Twin and Ryan Lakes Nutrient TMDL

Five Year Review

December 2014

Shingle Creek Watershed Management Commission

3235 Fernbrook Lane N • Plymouth, MN 55447
Phone (763) 553-1144 • Fax (763) 553-9326

www.shinglecreek.org

Prepared by:

WENCK ASSOCIATES, INC.
Wenck File 1240-142
1800 Pioneer Creek Center
Maple Plain, Minnesota 55359
(763) 479-4200

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 Summary

This report is a review of progress toward meeting the load reductions identified in the Twin and Ryan Lakes Nutrient TMDL (Wenck 2007a). It includes an assessment of actions that have been implemented and the water quality trends that have been observed. Finally, this report describes the actions planned for the next 5 years of the implementation plan and sets forth how progress toward the TMDL will be measured.

The three basins of Twin Lake –Upper, Middle, and Lower – and Ryan Lake was formally designated Impaired Waters for excess nutrients in 2002. A TMDL and Implementation Plan were approved in 2007. The TMDL determined that phosphorus load reductions of 58% (Upper), 13% (Middle), 12% (Lower) and 19% (Ryan) would be necessary to ensure the lakes met or exceeded state water quality standards for nutrients. Upper Twin requires a 40% reduction in load from internal sources, and a 64% reduction from the watershed. Because the other lakes are connected in series, the TMDL load reductions for the other lakes could be accomplished by improving the upstream lakes and thus reducing the load from upstream or by reducing watershed loads.

The Implementation Plan (Wenck 2007b) identified priority actions and strategies for the first five years of implementation. Some of these were discrete actions or projects, and for the most part those have been completed or are in planning. Other actions such as implementing load reduction and infiltration strategies as opportunities arise are ongoing.

Annual monitoring of lake water quality on Twin and Ryan Lake has been conducted intermittently over the past 20 years, primarily through the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). In preparation for this Five Year Review, more intensive monitoring, sediment core sampling, and aquatic vegetation monitoring were completed. While management actions have reduced loading to the lakes, no trend of improvement has been observed yet in Upper Twin, which still consistently exceeds state standards. No TP trends were observed in Middle and Lower Twin and Ryan Lakes; however, these lake TP concentrations occasionally meet water quality standards.

Priorities for the next five years will be:

- Continue to reduce watershed load to the lakes by adding new and enhancing existing treatment BMPs and by increasing infiltration of runoff.
- Develop and implement balanced short- and long-term aquatic vegetation and rough fish management plans. Prior to implementation, these plans will define goals, success indicators, and costs and the feasibility of achieving the desired goals.
- Reduce internal load released by sediments.
- Expand and enhance public education and outreach within the drainage area.

This Five Year Review identifies potential capital improvement projects and a prioritization process for identifying and completing smaller retrofit projects. A strategy is set forth for addressing internal load in Upper Twin and management of aquatic vegetation and rough fish, and an expanded and enhanced public education and outreach program is outlined.

2.0 TMDL Overview

2.1 BACKGROUND

The Twin and Ryan Lakes Nutrient Total Maximum Daily Load (TMDL) addressed a nutrient impairment in the Twin Lakes chain of lakes in the cities of Brooklyn Center, Crystal, Minneapolis, and Robbinsdale (see Figure 2.1). The TMDL and associated Implementation Plan were approved in 2007 and implementation actions have been underway since that time. The total phosphorus (TP) load reductions calculated in the TMDL are shown in Table 2.1 for each lake.

Table 2.1. TP load reductions in the Twin and Ryan Lakes TMDL.

			1999 kg/yr	1996 kg/yr	Avg kg/yr	TMDL* kg/yr	TMDL* lb/yr	Reduction kg/yr	Reduction lbs/yr
Upper	Waste-load	Watershed	591	467	529	192	422	337	741
	Load	Atmospheric	15	17	16	16	35	0	0
		Internal	115	115	115	69	152	46	101
		TOTAL Load	721	599	660	277	609	383	843
Overall Reduction, Upper Twin Lake: 58%									
Middle	Waste-load	Watershed	87	70	79	141	310	30	66
		Upstream	102	82	92				
	Load	Atmospheric	9	9	9	9	20	0	0
		Internal	54	54	54	54	119	0	0
		TOTAL Load	252	215	234	204	449	30	66
Overall Reduction, Middle Twin Lake: 13%									
Lower	Waste-load	Watershed	156	148	152	258	568	41	90
		Upstream	160	133	147				
	Load	Atmospheric	5	5	5	5	11	0	0
		Internal	40	40	40	40	88	0	0
		TOTAL Load	361	326	344	303	667	41	90
Overall Reduction, Lower Twin Lake: 12%									
Ryan	Waste-load	Watershed	86	84	85	170	374	50	110
		Upstream	143	127	135				
	Load	Atmospheric	3	3	3	3	7	0	0
		Internal	40	40	40	40	88	0	0
		TOTAL Load	272	254	263	213	469	50	110
Overall Reduction, Ryan Lake: 19%									

*TMDL is for the average precipitation year. Wasteload at the TMDL is the sum of watershed and upstream loads.

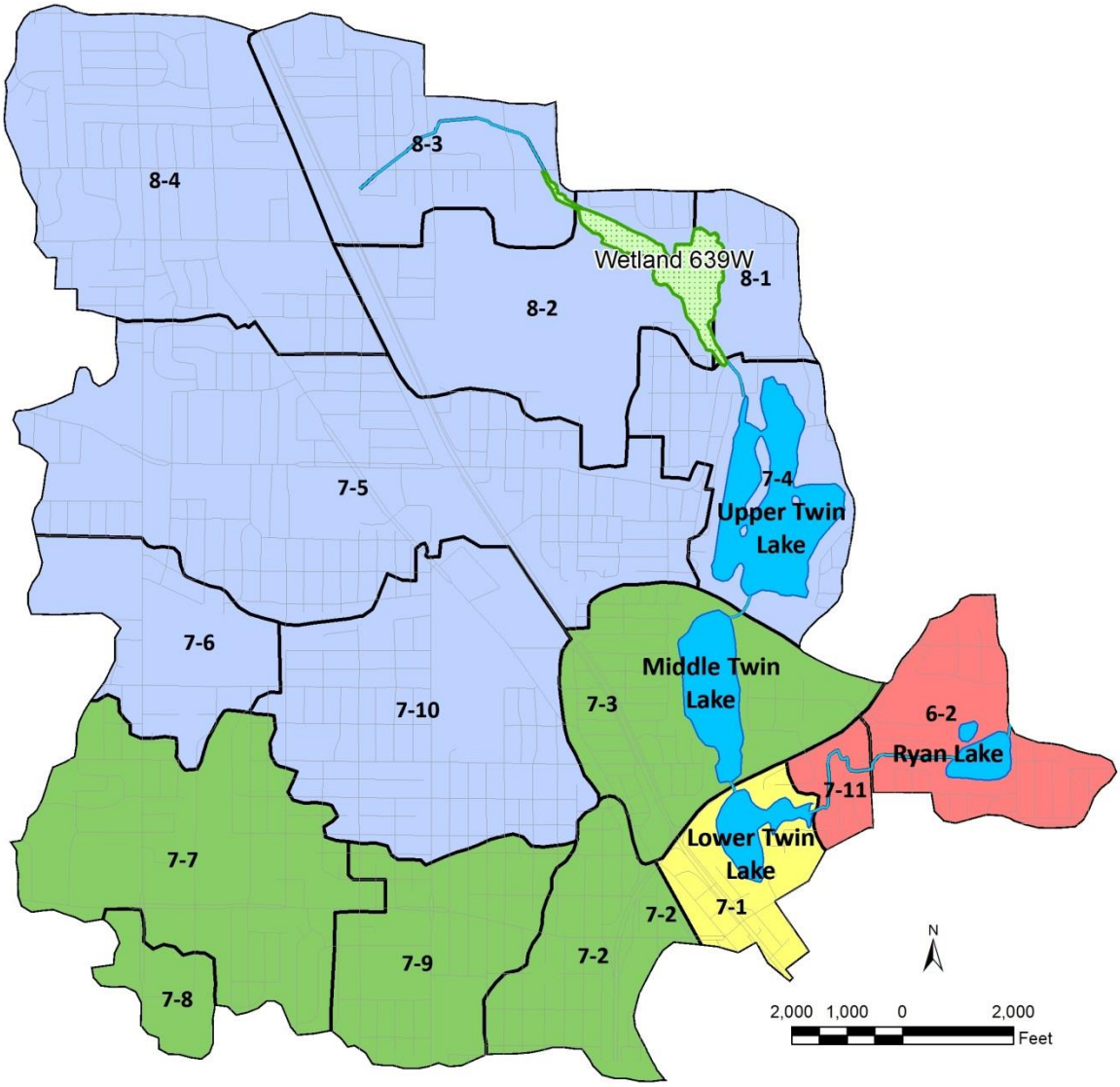


Figure 2.1. The Twin and Ryan Lakes watershed and their subwatersheds.

2.2 IMPLEMENTATION PLAN

2.2.1 Principles

The TMDL Implementation Plan enumerated the principles guiding development and implementation of the load reduction plan. These principles, in no order, included:

1. **Restoring biological integrity** and communities including fish, plants, and zooplankton;
2. **Controlling Internal load** and reducing the internal phosphorus loading in the lakes;
3. **Retrofitting existing BMPs** and taking advantage of highway and redevelopment projects to add or upsize BMPs.;
4. **Encouraging communication** between stakeholders and increase the opportunities for collaboration;
5. **Fostering stewardship** and providing education and training opportunities to city staff to better understand how their areas of responsibility relate to the protection and water quality in the lakes;

6. **Communicating with the public** and providing general and specialized information for everyone within the community.

2.2.2 Approach

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

The Implementation Plan took into account both short-term and long-term projects. The short-term projects that could be accomplished in a 10-20 year timeframe focused on the high-priority areas of the watershed that are the largest contributors to phosphorus loading. The long-term practices aimed to establish policies and practices that lower phosphorus loading through retrofitting of BMPs, redevelopment, or new construction.

2.2.3 Priorities

Implementation priorities were identified in the form of BMP strategies for both the chain of lakes and for each individual lake. Following are the BMP strategies that were highest priority during the first five years of the TMDL. Their 2014 status is shown in *italics*. More detail on completed strategies is discussed later in this report.

<u>Priorities for all lakes</u>

- Evaluate adequacy of existing rules and standards for runoff water quality treatment and volume management and revise if necessary. *The rules and standards were modified in the watershed Management Plan, incasing the volume management standard and expanding their application to smaller projects under 5 acres.*
- Add BMPs as opportunities arise to decrease runoff from the watershed and increase stormwater treatment. *Numerous projects large and small have been completed – see Table 3.1 below.*
- Increase infiltration and abstraction in the watershed. *Numerous projects large and small have been completed – see Table 3.1 below.*
- Increase frequency of street sweeping in sensitive areas. *Sweeping has been increased in some locations.*
- Conduct aquatic plant surveys and prepare management plans. *Aquatic vegetation surveys have been completed on all four lakes.*
- Encourage shoreline restoration to improve runoff filtration. *Demonstration projects have been completed.*

<u>Priorities for Upper Twin Lake</u>

- Initial focus on reducing external loads:
    - Add water quality treatment in watershed 3 [subwatersheds 7-6 and 7-10] *Crystal installed 29 rain gardens in the Phase 12 Forest North street reconstruction project. Hennepin County added ponds and infiltration along CSAH 81.*

    - Monitor and maintain existing ponds to sustain removal effectiveness. *Cities, county, and MnDOT are MS4s and perform routine pond inspections.*
    - Retrofit with offline underground treatment devices. *Not yet completed.*
- Restore DNR wetland 639W. *New outlet structures and channels were completed and are providing an estimated annual load reduction of 250-300 pounds TP.*
- Internal load management:
    - Remove and control rough fish. *Not yet complete.*
    - Prepare drawdown feasibility study. *Not yet complete.*
    - Conduct lake drawdown and/or apply alum treatment. *Not yet complete.*

<u>Priorities for Middle Twin Lake</u>

- Reduce external load through BMPs as opportunities arise. *As part of the TH 100 project in 2001, a significant area (catchments 7-7, 7-8, 7-9, and 7-2) was redirected through a MnDOT pond system into Middle Twin Lake. Numerous BMPs have been installed by Brooklyn Center, Crystal, Robbinsdale, and New Hope as shown in Table 3.1. Both Hennepin County and MnDOT installed new BMPs as part of highway reconstruction projects.*

<u>Priorities for Lower Twin Lake</u>

- Initial focus on reducing external loads:
    - Add water quality treatment in watershed 4 [7-7, 7-8, 7-9, 7-2, 7-1]. *As part of the TH 100 project in 2001, most of this drainage area was redirected through a MnDOT pond system into Middle Twin Lake, leaving only catchment 7-1 draining directly to Lower Twin. Robbinsdale has added several rain gardens and enhanced sweeping as shown in Table 3.1. Both Hennepin County and MnDOT installed new BMPs as part of highway reconstruction projects.*
    - Monitor and maintain existing ponds to sustain removal effectiveness. *Cities, county, and MnDOT are MS4s and perform routine pond inspections.*
    - Retrofit with offline underground treatment devices. *Not yet complete.*
- Internal load management:
    - Alum treatment may be feasible. *Not yet complete.*

<u>Priorities for Ryan Lake</u>

- Initial focus on reducing external loads:
    - Increase treatment in lakeshed. *15 rain gardens installed in Minneapolis, and five sump manholes in Brooklyn Center.*
    - Monitor and maintain existing treatment to sustain removal effectiveness. *Cities are MS4s and perform routine inspections.*
    - Increase rain gardens, filtration in lakeshed. *15 rain gardens installed in Minneapolis, and five sump manholes in Brooklyn Center.*
    - Shoreline restoration and maintenance. *A shoreline restoration project was completed in Ryan Lake Park in Minneapolis.*
- Internal load management:
    - Biological management. *Not yet complete.*

2.3 TMDL IMPLEMENTATION PLAN ACTIONS

2.3.1 Commission Actions

The Commission agreed to take the lead on general coordination, education, and ongoing monitoring. This information has been incorporated into the Commission's annual Water Quality Reports. Taking the lead, the SCWMC has conducted and will continue to facilitate the following activities. 2014 status is shown in *italics*:

- General Coordination. *All ongoing activities.*
  - Coordinate water resource policy and the following general activities:
    - Assisting member cities with their implementation activities
    - Disseminating information on changing BMP technology and practices
    - Collecting annual implementation activity data
    - Recommending activities such as vegetation or fishery management
    - Periodically updating the Commission's Capital Implement Program (CIP)
    - Conducting public hearings on proposed projects
    - Sharing the cost of qualifying improvement projects.
  - Annual monitoring and activities report
  - Establishment of performance standards

- Education. *All ongoing activities except internal load management feasibility studies.*
  - Public education and outreach
  - Promotion and encouragement of Public Official and Staff education
  - Presentations for lake associations, home ownership associations, block clubs, garden clubs, service organizations, senior associations, advisory commissions, City Councils, and other groups
  - Shoreline restoration, rain garden, and other BMP demonstration projects
  - Internal load management feasibility studies and recommendations

- Monitoring
  - Monitor water quality in the lakes. *Completed and ongoing.*
  - Track the effectiveness of activities implemented to reduce nutrient loading in the watershed. *Completed and ongoing.*
  - Provide additional monitoring such as:
    - Aquatic vegetation surveys. *Completed for all four lakes.*
    - Sediment chemistry. *Completed for all except Middle Twin.*
    - Zooplankton sampling and other biological assessments. *Not yet completed.*

2.3.2 Stakeholder Actions

The regulated stakeholders responsible for meeting the TMDL are the cities draining to the lake chain, Hennepin County, and MnDOT. In addition, property owners in the watershed have a role to play in implementing BMPs on their private properties. The stakeholders agreed to consider the following activities in implementing the TMDL. Their 2014 status is shown in *italics.* More detail on completed strategies is discussed later in this report.

- External Load Reduction
  - DNR Wetland 639W Restoration. *Completed.*

- Add treatment in the watershed
  - Twin Oak Pond (City of Crystal) *Completed.*
  - Wincrest Pond (City of New Hope) *Completed.*
  - 45th Avenue Ponds (City of New Hope) *Completed.*
  - Other opportunistic projects. *See Table 3.1.*
- Increase infiltration in watershed. *See Table 3.1.*
- Shoreline management and restoration. *See Table 3.1.*
- Wildlife management. *Some cities are actively controlling geese and deer.*
- Street sweeping. *Some cities have increased the frequency of sweeping, or are conducing more targeted sweeping.*
- Road salt reductions. *The cities, Hennepin County, and MnDOT are all actively reducing road salt use across the entire Shingle Creek watershed.*

- Internal Load Reduction
  - Chemical treatment. *Not yet completed.*
  - Lake drawdown. *Not yet completed.*

- Biologic Integrity
  - Aquatic plant management. *Not yet completed.*
  - Rough fish management. *Not yet completed.*

- Tracking and Reporting
  - Integration of BMPs into stakeholders' SWPPs. *Completed on an ongoing basis.*

3.0 Progress Review

3.1 TMDL IMPLEMENTATION ACTIONS

3.1.1 Shingle Creek Watershed Management Commission

The Commission has completed a number of actions in implementation of this TMDL. Some of these are specific to the Twin and Ryan Lakes TMDL, and some are general actions across the watershed that will also benefit Twin and Ryan Lakes.

- As will be discussed later in this document, the Commission sponsors ongoing citizen volunteer water quality monitoring on the four lakes, and has undertaken more intensive water quality, sediment core, and aquatic vegetation monitoring.
- Since the TMDL and Implementation Plan were completed, the Commission has updated its watershed management plan and development rules to be even more stringent. The development and redevelopment water quality and infiltration requirements now apply to non-single family residential parcels down to one-half acre in size. The previous threshold was five acres. The Twin and Ryan Lakes subwatershed contains numerous commercial and industrial parcels smaller than vie acres. As these develop or redevelop, they will now be required to implement load-reduction Best Management Practices (BMPs)
- The Commission and the member cities have received several grants to assist in implementing BMPs in this subwatershed. These include:
    - $360,000 of EPA/MPCA Section 319 funds to complete additional monitoring on Wetland 639W, use those results to determine the most feasible method(s) of reducing phosphorus export, and construct the selected improvement – the construction of new outlet structures and an overflow channel (Upper Twin)
    - $73,080 of Clean Water Funds and nearly $350,000 of Public Facilities Administration funds to purchase blighted property and to construct the Twin Oak Pond project in the City of Crystal (Upper Twin)
    - $160,000 of Clean Water Funds to expand the 45th Avenue Pond in New Hope (Middle Twin)
    - $6,200 in Hennepin County NRICH funds and 8 Minnesota Conservation Corps crew days to install 20 rain gardens in the Victory Neighborhood of Minneapolis (Ryan Lake)

3.1.2 Stakeholder Actions

The cities draining to the lake chain, Hennepin County, and MnDOT have implemented load reduction BMPs to improve water quality. The BMPs that have been implemented since 2004 are listed in Table 3.1 along with each BMP's estimated phosphorus load reduction. This table does not include actions completed by individual property owners or by the lake associations. It is important to note that after the TMDL Wasteload Allocations were established and implementation had begun, a MnDOT TH 100 project significant modified drainage patterns to Middle and Lower Twin Lake. Subwatersheds 7-2, 7-7, 7-8 and 7-9 (see Figure 2.1 above), which used to discharge into Lower Twin Lake, were rerouted through a new pond system that discharges to Middle Twin Lake. For reporting purposes BMPs in those subwatersheds actually "count" towards the Lower Twin Lake TMDL, but benefit Middle Twin.

Table 3.1. BMPs implemented since 2000 and estimated phosphorus load reductions.

Lake	City	BMP Name	BMP Description	TP Load Reduction (lbs/yr)
Upper Twin	Brooklyn Center	Kylawn Area	Rain gardens (8) and grit chamber (1)	14.4
	Brooklyn Center	Twin Lake Project	Rain gardens (3) and grit chamber (1)	5.4
	Brooklyn Center	Northport Project	Sump manholes (2)	0.9
	Brooklyn Center	Wangstad Project	Rain gardens (7) and grit chamber (1)	12.6
	Brooklyn Center	France Avenue relocation	Stormwater pond	1.9
	Brooklyn Park	62nd Ave Pond	Stormwater pond	46.0
	Crystal	Crystal Phase 12 Forest North	Rain gardens (29)	11.6
	Crystal	CSAH 81 Bass Lake Rd to 63rd	Infiltration basins (4)	32.3
	Crystal	CSAH 81 TH 100 to Bass Lake Rd	Wet ponds (4), infiltration basin, & dry pond/underground structure	26.0
	Crystal	Twin Oak Pond	Stormwater pond	120.0
	Crystal	Wetland 639W*	Outlet structure, overflow channel and weir	250.0
	New Hope	Wincrest Pond	Stormwater pond	17.0
			Subtotal	538.1
Middle Twin	Brooklyn Center	Southwest Area	Grit chamber	0.5
	Brooklyn Center	Twin Lake Beach	Shoreline restoration	1.0
	Brooklyn Center	TH100 Segment 4	Stormwater ponds (2)	10.0
	Crystal	Cavanaugh Oaks (Phase 9)	Rain gardens (3)	1.7
	Robbinsdale	MnDOT TH 100 Segment 3	Stormwater ponds (3)	28.7
	Robbinsdale	45th Ave reconstruction	Separation (CDS) unit	0.1
	Robbinsdale	Public Works rain garden	Rain garden	0.2
			Subtotal	42.2
In Middle Twin but was in Lower Twin TMDL	New Hope	45th Avenue Pond	Stormwater pond (1)	19.0
	Robbinsdale	40th Ave reconstruction	Draining manholes (6)	0.8
	Robbinsdale	No Place Like Home	Rain garden	0.6
	Robbinsdale	Common Bond	Rain garden	0.5
	Robbinsdale	Parker Cottages	Rain gardens (3)	0.8
	Robbinsdale	Regent Ave reconstruction	Draining manhole	0.2
	Robbinsdale	Regent Place	Stormwater pond	2.8
	Robbinsdale	Street sweeping	Street sweeping 4 times/year	1.6
	Robbinsdale	Twin Cities Imports	Rain garden	0.5
	Robbinsdale	Vera Cruz reconstruction	Draining manhole	0.2
			Subtotal	27.0
Lower Twin	Robbinsdale	Beachview reconstruction	Rain gardens (2)	0.6
	Robbinsdale	City Hall rain garden	Rain garden (1)	1.5
	Robbinsdale	CSAH 81 (Lowry to TH 100)	Ponds (3) and grit chambers (3)	7.0
	Robbinsdale	Street sweeping	Street sweeping 4 times/year	0.8
	Robbinsdale	TCF Bank	Rain garden (1)	0.5
	Robbinsdale	MnDOT TH 100 Segment 3	Stormwater ponds (1)	9.6
			Subtotal	20.0
Ryan	Brooklyn Center	Happy Hollow	Sump Manholes (6)	2.7
	Minneapolis	Victory rain gardens	Rain gardens (15)	3.4
	Robbinsdale	Beachview reconstruction	Sump manholes	1.4
	Robbinsdale	Street sweeping	Street sweeping 4 times/year	1.1
	Robbinsdale	MnDOT TH 100 Segment 4	Stormwater pond	1.1
			Subtotal	9.7

3.1.3 Wetland 639W Project History and TP Reduction

Monitoring and watershed modeling completed in 1999 and 2002 concluded that the phosphorus load out of the wetland complex just upstream of Upper Twin Lake, DNR number 27-0639W, was greater than would be expected for the land uses in the contributing watershed. At times the TP concentration in the outflow from the wetland was more than double the concentration of inflow. Additional monitoring in 2008 confirmed that rather than being a phosphorus sink, the wetland was exporting phosphorus. That exported load was estimated to be between 25-35% of the total phosphorus load to Upper Twin Lake.

The Commission completed a Wetland 639W Feasibility Study (Wenck 2011) to diagnose the cause(s) of this export and identify the most feasible method of reducing this load. As detailed in the Feasibility Study and the Wetland 639W Outlet Modification Final Report (Wenck 2014), it was determined that the most likely reason phosphorus is released from the wetland is the de-saturation of the central basin during the summer by the dense cattails that dominate the basin. When groundwater is drawn down, the desaturated soil becomes aerobic, and mineralizes faster than it would were it saturated. Thus, instead of tying up organic phosphorus in slowly decomposing peat, the phosphorus is transformed into an inorganic form that is bound with iron as ferric phosphate. When the soil becomes flooded again, the ferric iron is reduced to more soluble ferrous compounds that are released into the water column and discharged in outflow.

That feasibility study concluded that the most viable and effective means of mitigating this phosphorus discharge would be to construct a controlled outlet structure to store runoff in the wetland, keeping the soil saturated for longer periods. Because the wetland borders residential areas, an overflow structure and channel would also be necessary to minimize potential for flooding from larger rain and snowmelt events. This project, Wetland 639W Nutrient Export Reduction, constructed the two new outlet structures and the overflow channel. In addition to the overflow channel, two emergency relief valves were installed in the primary outlet structure. These are exepected to operate only in very wet conditions or in the early spring when there is a large snowpack to melt.

Post-construction monitoring suggests that the project has greatly reduced the phosphorus transport to Upper Twin Lake from the wetland. It was estimated that about 350-400 pounds per year of phosphorus was flowing into Upper Twin Lake before the construction of the weir and channel. In the two years since the construction it is estimated that about 100 pounds per year of phosphorus is exported from the wetland to Upper Twin Lake. The monitoring results varied and were dependent upon the precipitation during the monitoring period and whether the relief valves were in operation, however, the load reduction is estimated to be between 250-300 pounds per year. This report conservatively reports the TP load reduction value as 250 pounds per year (See Table 3.1).

3.2 WATER QUALITY TRENDS

3.2.1 Monitoring Program

Annual monitoring of lake water quality on Upper Twin, Middle Twin, Lower Twin, and Ryan Lake has been conducted periodically over the past 20 years. Much of the data was collected through the Metropolitan Council Environmental Services (MCES) Citizen Assisted Monitoring Program (CAMP) by volunteers. Surface samples were collected bi-weekly from May through October for total phosphorus

(TP), Secchi depth and chlorophyll-a (chl-a). In addition, in 2002 and 2012/2013 the Commission conducted surface, bottom and water column monitoring. Sediment core samples were taken in Upper and Lower Twin, and Ryan Lakes, and aquatic vegetation surveys were made in 2007 and 2012/2013 in all four lakes. Water quality data is summarized and current year and historical trends presented in the Commission's Annual Water Quality Report.

3.2.2 Trend Analysis

Water quality in Minnesota lakes is often evaluated using three associated parameters: total phosphorus (TP), chlorophyll-a (chl-a), and Secchi depth. Total phosphorus is typically the nutrient that limits algal growth in Minnesota Lakes. However, there are cases where phosphorus is widely abundant and the lake becomes limited by nitrogen or light availability. Chlorophyll-a is the primary pigment in aquatic algae and has been shown to have a direct correlation with algal biomass. Since chlorophyll-a is a simple measurement, it is often used to evaluate algal abundance rather than expensive cell counts. Secchi depth is a physical measurement of water clarity, measured by lowering a black and white disk until it can no longer be seen from the surface. Measurements of these three parameters are interrelated and can be combined to describe water quality.

Minnesota has different water quality standards for lakes depending on their depth. Upper Twin Lake and Lower Twin Lake both meet the definition of a Shallow Lake (maximum depth <15 feet, more than 80 percent shallow enough for rooted plants) while Middle Twin and Ryan Lakes are considered Deep Lakes. Figure 3.1 to 3.4 below show historic and current summer average TP concentration data. (See Appendix A for chl-a and SD trend figures.) No clear TP trends were observed, although in recent years Lower Twin (Figure 3.3) and Ryan Lake (Figure 3.4) TP concentrations appear to more frequently meet water quality standards than in the past. Due to annual variability it is too soon to determine whether that is a result of decreases in watershed loading or merely an artifact of the variability.

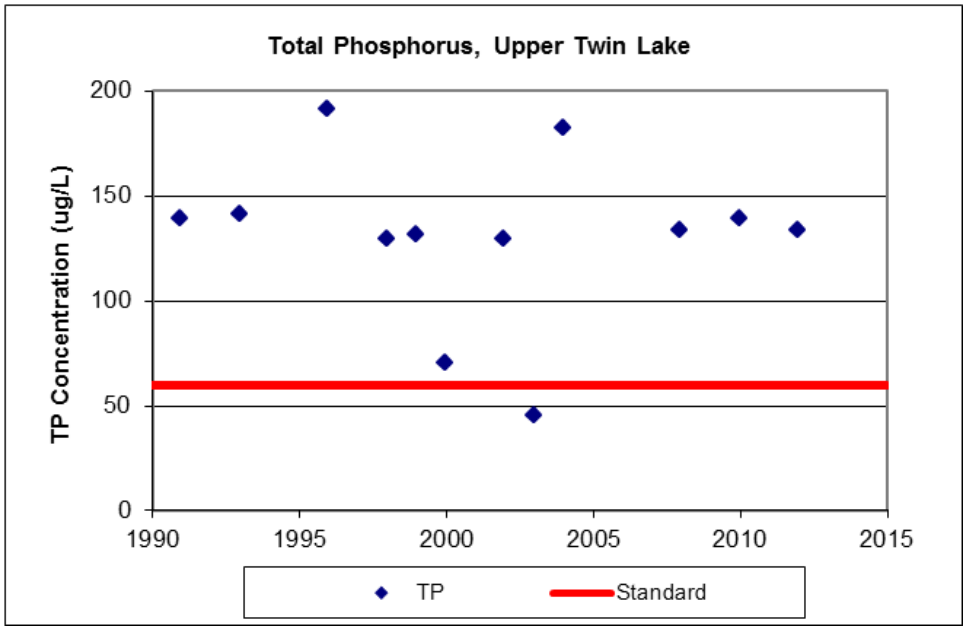


Figure 3.1. Upper Twin Lake summer average total phosphorus data.

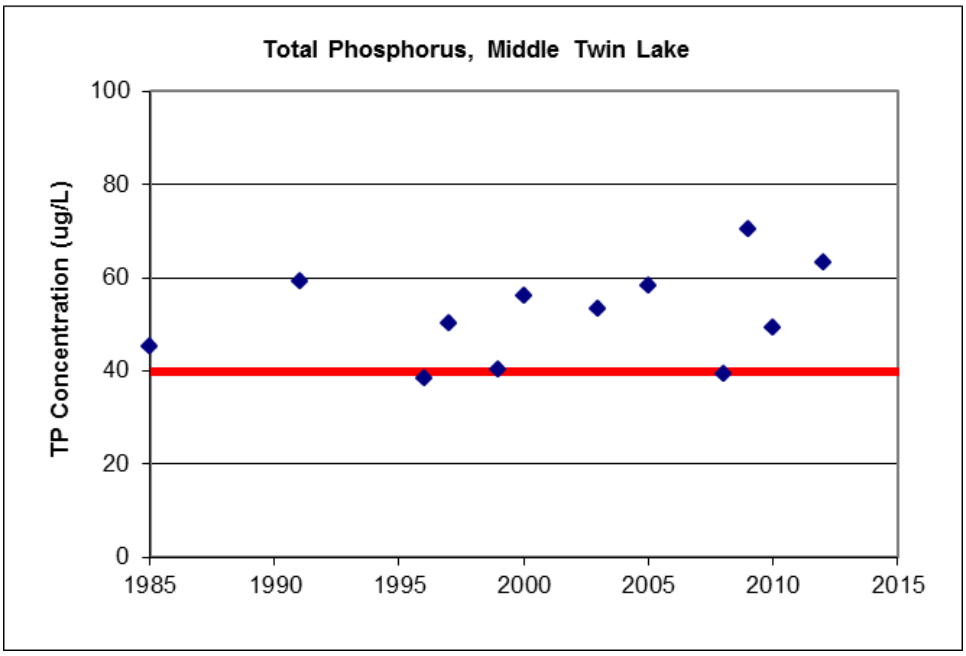


Figure 3.2. Middle Twin Lake summer average total phosphorus data.

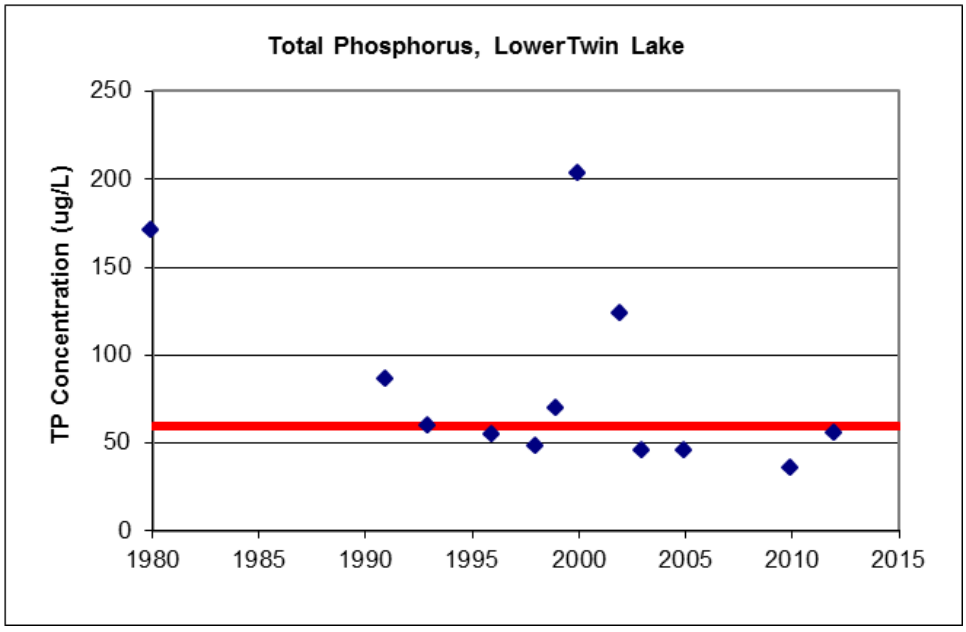


Figure 3.3. Lower Twin Lake summer average total phosphorus data.

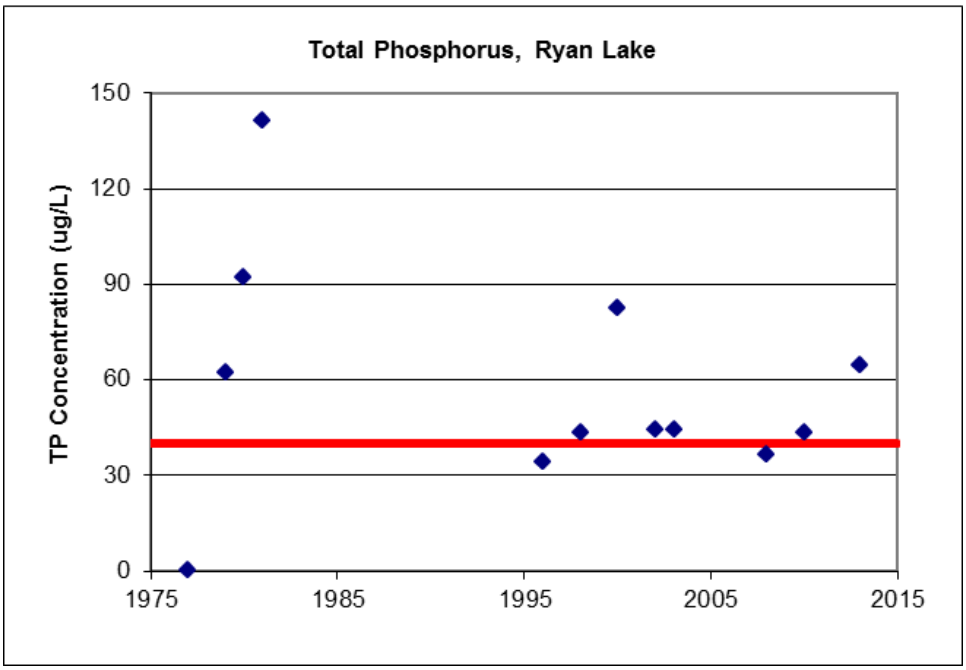


Figure 3.4. Ryan Lake summer average total phosphorus data.

3.3 SUMMARY OF PROGRESS

The lake models used 1996 and 1999 as base years for estimating the existing nutrient loading to the lakes and the TMDL. BMPs completed since 2000 then would be considered for computing load reduction toward the TMDL. Since 2000 it is estimated that BMPs implemented in the watershed have led to an annual TP reduction of about 598 pounds. A majority of the reduction efforts – about 84% of the load reduction achieved - were in the Upper Twin subwatershed. Figure 3.5 shows the estimated reductions achieved within the four subwatersheds.

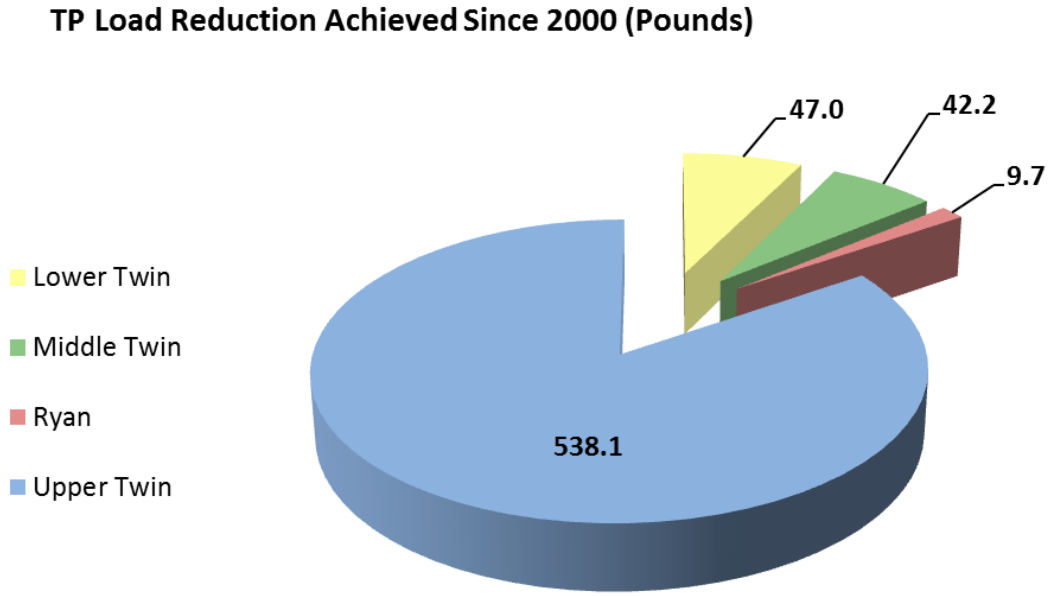


Figure 3.5. Annual Total Phosphorus reduction achieved since 2000.

While the reductions shown in Table 3.1 and Figure 3.5**Error! Reference source not found.** are ignificant, there are additional reductions needed for each of the subwatersheds to reach the TMDL. The achieved reductions and the remaining watershed and internal reductions needed to meet the TMDL specified reductions of Table 2.1 are shown in Figure 3.6.

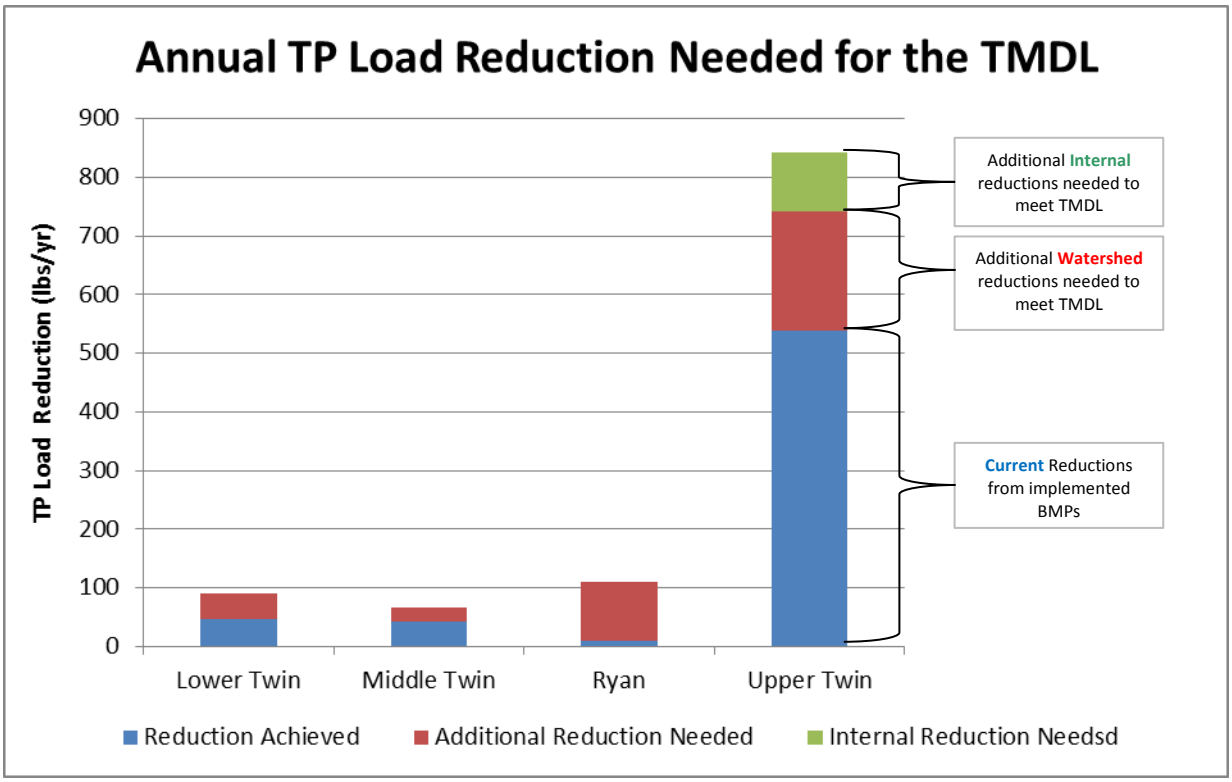


Figure 3.6. Twin and Ryan Lake TMDL TP load reduction status by lake.

4.0 Next 5 Year Actions

4.1 PRIORITIES

The Commission and its Technical Advisory Committee on several occasions reviewed and discussed the data and potential future actions. Two public meetings with lakeshore property owners were also held to obtain public input. Priorities for the next five years will be:

- Continue to reduce watershed load to the lakes by adding new and enhancing existing treatment BMPs and by increasing infiltration of runoff.
- Develop and implement balanced short- and long-term aquatic vegetation and rough fish management plans.
- Reduce internal load released by sediments.
- Expand and enhance public education and outreach within the drainage area.

4.2 COMMISSION IMPLEMENTATION ACTIONS

4.2.1 Continue Monitoring and Reporting

The Commission will continue to rely on volunteers to conduct water quality monitoring on the four lakes every other year through the Citizen Assisted Monitoring Program (CAMP) program, supplemented by surface and water column sampling every five years. That more thorough monitoring was completed on the three basins of Twin Lake in 2012, with the next assessment expected in 2017. Ryan Lake was assessed in 2013, with a repeat scheduled for 2018. The detailed assessments include aquatic vegetation monitoring.

4.2.2 Subwatershed Assessments

The Commission will work in partnership with Hennepin County Environmental Services and the member cities to complete assessments in priority subwatersheds. These assessments will identify and prioritize opportunities for small-scale BMPs such as boulevard rain gardens and public space bioinfiltration BMPs. The commission will periodically request Hennepin County to levy property taxes to maintain a Cost Share Fund to be used to assist the member cities in implementing identified small BMPs.

P8 modeling for the TMDL identified subwatersheds 7-6 to 7-10 (shown as hashed areas on Figure 4.1) as being under-treated. Subwatershed assessments will focus in those areas, as well as the commercial node at Bass Lake Road and West Broadway that includes the Crystal Shopping Center, Target, and other strip commercial buildings with little to no treatment. The Commission and the City of Crystal will work with property owners to evaluate the potential to retrofit this densely impervious area with BMPs such as parking lot infiltration islands, tree trenches, and capture and reuse BMPs.

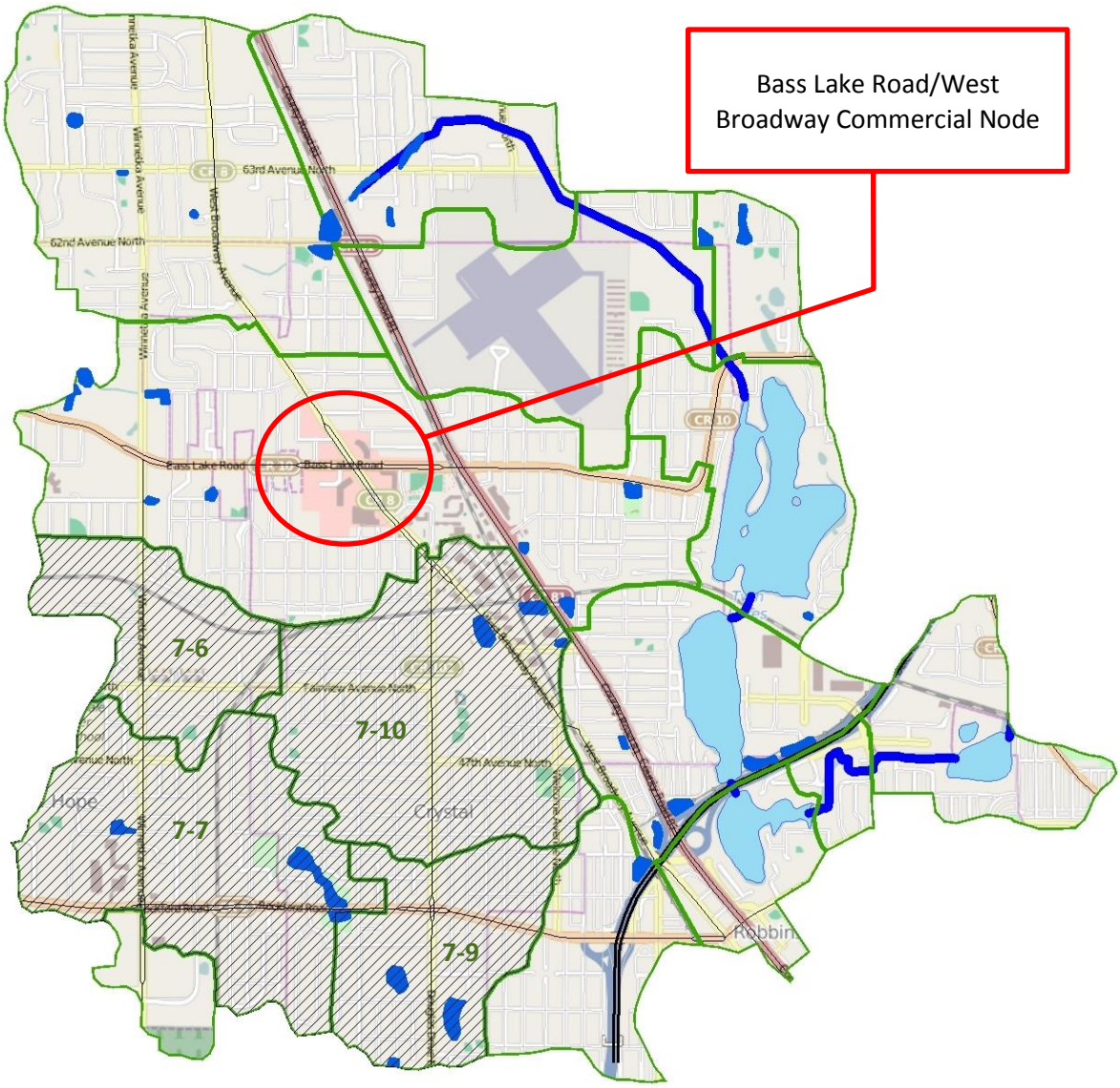


Figure 4.1. Priority areas for subwatershed assessments.

4.2.3 Carp Survey and Tracking Study

In partnership with the DNR and Dr. Pat Ceas of St. Olaf College, the Commission will develop an integrated carp and fish management plan including short- and long-term goals for the Twin Lake and Ryan Lake fisheries. This plan will include identification of carp overwintering and spawning areas, and may include radio tracking carp. This information will be used to determine the most effective methods of rough fish removal and long-term management, including potential locations for fish barriers, and will supplement the DNR's fish management plan for the lake.

4.2.4 Education and Outreach

The Commission will provide focused education and outreach to the cities and property owners/ residents in the drainage area. This will serve as a model for focused education elsewhere in the watershed as the other lakes with TMDL Implementation plans undergo their own Five Year Reviews.

In coordination with Project NEMO, the Commission will provide targeted education to policy makers and staff, including city councils, planning and environmental commissions, and city management and maintenance staff. This will focus on policies and actions the cities can do to protect and improve water quality, and to raise public awareness about the lakes, water quality, and best management practices. City staff will receive special training relevant to their roles on new trends and technologies in land use planning and development, street and park maintenance, and BMP designs.

The Commission's Education and Public Outreach Committee will develop and implement methods to provide information and incentives to all the households in the subwatershed to promote adoption of good housekeeping practices and small BMPs such as individual rain gardens.

With the West Metro Water Alliance (WMWA), the Commission will expand the Watershed PREP program so that every fourth grade classroom in the subwatershed is visited at least twice, and a follow-up lesson is integrated into a middle or senior high science class. Sponsor a family water quality fair each year.

4.2.5 Project Financial Assistance

The Commission's Cost Share Policy provides that member cities may submit capital improvement projects to the Commission's Capital Improvement Program (CIP), and the Commission will fund 25% of the cost of the project, with a maximum share of $250,000. The Commission has also been successful in obtaining grant funding for projects, and will continue to seek out sources of funding to assist the cities in completing projects. The Commission also operates a Cost Share program for small BMPs that is intended to provide assistance in completing projects identified in the subwatershed assessments described above.

4.2.6 Five Year Evaluation

The Commission will complete another Five Year Review in 2018-2019.

4.3 STAKEHOLDER ACTIONS

4.3.1 Opportunistic Projects

The cities, Hennepin County, and MnDOT have been routinely including load reduction and infiltration BMPs into their highway and street reconstruction projects. MnDOT and Hennepin County added ponds and infiltration basins into their TH 100 and CSAH 81 reconstruction projects that not only treated runoff from their highways, but also from adjacent residential and commercial areas that discharged into their storm sewer systems. BMPs have also been added in public spaces, such as rain gardens at Crystal City Hall and the Robbinsdale Maintenance Facility.

4.3.2 Maximize Existing BMPs

The member cities have identified several locations in the watershed where existing BMPs, mostly ponds, could be enhanced to achieve additional total phosphorus and dissolved phosphorus load reductions. These are shown on Figure 4.2, with the highest priority projects circled.

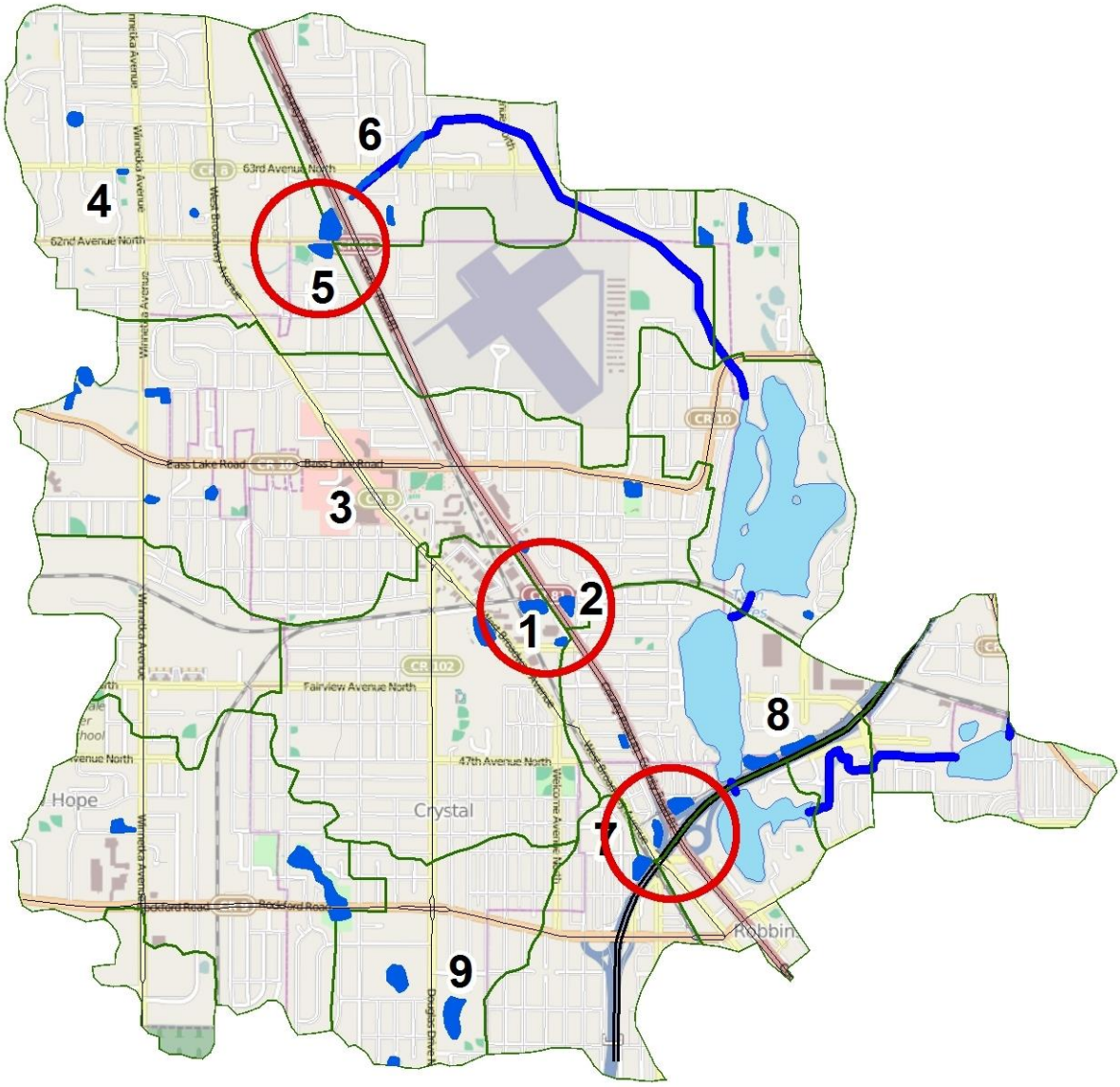


Figure 4.2. Potential BMP retrofit locations.
Note: The highest priority projects are circled.

These projects include but are not limited to:

1. Excavate and deepen pond/wetland at the southwest quadrant of CSAH 81 and the CP Railroad crossing, adjacent to Killmer Electric.
2. Add filter benches to the Killmer Pond and to the pond across CSAH 81 on the east side.
3. Retrofit the Crystal Shopping Center/Target area with BMPs.
4. Expand the pond at Sunnylane Park and add a filter bench.
5. Expand the 62nd Avenue pond and add a filter bench.
6. Stabilize the Twin Creek channel through Edgewood Park, add storage and a filter bench
7. Add filter benches to the MnDOT ponds at CSAH 81
8. Add filter benches to the MnDOT ponds between France Avenue and the lake
9. Expand Gaulke Pond when Public Works garage is demolished

4.3.3 Small BMP Projects

The subwatershed assessments completed by the Commission in consultation with the cities will identify a number of small BMPs that could be completed along with street or park projects or as stand-alone improvements. Cities will use this information to complete these BMPs as opportunities arise.

4.3.4 Street Sweeping

Some of the cities have already intensified street sweeping in critical areas draining to the lakes. The cities will continue to identify critical areas and sweep streets more frequently as necessary.

4.3.5 Shoreline Buffers and Restoration

The cities will continue to urge shoreline property owners to install and maintain shoreline buffers and to restore any unstable or eroded shorelines, and will undertake buffer and restoration projects on city-owned lakeshore property where feasible.

4.3.6 Aquatic Vegetation Management

Aquatic vegetation surveys show significant stands of invasive curly-leaf pondweed in Upper and Lower Twin Lakes, Eurasian water milfoil at nuisance levels, and coontail as the dominant species. In partnership with the DNR and the lake associations, prepare and implement an aquatic vegetation management plan, including short-term treatment of invasive curly-leaf pondweed and Eurasian water milfoil, and a long-term submerged aquatic vegetation management plan. The aquatic vegetation management plan will be completed in tandem with the fish management plan below and will establish clear goals and outcomes and assess the feasibility of achieving those outcomes. Maintaining the recreational use of the lakes as clarity improves and submerged aquatic vegetation thrives is of high priority to the lakeshore property owners.

4.3.7 Rough Fish Management

Based on the results of the Commission's rough fish survey and feasibility study, long –term goals, and the potential for further internal load reduction, the lakeshore cities will consider completing rough fish removals and installation of recommended fish barriers.

4.3.8 Sediment Release Reduction Project

If biological control is insufficient to stabilize lake sediments and reduce sediment release, further internal load reduction may be considered using either a whole-lake drawdown or alum treatment on Upper Twin and alum treatment on Middle and Lower. If a drawdown of Upper Twin Lake is feasible and receives sufficient shoreline property owner support, this could further reduce invasive vegetation, consolidate sediments, and encourage the native seedbank to flourish.

5.0 References

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

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

Wenck Associates, Inc. 2007a. Twin and Ryan Lakes Nutrient TMDL. http://www.pca.state.mn.us/sbiza46.

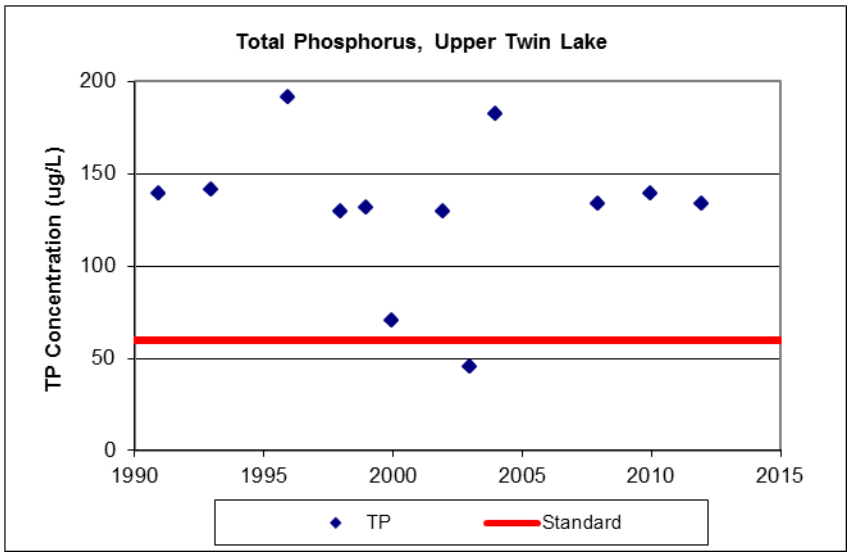
Wenck Associates, Inc. 2007b. Twin and Ryan Lakes Nutrient TMDL Implementation Plan. http://www.pca.state.mn.us/sbiza46.

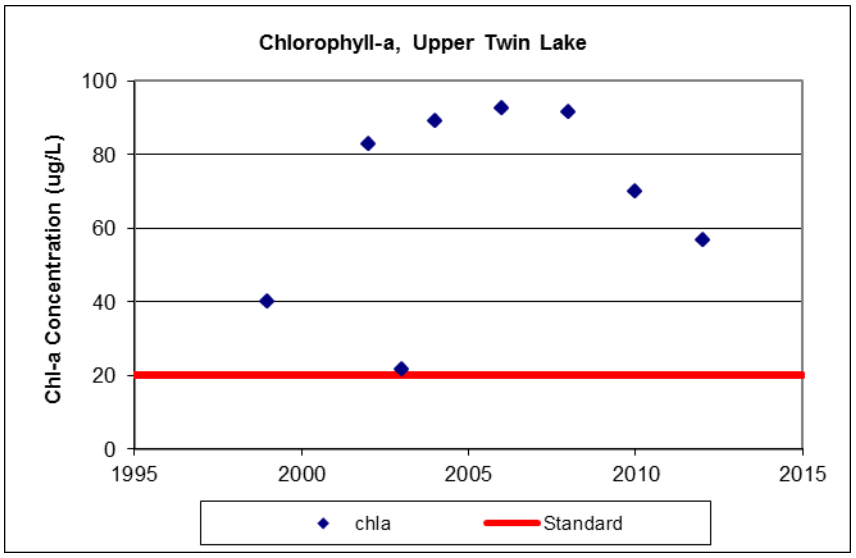
Wenck Associates, Inc. 2011. Feasibility Study Wetland 639W Outlet Modifications Final Report.

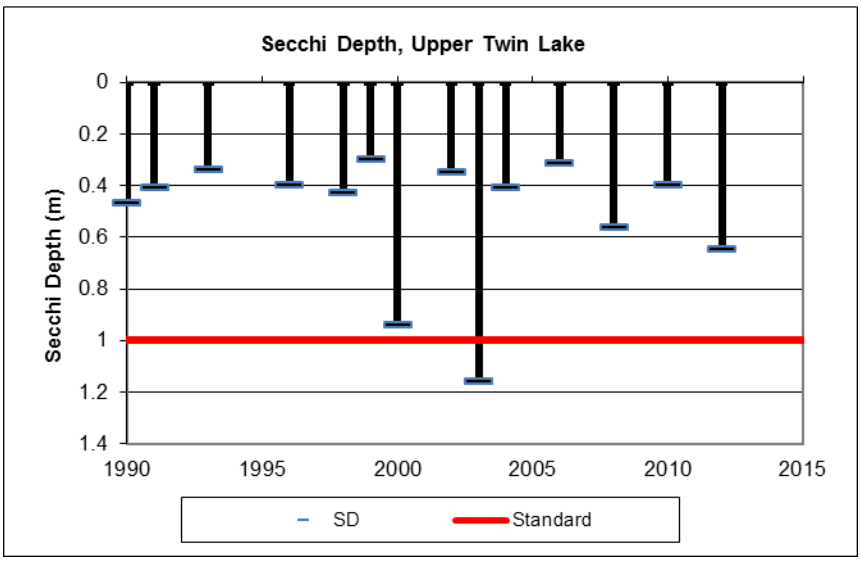
Wenck Associates, Inc. 2014. Wetland 639W Nutrient Export Reduction Final Report.

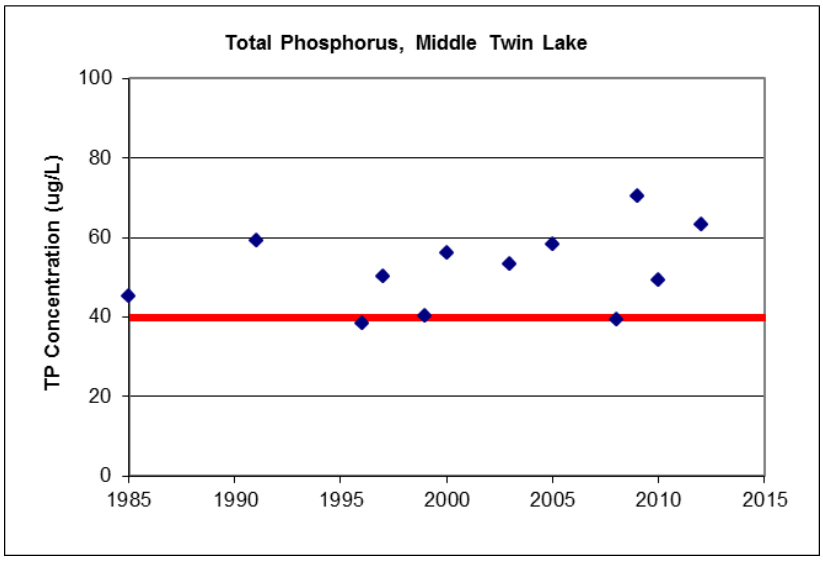
Appendix A

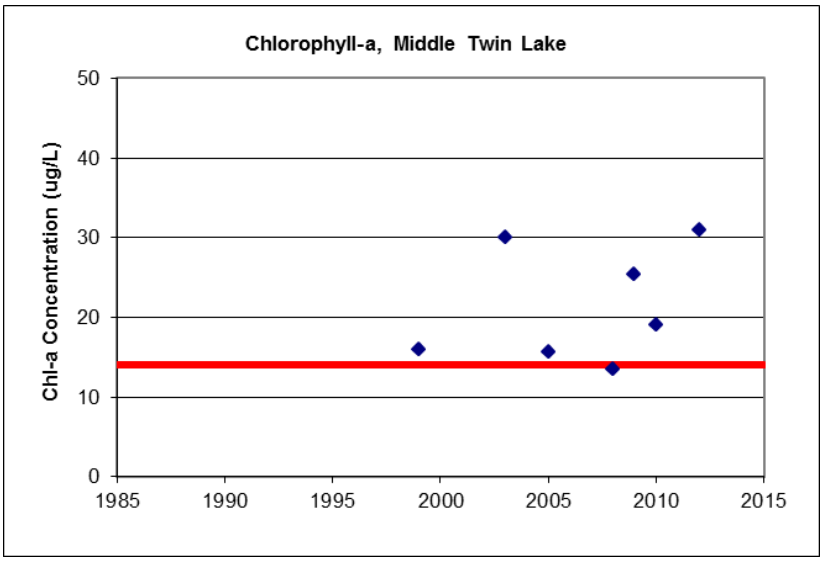
Water Quality Trend Figures

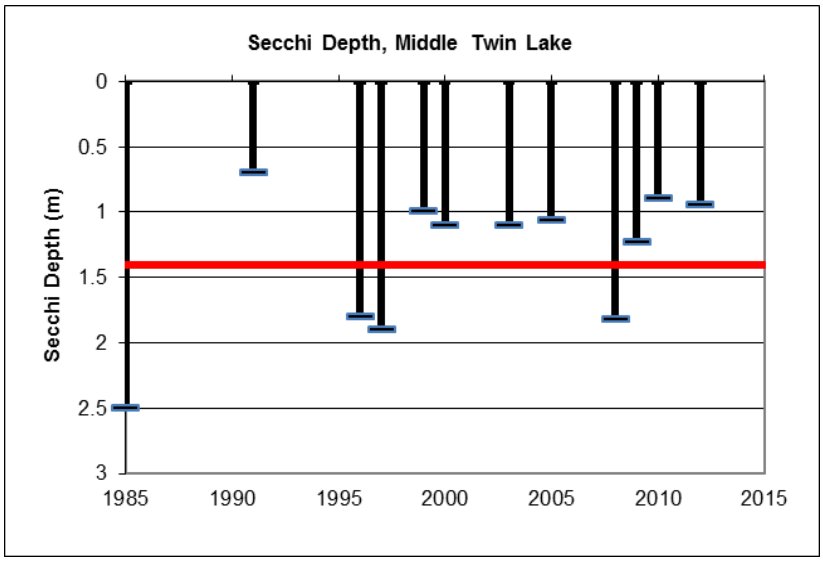

Total Phosphorus, Upper Twin Lake
TP Concentration (ug/L)
200
150
100
50
0
1990
1995
2000
2005
2010
2015
TP
Standard

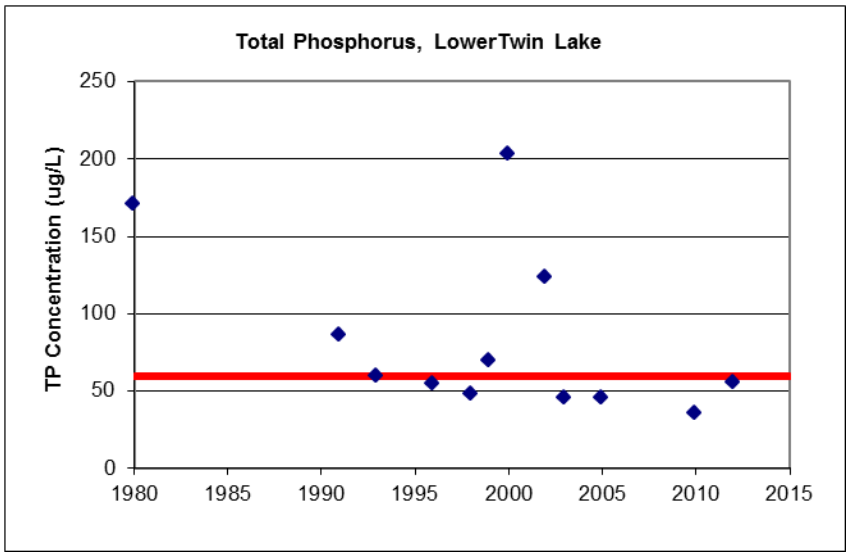

Chlorophyll-a, Upper Twin Lake
Chl-a Concentration (ug/L)
100
80
60
40
20
0
1995
2000
2005
2010
2015
chla
Standard

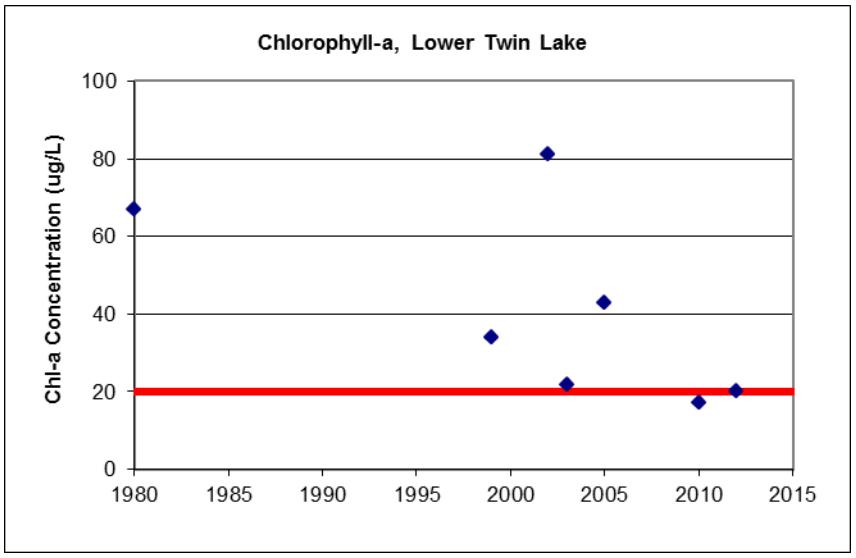

Secchi Depth, Upper Twin Lake
Secchi Depth (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1990
1995
2000
2005
2010
2015
SD
Standard

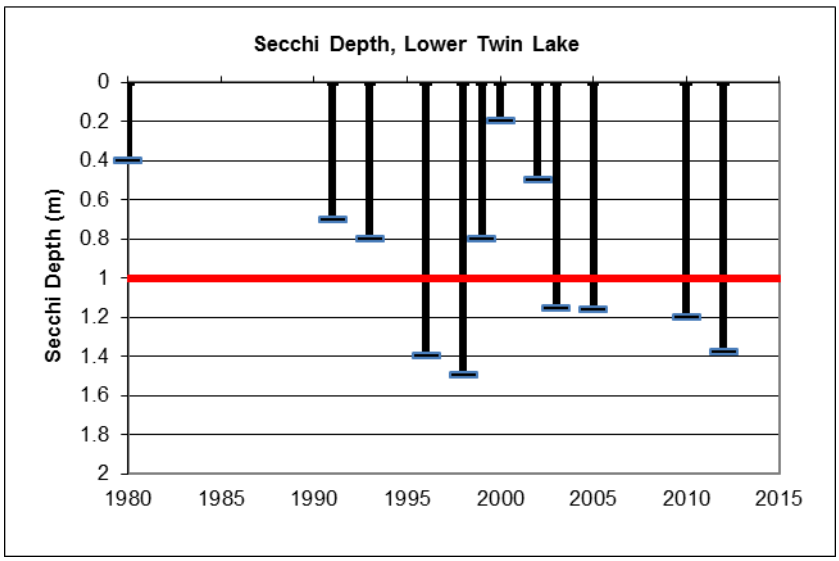

Total Phosphorus, Middle Twin Lake
TP Concentration (ug/L)
100
80
60
40
20
0
1985
1990
1995
2000
2005
2010
2015

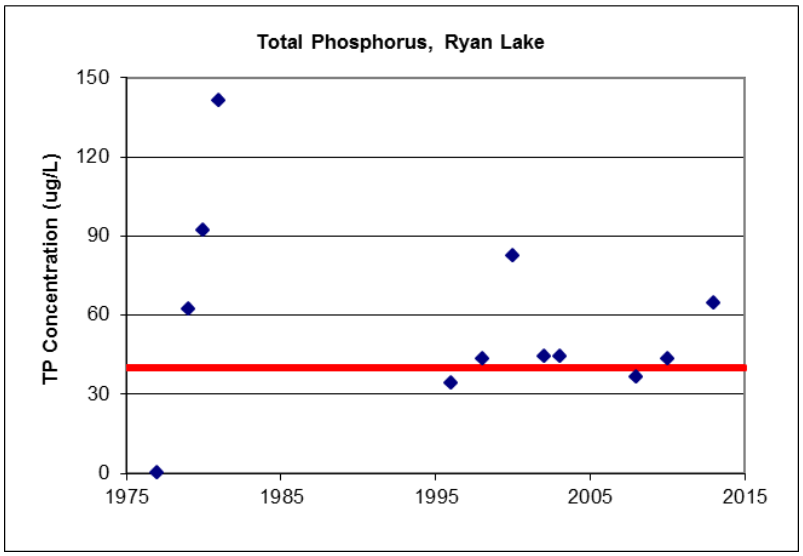

Chlorophyll-a, Middle Twin Lake
Chl-a Concentration (ug/L)
50
40
30
20
10
0
1985
1990
1995
2000
2005
2010
2015

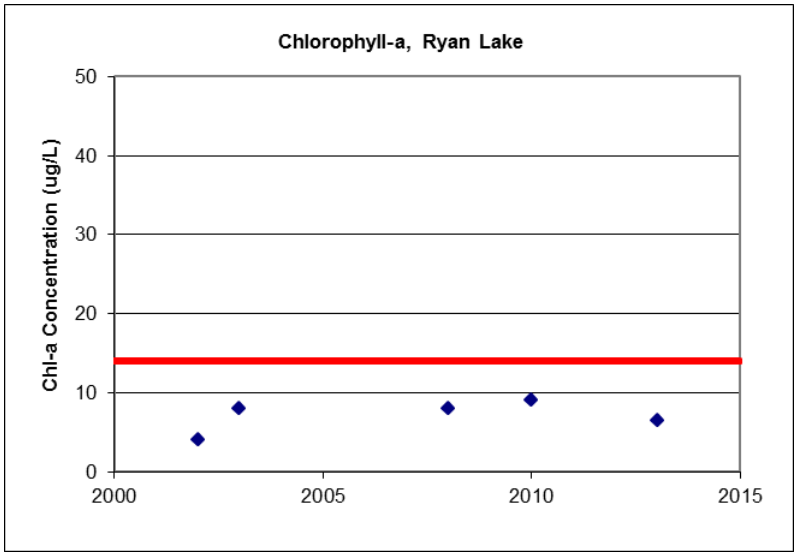

Secchi Depth, Middle Twin Lake
Secchi Depth (m)
0
0.5
1
1.5
2
2.5
3
1985
1990
1995
2000
2005
2010
2015

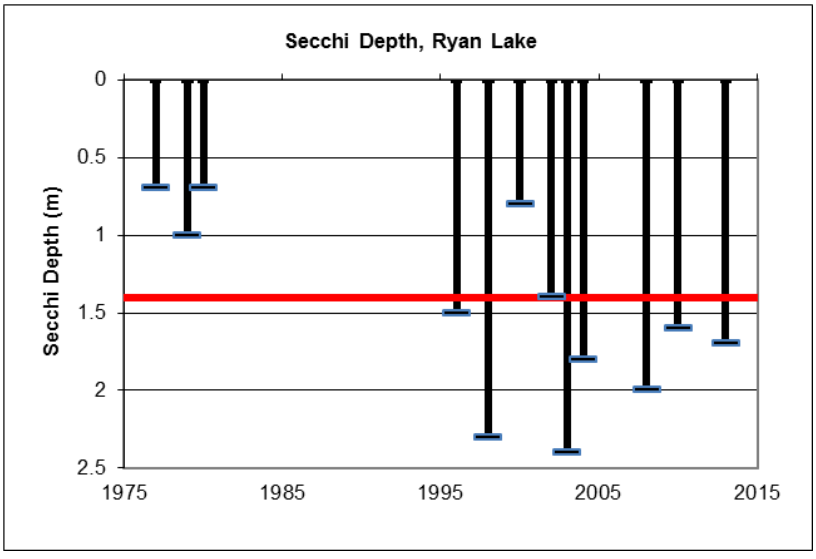

Total Phosphorus, LowerTwin Lake
TP Concentration (ug/L)
250
200
150
100
50
0
1980
1985
1990
1995
2000
2005
2010
2015


Chlorophyll-a, Lower Twin Lake
Chl-a Concentration (ug/L)
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015


Secchi Depth, Lower Twin Lake
Secchi Depth (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1980
1985
1990
1995
2000
2005
2010
2015


Total Phosphorus, Ryan Lake
TP Concentration (ug/L)
150
120
90
60
30
0
1975
1985
1995
2005
2015


Chlorophyll-a, Ryan Lake
Chl-a Concentration (ug/L)
50
40
30
20
10
0
2000
2005
2010
2015


Secchi Depth, Ryan Lake
Secchi Depth (m)
0
0.5
1
1.5
2
2.5
1975
1985
1995
2005
2015