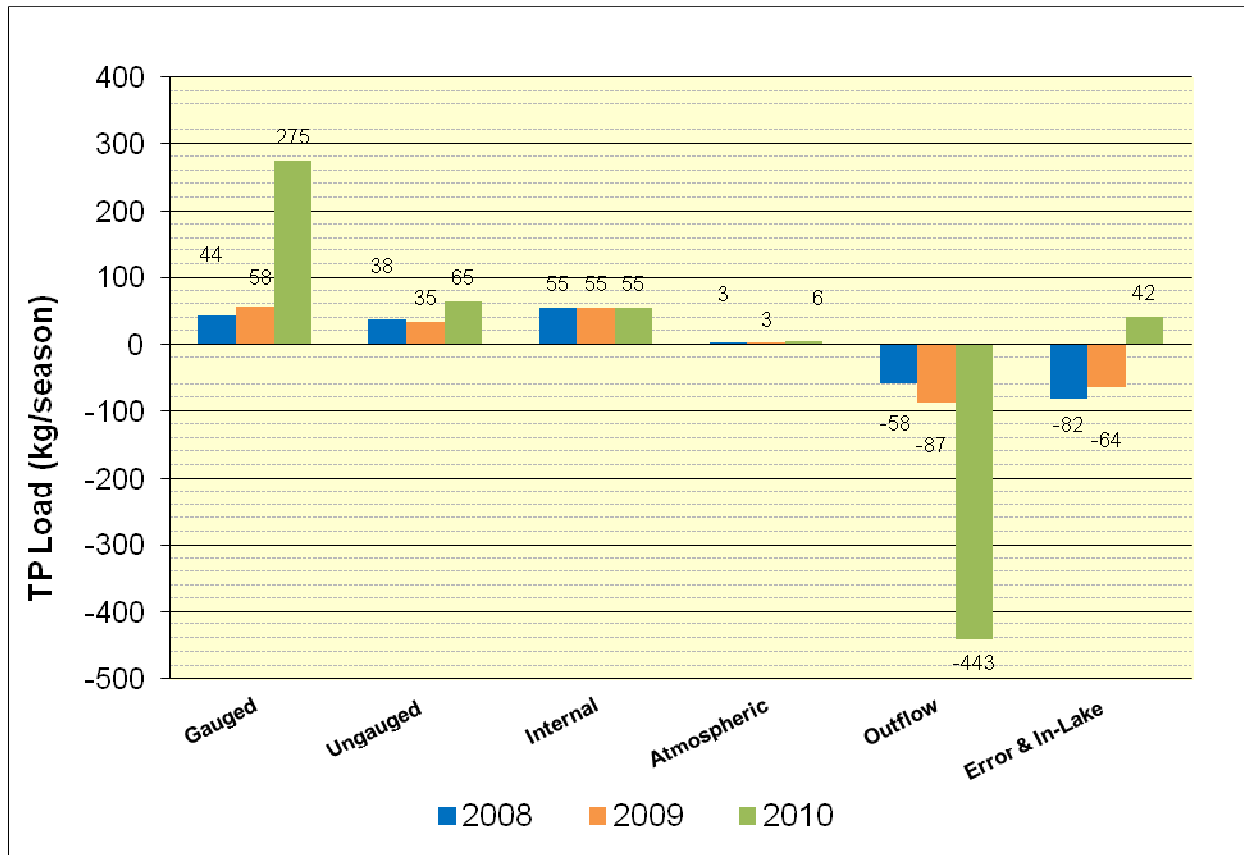


Figure 6: Colby Lake Summer Season (June through September) TP Budget: 2008, 2009, and 2010



Results of the Colby Lake hydrologic and TP budgets were used to calibrate a watershed loading model as detailed in **Appendix A**. Version 3.4 of the P8 model (Program for Predicting Polluting Particle Passage thru Pits, Puddles, & Ponds (<http://www.walker.net/p8/>)) was used to simulate the movement of water, and associated phosphorus loads, from the watershed into Colby Lake. The model was calibrated and validated with observed 2008 – 2010 summer season surface water runoff volumes, TSS loads, and TP loads at the three measurement locations shown in **Figure 1**. Complete details of this process and its results are available in the *Colby Lake Water Quality Modeling Project* report and appendices (**Appendix A**).

The calibrated Colby Lake P8 watershed model was used, in part, to identify catchment TP yield (**Figure 7**) and TP treatment efficiency of existing infrastructure (**Figure 8**) throughout the Colby Lake watershed. Both sets of information were used in prioritizing watershed retrofitting as described in Section 3.3. As shown, TP yields are highest in the few commercial areas within the Colby Lake watershed as well as a few relatively isolated neighborhoods throughout the watershed. The one exception to that, however, is the neighborhood immediately west of the Lake which was the first phase of residential development around Colby. The TP removal efficiencies shown in **Figure 8** reflect a similar dynamic and show opportunities for improvement throughout the watershed. In all, this data supports SWWD’s

management approach that treats TP as a widespread non-point source problem despite the extensive storm sewer network in place.

Figure 7: Colby Lake Watershed Average TP Yield by Catchment

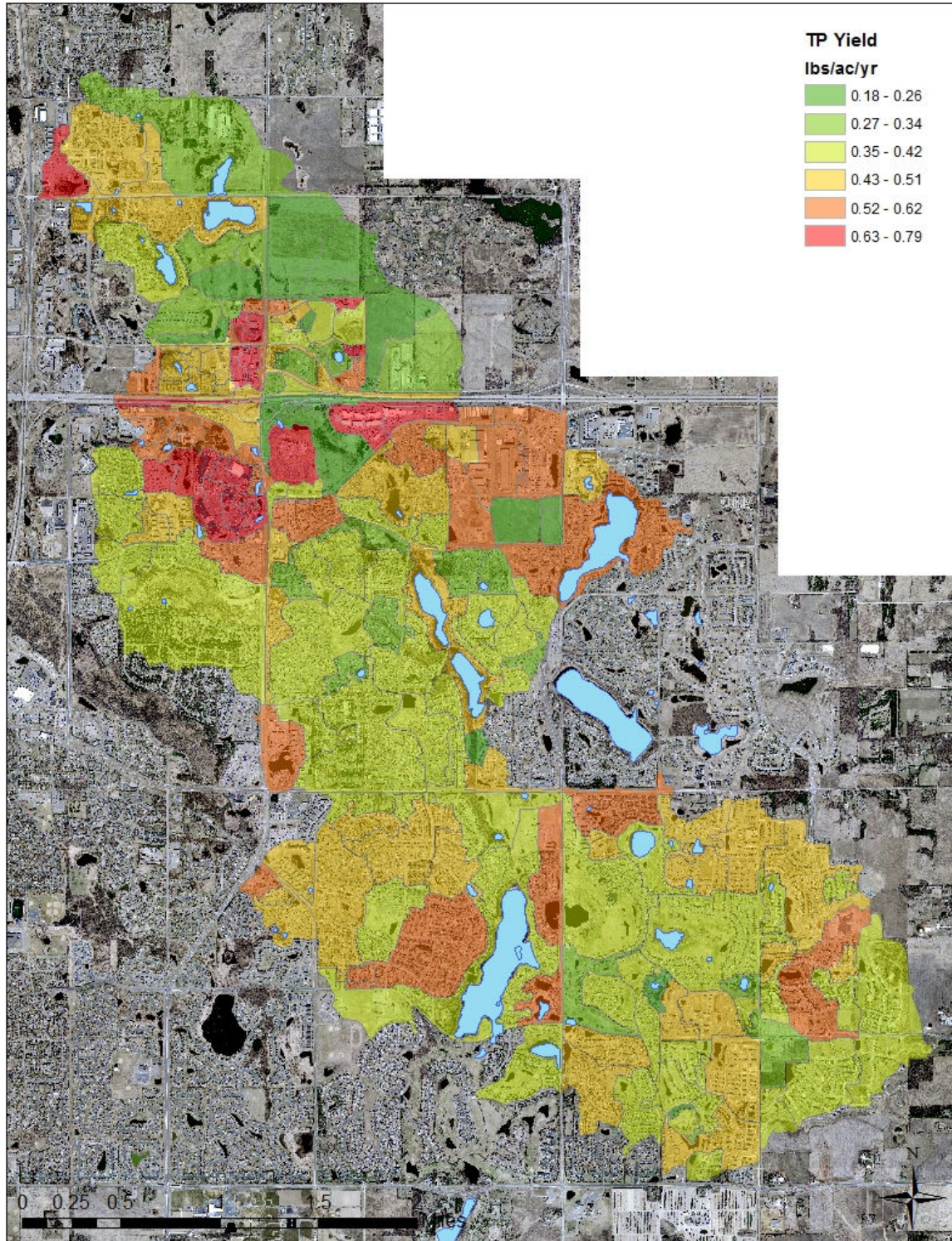
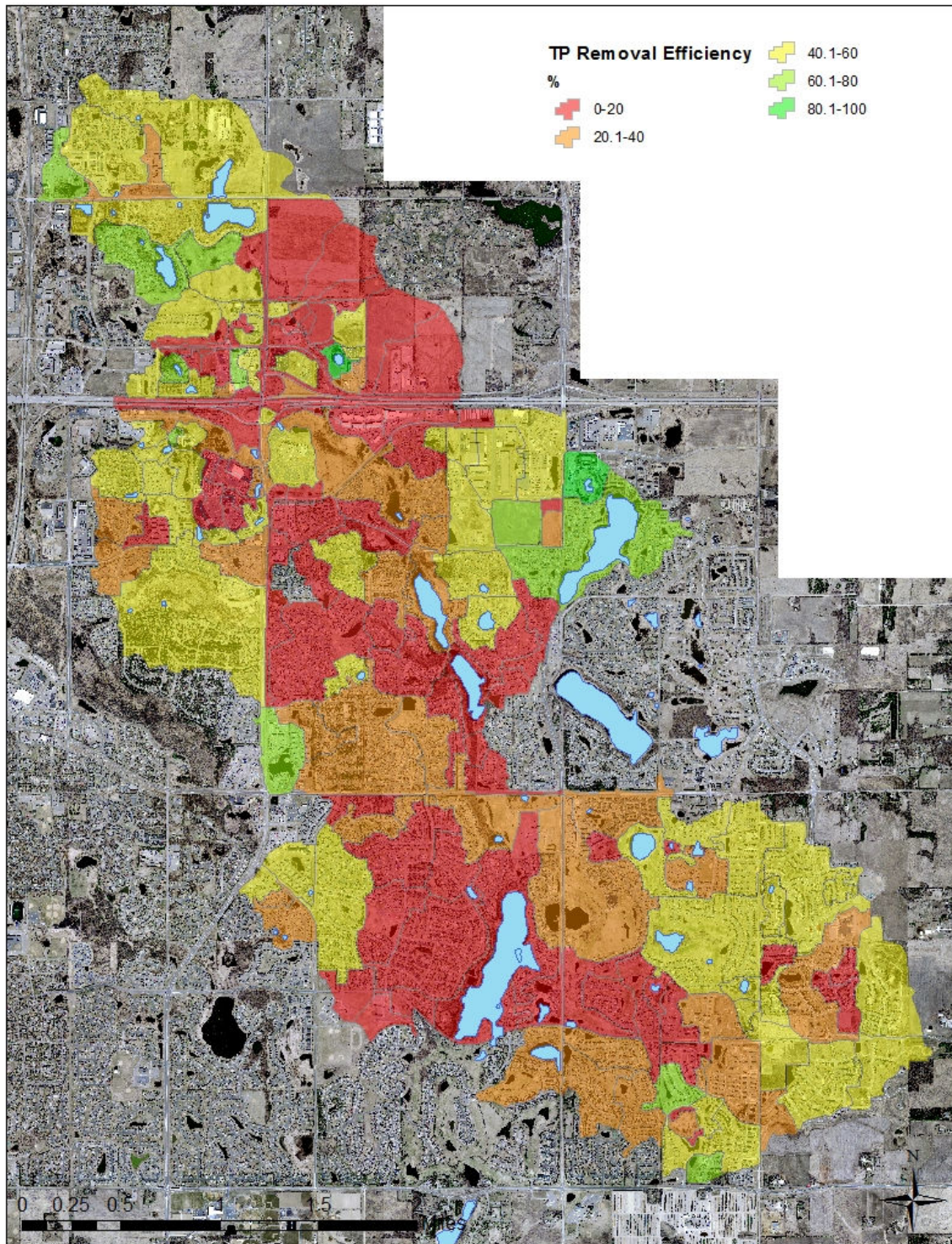


Figure 8: Colby Lake Watershed Average TP Removal Efficiency by Catchment



3.0 Description of Controls

3.1 Water Quality Target

Water quality targets for Colby Lake are defined in Minnesota Rules (MR) Chapter 7050. Colby Lake is not specifically listed in MR 7050.0186 (wetlands) or 7050.0470 (lakes), which pertain to water body use classifications within the major drainage basins of the State. According to 7050.0430, waters that are unlisted in these Rules are classified as Class 2B, 3C, 4A, 4B, 5, and/or 6 waters. Colby Lake is classified as a 2B water. Relative to the aquatic life and recreation classification for 2B waters (see MR 7050.0220) the quality of surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is not protected as a source of drinking water.

With a maximum depth of 11-feet and most of the surface area littoral, Colby Lake is considered a shallow lake. It has an average hydraulic residence time of approximately 1.5 months (according to the model simulations, discussed below). Colby Lake is managed as a Class C lake and is required to meet the MPCA Class 2B water quality standards for shallow lakes in the North Central Hardwood Forest Ecoregion. Based on the available data, the lake does not thermally stratify on a consistent basis. Applicable conventional water quality standards that apply to Colby Lake include dissolved oxygen, pH, and temperature, but nutrients and specifically TP are of primary interest as this is the stressor causing the use impairment. The applicable MPCA eutrophication numeric standards, expressed as the June 1 through September 30 average values for a near-surface (epilimnetic) sample, are listed below.

- TP should not exceed 60 micrograms per liter (ug/L),
- Chl-*a* should not exceed 20 micrograms per liter (ug/L), and
- SD should be not less than 1.0 meter

Recent guidance from MPCA indicates that, based on the analysis of eutrophication causal and response variables during the standards development process, by meeting the TP water quality standard all other standards can likewise be assumed to be met (Zadak, 2011). While SWWD modeling efforts examine all three measures of eutrophication, management goals and programs emphasize TP.

3.2 Source Loadings that will Achieve WQS

The eutrophication response within Colby Lake was modeled stochastically using a combination of the CNET in-lake eutrophication model and Crystal Ball. CNET is a modified version of the receiving water model BATHTUB (<http://www.walker.net/bathhtub/index.htm>), which was created by the Army Corps of Engineers. Crystal Ball is proprietary software developed by Oracle (<http://www.oracle.com/us/products/applications/crystalball/index.html>), which couples with CNET to allow for stochastic simulations within the Microsoft Excel software. Stochastic modeling is an approach where model parameters and input values (*e.g.*, precipitation) used in the equations to

compute the summer season mean concentration of TP, chl-*a*, and SD are allowed to vary according to their statistical distribution and therefore their probability of occurrence. This allows the effect of parameter uncertainty and normal variability in the inputs (*e.g.*, amount of surface runoff which varies annually depending upon the amount of precipitation) to be quantified when computing the summer season mean concentration of TP, chl-*a*, and SD in Colby Lake.

The stochastic modeling approach allowed for multiple probabilistic simulations of the model computations. Many trial values (1,000 trials in this study case) were generated, with each trial representing a different permutation of model parameters and input values within the bounds established by the statistical distributions. The many trials resulted in a computed distribution of summer season mean concentrations rather than a single, fixed output that was based upon only one possible combination of model parameters and inputs. The stochastic approach reflects the variability in model parameters and inputs, and allows explicit determination of their effect on the mean values and the expression of model results as risk. Additional information regarding the modeling approach, methods, and calibration is available in the *Colby Lake Water Quality Modeling Project* report and appendices (**Appendix A**).

In addition to simulating 2008 – 2010 conditions within the Colby Lake watershed, the P8 watershed loading model was also used to simulate a long-term hydrologic and TP loading scenario within the system, using 50-years of forcing function data from 1961 to 2010. Results of this modeling were used to develop stochastic inputs for the CNET model, which was then used to simulate long-term average hydrologic and phosphorus budgets for Colby Lake. Long-term average conditions were considered the current condition scenario when developing load reductions and allocations for Colby Lake. The long-term average (current condition scenario) hydrologic budget and TP mass balance for Colby Lake are shown in **Figure 9** and **Figure 10**. Results show that Colby Lake currently receives a total summer season TP loading of approximately 310 kg. Consistent with what was seen in the 2008-2010 empirical data, the majority (about 250 kg) of that TP comes from surface water runoff; the other major source of TP is from internal load.

Figure 9: Long-Term Average Colby Lake Summer Season (June through September) Hydrologic Budget

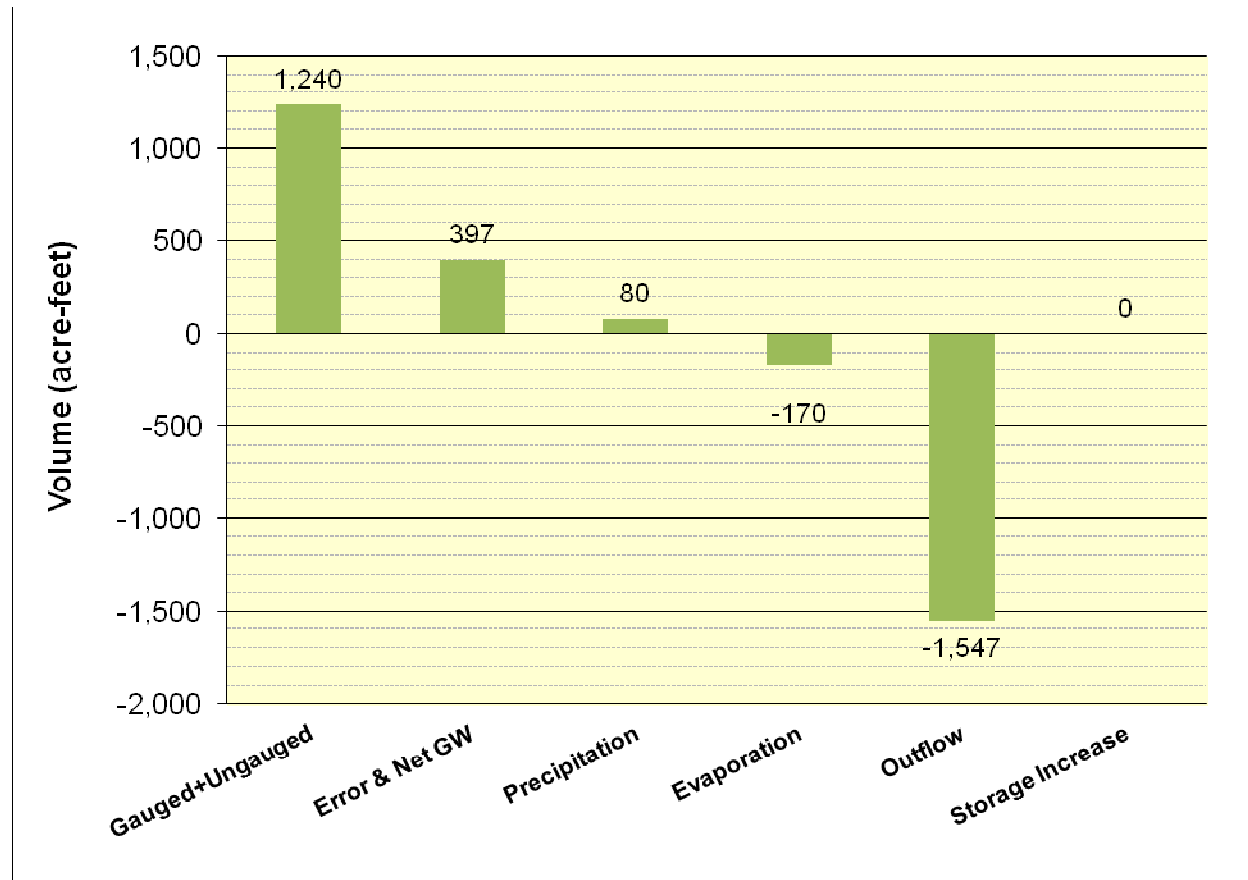
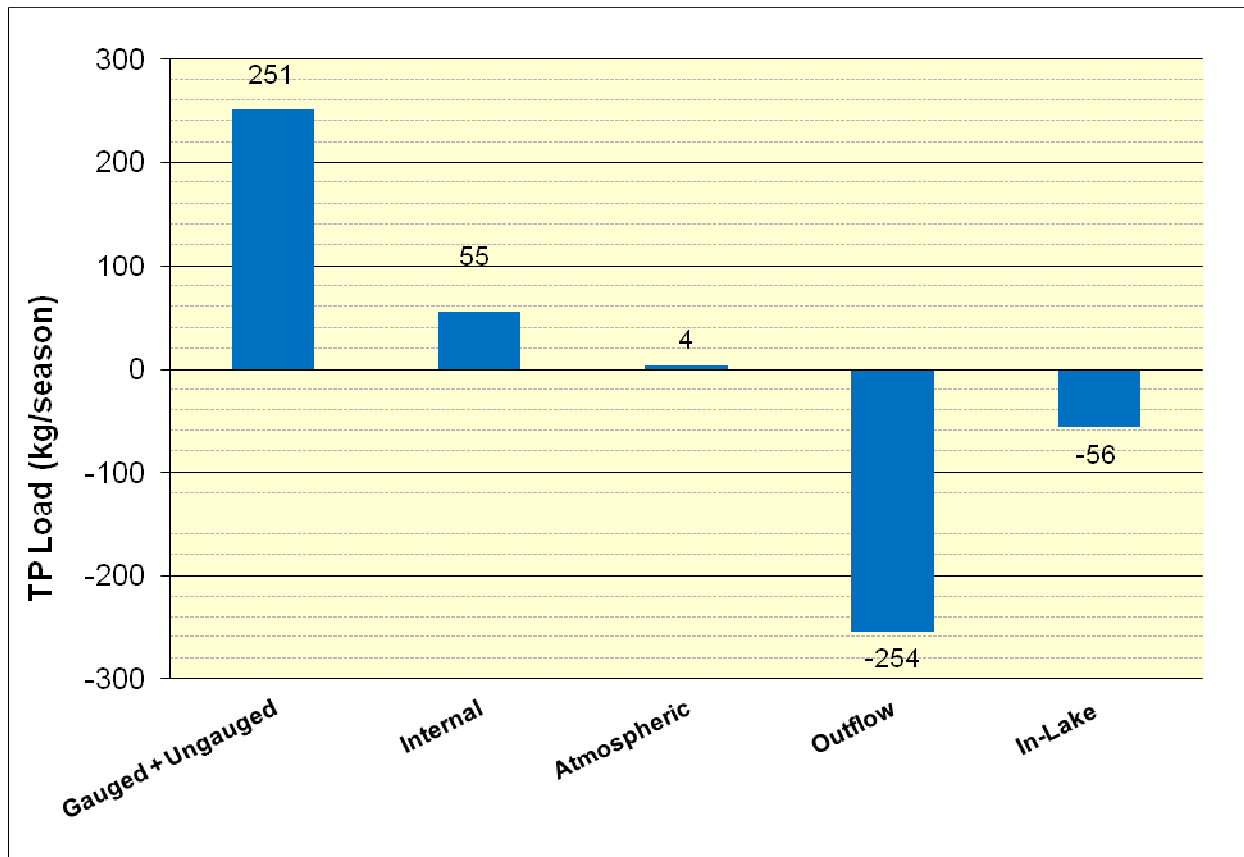


Figure 10: Long-Term Average Colby Lake Summer Season (June through September) TP Mass Balance



To simulate the load reductions and therefore the maximum allowable load (i.e., loading capacity) needed to achieve the state water quality standard in Colby Lake, a series of model simulations were performed. Each simulation reduced the total amount of TP entering Colby Lake during the summer season, computing the anticipated response within the Lake. The goal of the modeling was to identify the loading capacity of Colby Lake (i.e., the maximum allowable load to the system, while still allowing it to meet water quality standards) during the June 1 – September 30 summer season. Consistent with recent MPCA guidance, it was assumed that if Colby Lake meets the state’s TP water quality standard that chl-*a* and SD within the system will respond accordingly and eventually also reach the state-defined goals (Zadak, 2011).

Figures 11 and 12 show the effects of reducing summer season TP loads to Colby Lake on summer mean TP within the lake (based on the CNET model). Loads were reduced incrementally within the CNET model and assumed to come from the surface runoff and internal loading components of the mass balance. Results are presented both in terms of the seasonal mean concentrations (shown by the column graphs) and the results of the Monte Carlo analysis. The stochastic Monte Carlo analysis results are presented as a series of lines, where each line represents a statistical distribution of the seasonal mean TP values.

The loading capacity of Colby Lake is the maximum allowable TP load that the Lake can receive, while still achieving the MPCA's in-lake TP water quality numeric standard of 60 ug/l. Although work completed for the *Colby Lake Water Quality Modeling Project* and summarized in this demonstration was not meant to serve as a TMDL study, the function of a loading capacity described here replicates that developed under a TMDL. Given the similarity between this work and a TMDL, the loading capacity computed for Colby Lake is allocated between non-point sources (i.e., the load allocation – LA – in a TMDL study), point sources (i.e., the wasteload allocation – WLA – in a TMDL study), and a margin of safety (MOS). The LA component of the loading capacity includes existing and future nonpoint sources (i.e., atmospheric deposition and internal load); the WLA component includes storm-sewered and overland runoff from the Colby Lake watershed. The MOS used is an explicit expression, intended to reflect the lack of knowledge and uncertainty in establishing the load capacity.

Using a stochastic approach, the loading capacity (allowable load) of Colby Lake was defined as that which reduces the seasonal mean TP concentration for the 50th percentile non-exceedance value to the MPCA numeric standard (60 ug/l). Since the loading capacity of Colby Lake is computed using a stochastic approach (which takes uncertainty and variability into consideration), the result is already conservative so the MOS was computed as 5% of the allowable load.

Results of the loading capacity analysis are shown in **Figure 12**. A line at 60 ug/L represents the average summer season TP concentration eutrophication standard for the protection of lake quality in shallow Class 2B surface waters in the North Central Hardwood Forest ecoregion. A table accompanying **Figure 11** shows the values used to produce the Figure. Results of this analysis show that the loading capacity of Colby Lake is approximately 160 kg/summer season and that a 150 kg summer season TP load reduction is needed to achieve the water quality standard.

Figure 11: Colby Lake Seasonal Mean (June through September) TP Concentrations under Select Load Reduction Scenarios; Current Conditions = 310 kg/season

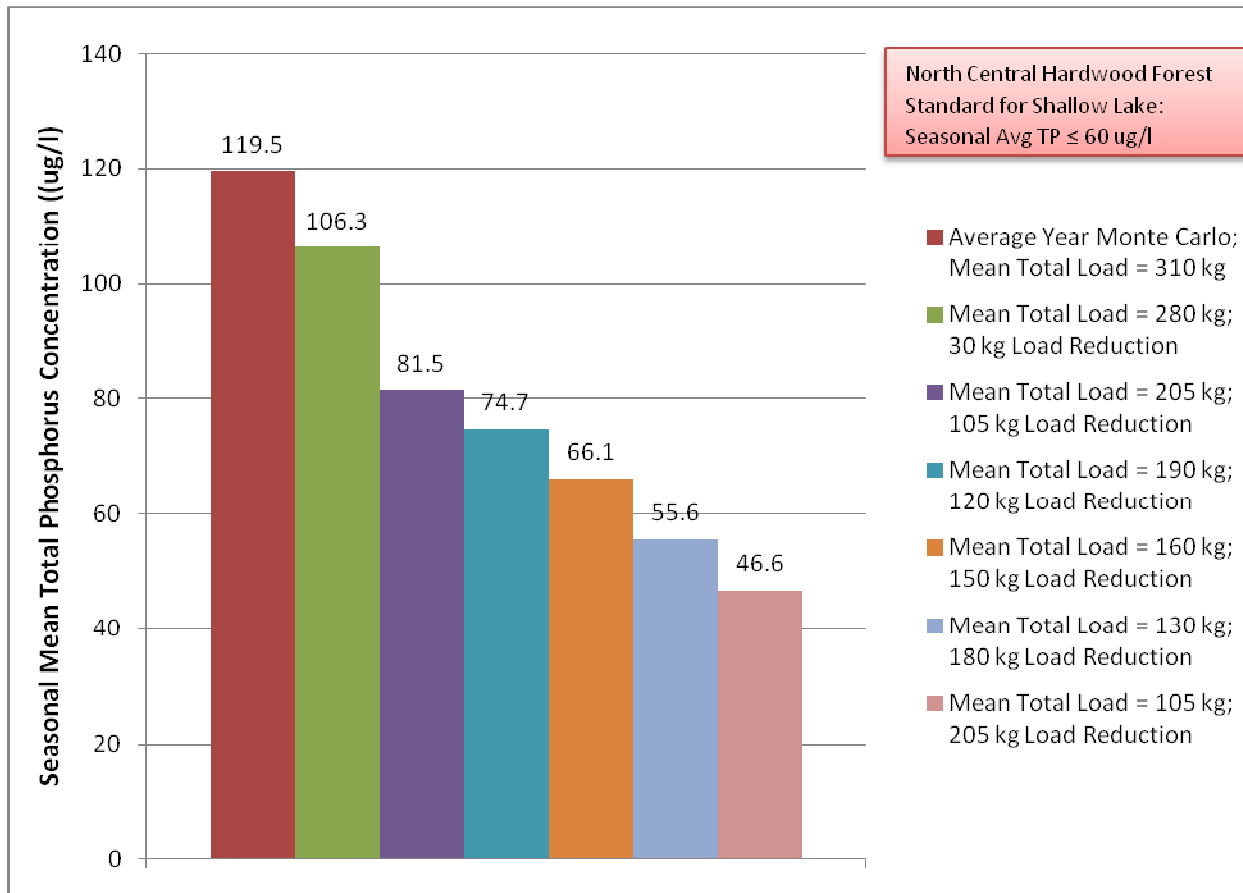
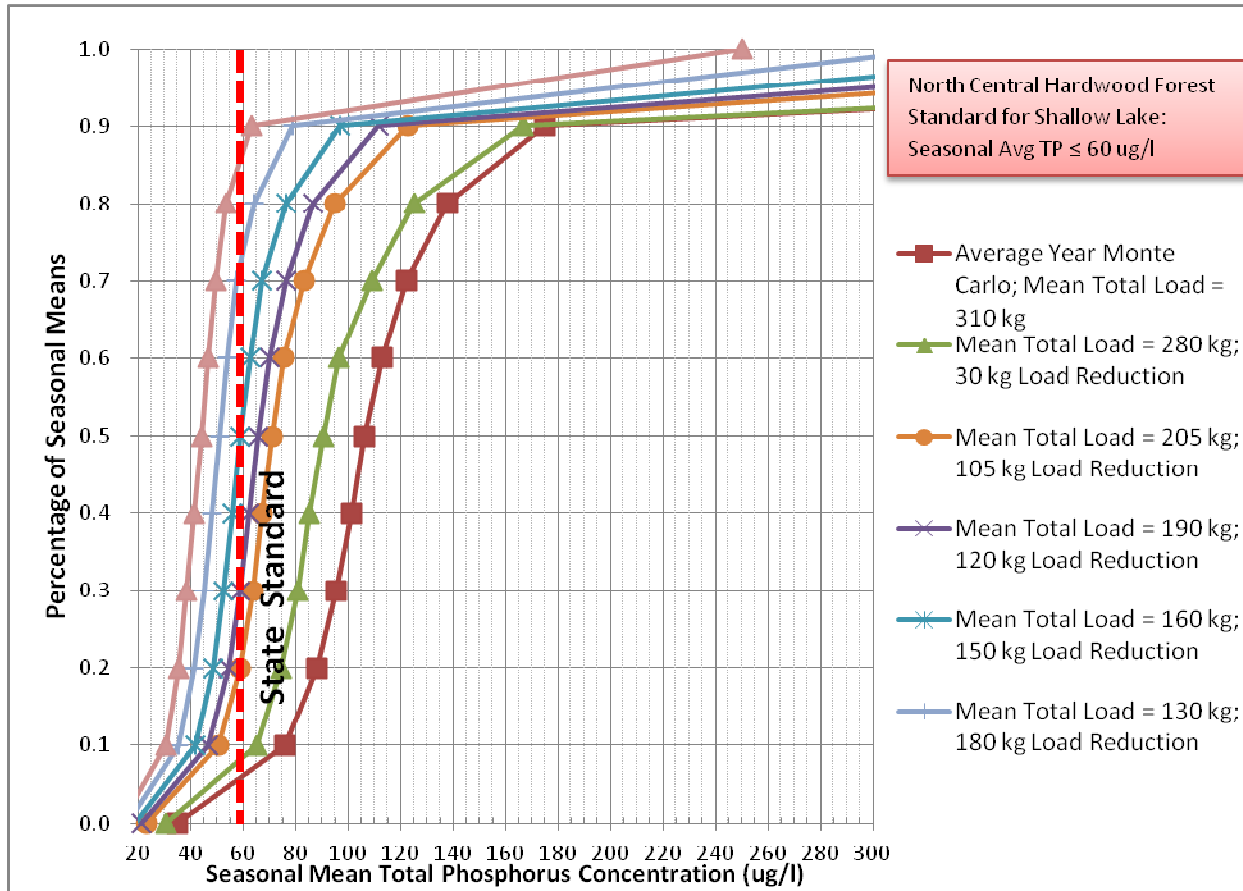


Figure 12: Colby Lake Frequency Distribution of Seasonal (June through September) Mean TP Concentrations Resulting from Select Load Reduction Scenarios and Table of Data used to Produce the Graphical Illustration; Current Conditions = 310 kg/season



Load Reduction from Current Load for Average Summer Season

Non-exceedance Percentile	Average Year (current)	30 kg	105 kg	120 kg	150 kg	180 kg	205 kg
Mean	119.5	106.3	81.5	74.7	66.1	55.6	46.6
0%	35.0	30.7	23.3	21.3	18.9	15.9	13.4
10%	75.9	65.0	50.6	46.5	41.7	35.5	30.4
20%	88.3	74.4	59.0	54.3	48.6	41.5	35.2
30%	95.5	80.6	63.8	59.0	52.5	45.2	38.6
40%	101.3	85.2	67.0	62.2	56.0	48.1	41.4
50%	106.3	90.5	71.0	65.7	59.0	51.1	44.1
60%	113.1	96.6	75.4	70.1	62.8	54.0	46.6
70%	122.2	109.0	83.1	76.3	67.4	57.2	49.5
80%	137.7	125.3	95.1	86.7	76.3	64.0	53.4
90%	174.8	166.9	122.8	111.6	97.0	78.9	63.3
100%	756.3	753.9	545.6	488.4	415.7	326.4	250.1

Table 1 shows the current condition loading and desired future loading to Colby Lake on a daily basis. This is the load allocation that would be employed if Colby Lake were to be evaluated as a TMDL-listed water body. The summer season daily values presented in **Table 1** were computed based on seasonal values shown in **Figure 11** and its accompanying table.

Table 1: Colby Lake Loading Capacity to Meet State Standards

	Loading (kg/day)	=	Load Allocation (kg/day)	+	Wasteload Allocation (kg/day)	+	Margin of Safety (kg/day)
Current Condition	2.54	=	0.48	+	2.06	+	0
Goal: 60 ug/L	1.31	=	0.23	+	1.02	+	0.06

As summarized in **Table 1**, it is estimated that the current 2.54 kg/d (310 kg/ season) summer season TP load to Colby Lake would have to be reduced to 1.31 kg/d (160 kg/season) to meet applicable water quality targets. Under this scenario, the wasteload allocation (storm-sewered runoff from the watershed) would have to be reduced by 51%; from 2.06 to 1.02 kg/d (250 to 124 kg/season). The wasteload allocation represents what is considered a technically feasible reduction through the installation of BMPs during retrofit and redevelopment. The load allocation (internal load) would have to be reduced by 55%; from 0.45 kg/d to 0.20 kg/d (55 to 25 kg/season). The load allocation represents what is considered a technically feasible reduction associated with changing Colby Lake from the turbid to clear phase. In reality any combination of waste load allocation and load allocation equaling 1.31 kg/d is able to achieve the loading capacity.

3.3 Controls that will achieve WQS

There are three sources that need to be addressed in order for Colby Lake to ultimately meet water quality standards. First, upstream loading from Wilmes Lake needs to be reduced by 71kg/summer season. Second, loading from Colby Lake’s immediate drainage area needs to be reduced by 55 kg/ summer season. And, finally, internal loading needs to be reduced by 30 kg/ summer season.

The necessary 71 kg/ summer season load reduction coming from Wilmes Lake will be realized when Wilmes Lake meets state water quality standards. Analysis of processes within Wilmes Lake and reductions necessary for Wilmes Lake to meet water quality standards is outside the scope of this demonstration; however, those activities are planned and budgeted for in the SWWD long range work plan and included in section 4 (Implementation Schedule) of this report. That work will be included in the next update of the SWWD NWS 4B Demonstration.

To reduce internal TP loading, some form of phosphorus sequestration will be needed. Various methods can be employed toward that goal; one of the more common methods is alum treatment. Alternatively and perhaps more likely for Colby Lake, is that the internal load reduction can be realized by

transitioning the lake from the turbid to clear state, through a combination of curly leaf pond weed control, fish management and the establishment of native aquatic vegetation. Assumptions about achieving this amount of reduction are reasonable based on data from Lake Christina (west-central Minnesota) collected by the MnDNR, which show a 50% reduction in, in-lake concentrations when the lake is in the clear versus turbid state.

The bulk of the controls described in this demonstration address loading from Colby Lake's immediate watershed as shown in **Figure 1**. Drawing on information provided from the *Colby Lake Water Quality Modeling Project (Appendix A)*, SWWD utilized the Metro Conservation District's (MCD) Subwatershed Retrofit Assessment Protocol for identification and prioritization of projects to meet necessary load reductions in the Colby Lake watershed. The protocol prioritizes projects based on performance and cost-effectiveness to help maximize the value of each dollar spent on implementation.

The Retrofit Assessment Protocol is carried out in the four steps outlined below.

1. Project Scoping

Retrofit scoping includes determining the objectives of the retrofits (volume reduction, target pollutant etc) and the level of treatment desired. It involves meeting with local stormwater managers, city staff and watershed district staff to determine the issues in the subwatershed. This step also helps to define preferred retrofit treatment options and retrofit performance criteria. In order to create a manageable area to assess in large subwatersheds, a focus area may be determined.

With the Colby Lake watershed and target pollutant (total phosphorus) already established, project scoping for the Colby Lake Retrofit Assessment included determining a specific focus area within the Colby Lake subwatershed. SWWD and WCD determined that, based on past assessments of similar areas, the primary focus area should be within catchments having two or fewer existing levels of treatment. This led to the selection of 22 catchments where potential BMP retrofits would maximize the impact of installation. All treatment options were considered.

2. Desktop Assessment

The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. All 22 catchments identified in step 1 were analyzed using GIS software and readily available data to identify potential retrofits and eliminate catchments where retrofits would be of little benefit.

3. Retrofit Reconnaissance Investigation

For Colby Lake, all 22 focus catchments were investigated and 3 were eliminated from consideration due to a lack of potential for BMP retrofits. WCD staff identified 497 potential BMP retrofit locations within the remaining 19 catchments, with BMP types including pond modifications, treatment swales, bioretention cells, and sand-iron filters. Sites identified during

this process represent the greatest opportunities for water quality improvement in the Colby Lake watershed.

4. Treatment and Cost Analysis

Treatment analysis was performed using the P8 calibrated and validated for the Colby Lake Water Quality Modeling Project. Cost analysis was completed using a spreadsheet model to estimate the cost of BMPs considering site constraints, average local soil conditions, directly/indirectly connected impervious areas, and expected BMP performance. The existing conditions P8 model was modified to include all BMP scenarios within the existing infrastructure. In some cases catchments do not currently receive any treatment (e.g., the direct drainage areas surrounding Colby Lake), and other catchments drain through several levels of existing stormwater ponds or wetlands before reaching the lake. Loading reduction results obtained from P8 are useful both as a relative comparison between catchments to determine the highest priority catchments for BMP installation, and as a way to quantify loading reduction estimates to Colby Lake from each catchment. When considered cumulatively, adding BMP retrofits within the modeled catchments will help Colby Lake meet seasonal load reduction goals.

The completed Colby Lake Retrofit Assessment analysis and report is included in **Appendix B**. The summary table, which lists identified priority catchments, estimated retrofit benefits, and projected cost is included in **Table 2**, below. As discussed on page 20, the load allocation for Colby Lake assumes a 55 kg/season reduction in TP loading from the watershed surrounding the Lake through implementation of identified projects. As shown in Table 2, implementation of all of the currently identified projects would result in a 67 kg/season TP reduction, more than that needed to meet the water quality standard. Priority catchments and identified BMP projects are shown in **Figure 13**.

Table 2: Colby Lake Retrofit Assessment Summary Table

Catchment ¹	Project Type	BMP Quantity	Growing Season TP Reduction (kg)	Design and Installation Cost	Annual Operation/Maintenance Cost ²	Total Term Cost (\$/kg/yr)	Anticipated SWWD Cost Share ³	Anticipated SWWD CCIP	Anticipated SWWD SUF	Anticipated Implementation
CL1E6_1 and CL1E8_1	Sand/Iron Filter	2	23.7	\$85,880.00	\$2,640.00	\$232.18		\$30,058.00		2012
CL1N3_1	Bioretention	1	0.6	\$2,430.00	\$112.50	\$322.50	\$1,215.00			2013
CL1N2_1	Sand/Iron Filter	1	7.1	\$42,940.00	\$1,320.00	\$387.51		\$15,029.00		2012
CL1_1	Sand/Iron Filter	1	6.4	\$42,940.00	\$1,320.00	\$429.90			\$42,940.00	2014
CL1E3_1	Bioretention	6	1.8	\$18,014.40	\$972.00	\$873.60	\$9,007.20			2018-2021
CL1W1_1	Bioretention	15	0.9	\$36,450.00	\$1,687.50	\$3,225.00	\$18,225.00			2018-2021
CL1E6_2	Bioretention	16	0.9	\$33,360.00	\$1,800.00	\$3,235.56	\$16,680.00			2018-2021
CL1E6_1	Bioretention	10	0.5	\$20,850.00	\$1,125.00	\$3,640.00	\$10,425.00			2018-2021
CL1N1_1	Bioretention	4	0.2	\$9,720.00	\$450.00	\$3,870.00	\$4,860.00			2018-2021
CL1E3_1A	Bioretention	32	1.6	\$77,760.00	\$3,600.00	\$3,870.00	\$38,880.00			2018-2021
CLCL1Ad12	Bioretention	29	1.8	\$86,417.10	\$4,306.50	\$3,992.82	\$43,208.55			2017-2020
CLHghHt1P1	Bioretention	9	0.6	\$30,836.70	\$1,427.63	\$4,092.53	\$15,418.35			2017-2020
CLQryRdgPA	Bioretention	10	0.6	\$28,356.00	\$1,530.00	\$4,125.33	\$14,178.00			2017-2020
CL1N2_1	Bioretention	51	2.7	\$162,052.49	\$5,737.50	\$4,125.65	\$81,026.25			2016-2019
CL1N3_1	Pond Modification	1	1.6	\$183,387.60	\$500.00	\$4,133.08		\$64,185.66		2016
CL2_1	Bioretention	24	1.6	\$85,604.40	\$4,266.00	\$4,449.68	\$42,802.20			2013-2016
CL1_1	Bioretention	110	7.5	\$409,736.25	\$20,418.75	\$4,543.55		\$35,000.00	\$150,000.00	2012-2016
CL1W2_1	Bioretention	76	2.9	\$158,460.00	\$8,550.00	\$4,769.66			\$79,230.00	2014-2017
CLBLdCDP38	Bioretention	12	0.8	\$48,114.00	\$2,227.50	\$4,789.13	\$24,057.00			2017-2020
CL1E7_1	Bioretention	36	1.4	\$87,480.00	\$4,050.00	\$4,975.71	\$43,740.00			2015-2018
CL1E2_1	Swale	1	0.2	\$6,000.00	\$900.00	\$5,500.00		\$2,100.00		2012
CL3_1	Bioretention	25	0.9	\$96,595.50	\$4,471.88	\$8,546.37	\$48,297.75			2015-2018
CL1E6_2	Pond Modification	1	0.4	\$131,488.91	\$358.50	\$11,853.66		\$46,021.12		2012
Totals			67.0					\$412,020.30	\$192,393.78	\$272,170.00

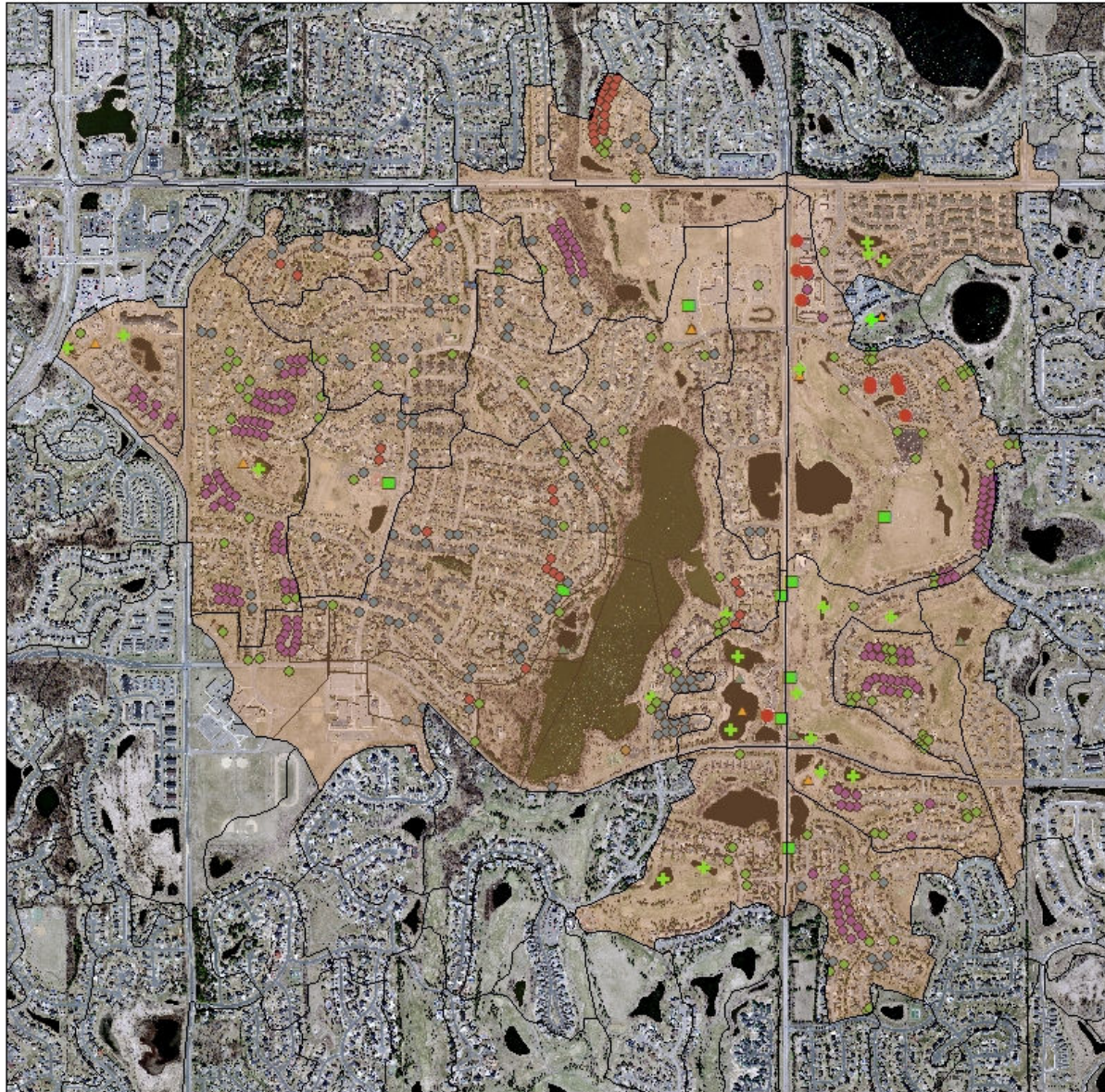
¹Catchment and project descriptions are included in the Retrofit Assessment Report (**Appendix B**).

²Annual operation and maintenance cost is the responsibility of the property owner, as typically required under SWWD funding agreements.

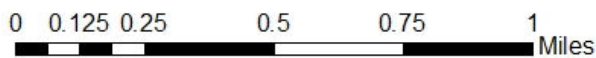
³Assumes SWWD cost share will cover an average of 50% of the project cost, as is typical for the program.

Figure 13: Colby Lake Priority Catchments and Identified Projects

Colby Lake Priority Catchments and Identified BMPs



- | | | |
|------------------------------|--------------------------|-------------------------|
| Priority Catchments | Bioretention Maintenance | Complex Bioretention B |
| Swale | Moderate Bioretention A | Pond Mod or Maintenance |
| Underground Sand Iron Filter | Moderate Bioretention B | Stormwater Planter |
| Sand Iron Filter | Complex Bioretention A | Permeable Pavers |



3.4 Requirements under which Pollution Controls will be Implemented

SWWD is a special purpose, local unit of government with independent taxing and limited regulatory authorities. Rather than following political boundaries, SWWD's boundary follows that of a natural watershed allowing it to manage water resources as a whole. Managing resources on a watershed basis allows for an overall, holistic approach to conservation and eliminates difficulties generally encountered when working across political boundaries. Watershed Districts were authorized by the state of Minnesota in the 1955 Watershed Act, MS103D, which sets the roles and responsibilities of watershed districts.

As a watershed district in the state of MN, SWWD has the following general power under MN Statutes 103D.335 subdivision 1:

1. To sue and be sued;
2. To incur debts, liabilities, and obligations;
3. To exercise the power of eminent domain;
4. To provide for assessments and to issue certificates, warrants, and bonds; and
5. To perform all acts expressly authorized, and all other acts necessary and proper for the watershed district to carry out and exercise the powers expressly vested in it.

Additionally, as a Twin Cities Metropolitan Watershed District, SWWD has the following authorities and purposes according to MN Statutes 103B.201:

1. To protect, preserve, and use natural surface and groundwater storage and retention systems;
2. To minimize public capital expenditures needed to correct flooding and water quality problems;
3. To identify and plan for means to effectively protect and improve surface and groundwater quality;
4. To establish more uniform local policies and official controls for surface and groundwater management;
5. To prevent erosion of soil into surface water systems;
6. To promote groundwater recharge;
7. To protect and enhance fish and wildlife habitat and water recreational facilities; and
8. To secure the other benefits associated with the proper management of surface and ground water.

MN Statutes require watershed districts to adopt a Watershed Management Plan (WMP; 103D.401; Metro; 103B.231 and MN Rules 8410) and Rules (103D.341) to implement powers necessary to implement the WMP. MN Statutes also authorize SWWD to regulate, conserve, and control the use of water within the District (103D.335), conduct studies and monitoring of water resources within the District and implement water resource management programs (103D.335), review and approve local water management plans (103B.211), regulate the use and development of land in the watershed in the absence of an approved local management plan (103B.211), to adopt a budget and raise necessary

funds through ad valorem tax levies (103B.211), and raise funds through assessments for project funding (103B.211).

SWWD's WMP follows the guidelines (MS 103D.405) of the MN Board of Water and Soil Resources (BWSR) and was approved following review by BWSR, the Metropolitan Council, the MN Department of Health, the MnDNR, the MN Department of Transportation, and the MPCA. The WMP serves as the foundation on which all SWWD actions are based by documenting priorities, establishing SWWD water quantity and quality standards, authorizing planning efforts, establishing taxing and levy mechanisms, and establishing implementation programs.

SWWD development and redevelopment standards (Chapter 6, SWWD WMP) as developed for the WMP require phosphorus loading from the site to be less than 0.34 lbs/ac/yr in the Colby Lake watershed. While we do not expect the SWWD TP loading standard to meet in lake water quality goals and standards for Colby Lake, it does represent a reduction from the current level of loading from most Colby Lake catchments (**Figure 7**) and will guard against future increases in phosphorus loading following development and redevelopment. Nonetheless, opportunities for further development or redevelopment in the Colby Lake watershed are limited. As such, SWWD is not relying on phosphorus reductions due to the SWWD TP loading standard to achieve any of the load reduction necessary to meet water quality standards. Rather, SWWD anticipates that the direct watershed load reduction will be achieved through implementation of projects identified through the MCD Retrofit Assessment Protocol.

Projects identified through the Colby Lake Retrofit Assessment (**Appendix B**) will be implemented through a variety of SWWD programs and collaborative efforts with the City of Woodbury, Washington County, the Washington Conservation District, and private landowners. SWWD has a long track record of success with these collaborative efforts, examples of which are discussed below.

Implementation of identified projects on private lands will be pursued through the District's Water Quality Cost Share Program (**Appendix C**) which has proven to be popular with residents in the Colby Lake watershed. The cost share program, authorized by SWWD's WMP, has been in place since 2008 and currently provides \$5,000/lb of TP treated or retained on site. Generally, the current funding rate covers 25-75% of the cost of installing a BMP depending on whether the resident does the work or hires a contractor. The District's 2011 cost share program budget was \$95,000. As of June, the entire 2011 budget had been allocated, and several potential applicants were turned away. Of the projects funded in 2011, more than three-fourths were in the Colby Lake watershed even though no efforts were made to actively promote the program in those neighborhoods. Beginning in 2012, the program will be actively promoted to Colby Lake residents in collaboration with the WCD and East Metro Water Resource Education Program (EMWREP, http://www.mnwcd.org/water_education_contact.php) of which SWWD is a partner. EMWREP is a partnership formed to develop and implement a comprehensive water resource education and outreach program with the goal of improving water quality education and outreach.

A similar effort was undertaken in SWWD's Powers Lake watershed in 2011 for the Powers Trees project. The Powers Lake watershed is adjacent to the Colby Lake watershed and is nearly identical demographically. While Powers Lake is not currently impaired, excess nutrient loading is an increasing

concern. In an effort to protect Powers Lake, SWWD in collaboration with WCD and the City of Woodbury funded and promoted a program to increase infiltration through reforestation of a single study catchment. Organizers made extensive outreach efforts to identify homeowners willing to participate in the program. Organizers of that outreach effort set a goal of identifying locations for 100 tree bioinfiltration BMPs. Of 82 homeowners contacted during the outreach efforts, 64 were receptive to participating in the project. Ultimately, 147 trees were planted on 54 properties, surpassing the original goal of the program. A similar approach will be employed in the Colby Lake watershed to enlist owners of properties prioritized using the retrofit assessment protocol in public/private partnerships. We expect outreach efforts in the Colby Lake watershed to have success similar to the Powers Trees project. Likewise we anticipate that available funding for implementation of priority projects on private lands to be quickly allocated.

Implementation of identified projects on public lands and right-of-ways will be pursued through the District's Coordinated Capital Improvement Program (CCIP, **Appendix D**). The program was developed to facilitate actions that improve stormwater management in existing developed areas and is operated as a grant program with applications accepted each spring. CCIP, authorized by SWWD's WMP (section 2.3), has been in place since 2010 and currently provides funding for up to 35% of the total project cost. In 2010, SWWD allocated \$322,625 for two projects that treated or retained 72 lbs (33 kg) of phosphorus on-site. In 2011, available funding was separated into two pots; \$300,000 for Capital Improvements and \$120,000 for maintenance of existing infrastructure. 2011 CCIP Capital Improvements are expected to treat or retain 94 lbs (43 kg) on site. In 2012, \$600,000 is budgeted for CCIP; \$500,000 for capital improvements and \$100,000 for maintenance. Implementation of projects identified through the retrofit assessment protocol will be prioritized for allocation.

In addition to the Water Quality Cost Share and CCIP funding identified above, SWWD budgets an additional \$50,000 annually for water quality improvement in the Colby Lake watershed. These funds can be used to implement individual projects, supplement Cost Share and CCIP funding, pursue unexpected opportunities, or implement in-lake TP sequestration efforts. Past uses of similar funds have included construction of regional infiltration basins, installation of flood control gates at lake outlets, construction of a road salt storage facility and retrofit of road salt application equipment, ravine restoration, property acquisition, and improvement of regional detention ponds.

In addition to funding provided through SWWD's annual budget, we anticipate supplemental funding to be provided through the State's Clean Water Fund (CWF) which is administered as a grant program through the State Board of Water and Soil Resources. Fiscal year 2011 CWF grant dollars secured by the Washington Conservation District were used to supplement SWWD cost share and CCIP funding for priority projects identified through the MCD Retrofit Assessment Protocol. Likewise, we expect future applications featuring similar projects to remain competitive in the grant process with grant dollars used to complement existing SWWD cost share and CCIP funding as further incentive to participation.

4.0 Estimate or Projection of Time When WQS will be Met

The anticipated time frame for implementation of the projects identified in **Table 2** is 10 years (see Section 5.0). Given that Colby Lake is a shallow system with a very short residence time, a rapid response to reduced TP loading from watershed and internal loading is expected. Under typical climatic

conditions, Colby Lake is expected to meet in-lake water quality standards at the end of the implementation time frame.

5.0 Schedule for Implementing Pollution Controls

As mentioned previously, there are three TP sources that need to be addressed in order for Colby Lake to ultimately meet water quality standards—loading from Wilmes Lake, immediate watershed drainage, and internal loading. Modeling and retrofit assessments for Wilmes Lake, similar to those described above for Colby Lake are scheduled and budgeted for in the SWWD long-range work plan and will identify a loading capacity and identify implementation priorities for Wilmes Lake. We expect those efforts will be complete in 2012 and included in the 2013 update for this 4b Demonstration. Likewise, as we expect this 4b Demonstration to ultimately cover the entire SWWD NWS, modeling and retrofit analysis efforts the remaining NWS lakes are scheduled and budgeted. **Table 3** summarizes the schedule for completing modeling and retrofit analyses on for all NWS lakes.

Table 3: Timeline for Completion of NWS Modeling and Retrofit Analysis Efforts

Lake	Watershed Modeling	In-Lake Modeling	Subwatershed Retrofit Analysis	Included in 4b Demonstration/ Update
Armstrong	2011	2014	2014	2015
Markgrafs	2011	2013	2013	2015
Powers*	2010	2010	2010	N/A
Wilmes	2011	2012	2012	2013
Colby	2011	2011	2011	2011

* Powers Lake is considered to be hydrologically disconnected from the rest of the NWS and is not impaired. Efforts completed in 2010 were meant to be used in protection of the resource and will not be incorporated into future NWS 4b Demonstration Updates.

SWWD has been implementing water quality improvement projects in the immediate Colby Lake watershed for the last three-years through its residential cost share program. To this point, implementation has been untargeted. Implementation of projects identified in the Colby Lake Subwatershed Retrofit Assessment will begin in 2012, through the SWWD cost share and CCIP programs. Implementation of projects on private land will be promoted through neighborhood outreach in collaboration with WCD and EMWREP. Implementation of projects on public land will be pursued collaboratively with the City of Woodbury and Washington County. Based on available funding and anticipated cost of implementation, we expect implementation of identified priority projects to take approximately 10-years as laid out in **Table 2**. That timeline may be accelerated if, as we expect, grant funding is secured to complement dedicated funding. There are fast approaching milestones in implementation of priority projects. The CSAH 19 corridor, which cuts through the immediate Colby

Lake watershed, is scheduled for reconstruction in 2013. SWWD is currently engaged in discussion with Washington County and their project engineers to incorporate projects identified through the Colby Lake retrofit assessment into this project design. Additionally, the City of Woodbury is scheduled to rehabilitate several roadways in the Colby Lake 1st addition, one of the oldest neighborhoods in the immediate Colby Lake watershed. SWWD will work with the City of Woodbury to incorporate identified retrofit projects and provide enhanced treatment.

The internal loading of Colby Lake will be addressed through collaboration with the City of Woodbury and MnDNR. The best means of controlling internal loads is by flipping Colby Lake from the current turbid state to a stable, clear state through the use of in-lake measures. The use of in-lake measures is expected to occur concurrently with the implementation of measures within the watershed focused on reducing external loads. Converting the lake to the clear state is expected to be accomplished through a combination of in-lake activities focused on managing undesirable aquatic plant species (primarily curly leaf pond weed) and the predator-prey relationships which diminish the population of desirable (large) zooplankton (primarily *Cladocera spp.*). Management of the undesirable aquatic plants will be through either mechanical or chemical harvesting, as water level management is not a viable tool because of a lack of ability to draw down the lake depth during the winter months. The structure of the fish population will be manipulated to encourage an increase in large zooplankton species through harvesting. Active management of the lake system is expected to maintain the lake in the clear phase for a duration of time ranging from seven to twelve years.

6.0 Monitoring Plan to Track Effectiveness of Pollution Controls

SWWD has operated a District-wide monitoring program since 2000 with a current annual budget of \$150,000. Data collected through the District's monitoring program is used to inform SWWD actions to improve water quality. As per the SWWD Monitoring Plan (**Appendix E**), in-depth assessment of individual waterbodies is initiated when data from screening-level monitoring programs indicate impairment or nutrient loading in excess of SWWD or MN standards. Assessments generally last 3-5 years and consist of CAMP (Metropolitan Council's Citizen Assisted Monitoring Program) monitoring and a network of automated water quality and quantity monitoring sites at the waterbody's inlets and outlets. Data is used to characterize the watershed and in-lake response and identify portions of the watershed leading to the impairment or nutrient loading. The assessment work was completed for Colby Lake through the *Colby Lake Water Quality Modeling Project* which is the basis for much of this report and included in **Appendix A**.

During implementation, annual CAMP monitoring will continue in Colby Lake in order to characterize in-lake water quality. Automated monitoring sites will be rotated amongst the lake's inlets so that each is monitored at least once every five-years. Inlets will be monitored more frequently if poor water quality or high year-to-year variability in data persists. Data from tributaries will be used to verify progress from implementation until we can reasonably expect to see a measurable response in the Lake itself. SWWD compiles annual monitoring reports which are available on the SWWD website

(www.swwdmn.org). Monitoring reports will be included in bi-annual 4b Demonstration updates and progress reports provided to MPCA and EPA by June 1 in odd-numbered years.

7.0 Commitment to Revise Pollution Controls, as Necessary

On an organizational level, SWWD believes in adaptive management. Guided by data collected through our existing monitoring program, we continually seek to refine understanding of the District's water resources and adapt management efforts as necessary to identify the most effective and efficient approaches to improving water quality. We feel that the ability to rapidly adapt management efforts is necessary, especially in a rapidly evolving watershed. As a local agency, we are uniquely able to adapt our management efforts and pursue high value or innovative projects as they arise. Likewise, our management flexibility allows us to more quickly recognize when efforts are not effective and revise or modify any of our existing management and implementation plans and programs. Any necessary revisions to our Colby Lake management plans or controls identified in this report will be addressed in semi-annual updates and progress reports submitted by June 1 of odd-numbered years. However, if SWWD fails to make progress in implementation or demonstrate improvement in water quality, MPCA reserves the right to relist Colby Lake on the 303(d) list and undertake a TMDL study.

8.0 References

Houston Engineering, Inc. 2011. Colby Lake Water Quality Modeling Project Report.

MPCA. 2011. MPCA Guidance for Category 4b Requests Developed by Third Parties

SWWD. 2011. Watershed Management Plan.

SWWD. 2009. Monitoring Plan

USEPA. 2006. *Recommended Structure for Category 4b Demonstrations*, in, Information concerning 2008 clean water act sections 303(d), 305(d), and 314 integrated reporting and listing decisions.

WCD. 2011. Colby Lake Subwatershed Retrofit Assessment.

Zadak, C. 2011. Personal Communication

List of Appendices

Appendix A: Colby Lake Water Quality Modeling Project

Appendix B: Colby Lake Subwatershed Retrofit Assessment

Appendix C: SWWD Water Quality Improvement Cost Share Program

Appendix D: SWWD Coordinated Capital Improvement Program

Appendix E: SWWD Monitoring Plan

Appendix F: Letters of Support