

2021 VBWD Water Quality Monitoring Results

Prepared for
Valley Branch Watershed District Board of Managers

March 18, 2022



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Contents

1.0	Executive Summary	1
2.0	Introduction	3
3.0	2021 Water Quality and Other Monitoring Results	10
3.1	Lakes and Wetland Water Quality.....	11
3.1.1	Acorn Lake.....	15
3.1.2	Lake DeMontreville.....	16
3.1.3	Downs Lake.....	16
3.1.4	Echo Lake.....	17
3.1.5	Lake Edith	17
3.1.6	Lake Elmo.....	17
3.1.7	Goose Lake.....	18
3.1.8	Horseshoe Lake.....	18
3.1.9	Lake Jane.....	19
3.1.10	Long Lake	19
3.1.11	McDonald Lake.....	20
3.1.12	Silver Lake.....	20
3.1.13	Sunfish Lake.....	22
3.2	Aquatic Vegetation Surveys.....	22
3.3	Stream and Watershed Outlet Water Quality	23
3.3.1	Valley Creek Monitoring	23
3.3.1.1	Valley Creek Bacteria Monitoring	23
3.3.1.2	Valley Creek Watershed Outlet Monitoring Program (WOMP)	25
3.3.1.3	Valley Creek Macroinvertebrate Monitoring	26
3.3.2	Kelle’s Creek Monitoring	31
3.3.3	Rest Area Pond Outlet Monitoring.....	34
4.0	Conclusions.....	35

List of Tables

Table 2-1	Rationale for Priority Rankings for VBWD Water Bodies	5
Table 2-2	VBWD Basins with Priority Rankings, MPCA Classifications, Impairments, and 2021 Monitoring Summary	7
Table 2-3	Recommended Water Quality Management Actions for High- and Medium-Priority Water Bodies	9
Table 3-1	Summary of Water Quality for VBWD Basins: Summer Averages (June–Sept.)	14
Table 3-2	VBWD Basins with Statistically Significant Trends in Summer-Average Water Quality for Years 2012–2021	15

List of Figures

Figure 2-1	Water Bodies Monitored in 2021.....	6
Figure 3-1	Summer Averages of SDT in Lakes and Wetlands, 2021	11
Figure 3-2	Summer Averages of Chlorophyll- <i>a</i> in Lakes and Wetlands, 2021	12
Figure 3-3	Summer Averages of Total Phosphorus in Lakes and Wetlands, 2021	12
Figure 3-4	Valley Creek 2021 <i>E. coli</i> Monitoring Results.....	24
Figure 3-5	Geometric Means of <i>E. coli</i> in Valley Creek (Main Branch) by Calendar Month, 2012–2021	25
Figure 3-6	Valley Creek (Main Branch) Summer Averages of Total Phosphorus.....	26
Figure 3-7	Valley Creek Aquatic Biota Monitoring Locations	28
Figure 3-8	HBI Scores for Valley Creek.....	29
Figure 3-9	Valley Creek Macroinvertebrate Site B, Rock Riffle	29
Figure 3-10	Valley Creek Macroinvertebrate Site B, Woody Debris.....	30
Figure 3-11	Valley Creek Macroinvertebrate Site C, Rock Riffle	30
Figure 3-12	Valley Creek Macroinvertebrate Site C, Woody Debris.....	31
Figure 3-18	Kelle’s Creek 2021 <i>E. coli</i> Monitoring.....	33
Figure 3-19	Geometric Means of <i>E. coli</i> in Kelle’s Creek by Calendar Month, 2012–2021.....	33

List of Attachments

Attachment A	Summer Averages of Water Quality Parameters for VBWD Lakes and Wetlands
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Acronyms and Abbreviations

Acronym	Description
cfs	cubic feet per second
cfu/100mL	colony forming unit per 100 milliliters (a measure of bacteria concentration in water)
MCES	Metropolitan Council Environmental Services
MPCA	Minnesota Pollution Control Agency
MPN/100mL	most probable number per 100 milliliters (a measure of bacteria concentration in water)
RES	river eutrophication standards
SCWRS	St. Croix Watershed Research Station
SDT	Secchi disc transparency
SSTS	subsurface sewage treatment systems
TMDL	total maximum daily load
µg/L	micrograms per liter
VBWD	Valley Branch Watershed District
WCD	Washington Conservation District

1.0 Executive Summary

This report summarizes the results of water quality and aquatic biota monitoring activities conducted in Valley Branch Watershed District (VBWD) lakes, wetlands, and streams in 2021.

A total of 26 VBWD lake, wetland, and stormwater pond basins were monitored for water quality in 2021. Water quality parameters measured included Secchi disc transparency (SDT, a measure of water clarity), chlorophyll-*a* (a pigment used to measure algae abundance), and total phosphorus (the limiting nutrient of algae in most lakes). The Minnesota Pollution Control Agency (MPCA) has set standards for parameters to assess whether Minnesota lakes are impaired for eutrophication—the process by which an increase in nutrients (i.e., phosphorus) causes an increase in plant and algae growth. Eutrophic lakes often have diminished recreational value.

Barr evaluated the results of 2021 water-quality monitoring activities and summer averages for the most recent 10 years of monitoring. The water quality in several VBWD basins has improved overall, including Downs Lake, Lake Edith, Eagle Point Lake, and Silver Lake. In Silver Lake, the summer average for SDT and chlorophyll-*a* were better than MPCA eutrophication standards, but the summer average of total phosphorus remained worse than the standard. Water quality continued to be worse than before herbicide treatments were completed in 2007 and 2008. These treatments diminished the native aquatic plant community and allowed for increased phytoplankton growth.

Echo Lake and Sunfish Lake are on the MPCA's list of impaired water bodies for eutrophication but have had better water quality than MPCA standards in recent years. Echo Lake had water quality better than lake eutrophication standards for the ninth-consecutive year, and the MPCA has proposed removing the lake from the impaired waters list in 2022. Sunfish Lake had its best water quality ever, with consecutive years of increased water clarity in 2019, 2020, and 2021. The summer averages of total phosphorus, chlorophyll-*a*, and SDT all met the MPCA's standards.

Overall, water quality in several of the shallow lakes, including Sunfish Lake and Goose Lake (South), appears to be benefiting from increased water volume and depth due to higher precipitation totals in recent years (compared to 10–14 years ago). There was record-setting precipitation in 2019 and above-average precipitation in 2018 and 2020. Precipitation totals in 2021 were below average, but lake levels continued to be high in landlocked basins due to the previous 3 years' high precipitation totals. Even so, several shallow lakes continue to have water quality worse than eutrophication standards. The VBWD deep lakes continue to have better water quality than eutrophication standards.

Valley Creek, Kelle's Creek, and the discharge from Rest Area Pond are the only stream channel and storm sewer discharges into Lake St. Croix from VBWD water bodies. Precipitation was below average in 2021, and water levels were below the Rest Area Pond outlet elevation for part of the 2021 monitoring season.

In addition to collecting data on typical water quality monitoring parameters, VBWD also contracted with the Washington Conservation District (WCD) to monitor Kelle's Creek and Valley Creek for *E. coli* (an indicator of fecal coliform bacteria). Kelle's Creek is on the MPCA's list of impaired waters (303(d)) for

bacteria impairments; results of 2021 monitoring show that the creek still does not meet water quality standards for *E. coli*. Barr compared the 2021 *E. coli* monitoring results for Valley Creek to water quality standards and results over the last decade. This evaluation indicates that Valley Creek is impaired for *E. coli*.

VBWD also continued to monitor the habitat of some of its basins and streams, including aquatic plants in several lakes and macroinvertebrates at two sites in Valley Creek. A qualified contractor conducted point-intercept aquatic plant surveys in June 2021 at Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake. Barr presented a summary of the survey results to the VBWD Board in a December 2021 report. Macroinvertebrate monitoring results, as measured by Hilsenhoff Biotic Index (HBI) values presented in this report, show “very good” and “excellent” aquatic macroinvertebrate communities at the two sites monitored on Valley Creek.

The MPCA has proposed adding several VBWD lakes and streams to the Draft 303(d) List of impaired water bodies. Assuming the proposed additions will be finalized, the following water bodies will be added in 2022: McDonald Lake (nutrients), Silver Lake (nutrients), Eagle Point Lake (PFOS), H.J. Brown Pond (PFOS), Kelle’s Creek (total suspended solids), Valley Creek (bacteria), and Lake Jane (fish bioassessment). The MPCA has proposed that Echo Lake, added to the impaired waters list for nutrients in 2012, be removed from the list due to improved water quality in recent years.

Recommendations for 2022 water quality monitoring activities are included in a separate memorandum to the VBWD Managers.

2.0 Introduction

VBWD lakes fall within the North Central Hardwood Forest Ecoregion. The MPCA has separate lake eutrophication summer-averaging (June 1–September 30) standards for shallow and deep lakes within this ecoregion. These are presented on water quality figures for comparison purposes. Several monitored VBWD water bodies are shallow enough to be classified as wetlands; MPCA lake eutrophication standards do not apply to wetlands or stormwater ponds.

The MPCA recently adopted new rules regarding eutrophication impairments in Minnesota rivers and streams, including new river eutrophication standards (RES). Like lake eutrophication standards, RES includes a standard for summer averages of phosphorus (the limiting nutrient for algae growth) and other response parameters that are eutrophication measures (seston chlorophyll-*a*, 5-day biochemical oxygen demand, dissolved oxygen, and pH). For the MPCA to add a river or stream to its impaired waters list for eutrophication, one of the following must be true:

1. The summer averages of phosphorus (the causal parameter) are worse than the standard, *and* any one of the other response parameters is worse than the standard.
2. The periphyton chlorophyll-*a* is worse than the standard.

Chlorophyll-*a* is a pigment used for photosynthesis in algae and plants and is commonly used as a measure of algae abundance. Seston chlorophyll-*a* is the concentration of chlorophyll-*a* in algae suspended in water. Periphyton chlorophyll-*a* is the concentration of chlorophyll-*a* in algae that grow on stream bottoms or other surfaces.

All major water bodies in the VBWD are classified according to the system outlined in the *VBWD 2015–2025 Watershed Management Plan* (Table 2-1). Because funds are not available to monitor all basins every year, the plan establishes priority levels (high, medium, or low) for lake and wetland basin monitoring. Stormwater ponds are classified separately. All high-priority basins were monitored in 2020; monitoring locations are identified in Figure 2-1. The majority of basins not monitored are categorized as low-priority.

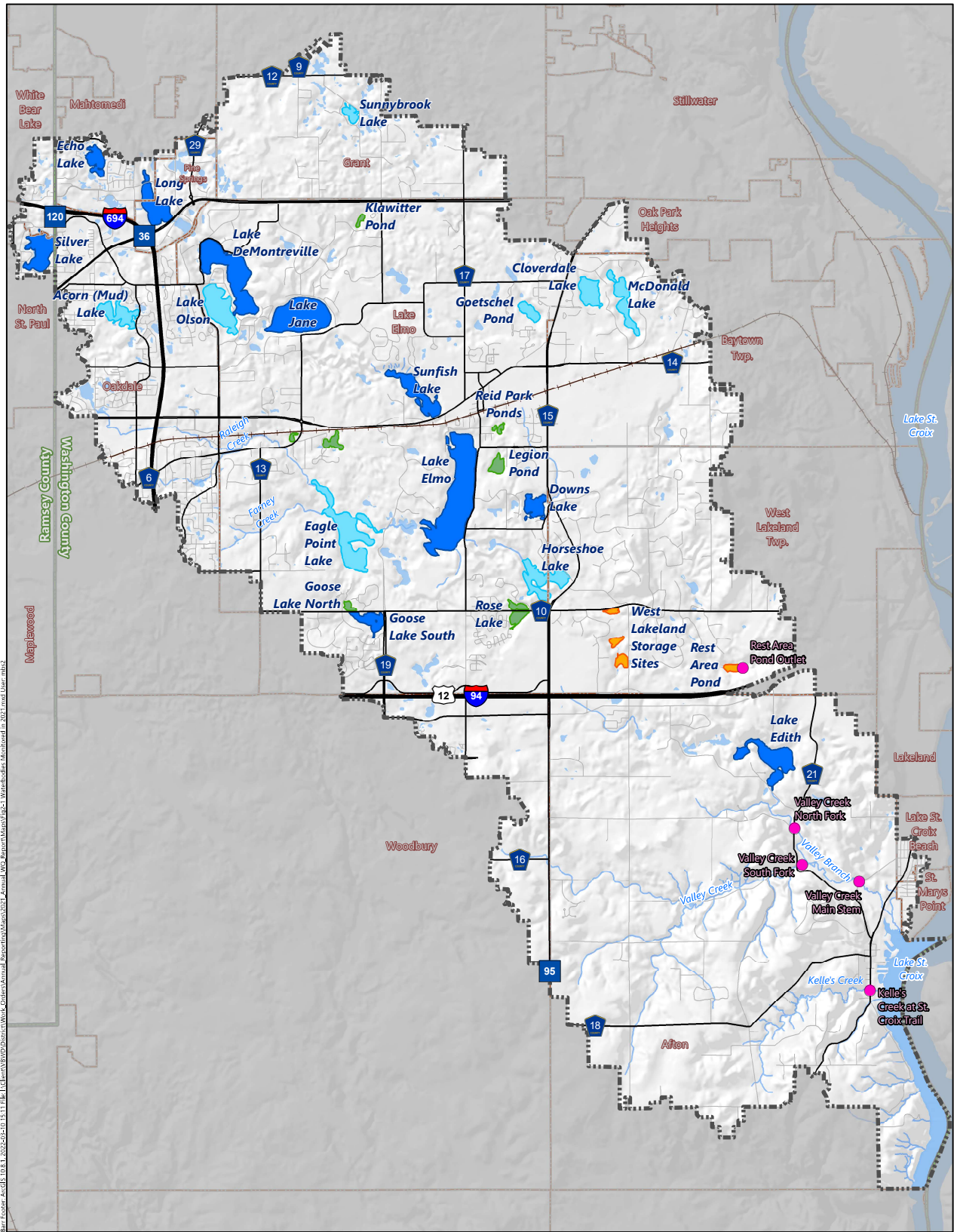
Table 2-2 lists the VBWD priority rankings, MPCA classification, and MPCA water quality impairment status for VBWD lake and wetland basins. Thirty-seven VBWD lake and wetland basins have been monitored for water quality at some time in the past.

The MPCA investigates PFAS (per- and polyfluoroalkyl substances) in surface water and groundwater in the East Metro, including water bodies within VBWD. PFAS are a large group of synthetic chemicals that have been manufactured and used extensively by various industries around the globe since the 1940s. PFOS and PFOA are the most recognized and studied individual compounds in the larger group of PFAS chemicals. PFOS—perfluorooctane sulfonate—was the key ingredient in the stain repellent Scotchgard™ and was used in surface coatings for common household items such as carpets, furniture, and waterproof clothing. PFOA—perfluorooctanoic acid—was used to produce nonstick coatings for cookware. The best known of these coatings, PTFE or Teflon™, is made from PFOA and may contain some traces of PFOA. It was also used in the production of carpets, upholstery, clothing, floor wax, and sealants. Some PFAS

compounds are persistent in the environment, meaning they do not break down. Some PFAS—including the compound PFOS—bioaccumulate, meaning the amount builds up in the body over time. Lake Elmo is already on the MPCA’s list of impaired waters for PFOS, and there is an advisory not to eat fish from the lake. The MPCA has proposed adding two more VBWD water bodies to the impaired waters list for PFOS: Horseshoe Lake and H.J. Brown Pond.

Table 2-1 Rationale for Priority Rankings for VBWD Water Bodies

VBWD Classification	High Priority	Medium Priority	Low Priority
Any criterion is reason for priority level	MPCA-classified deep lake	MPCA-classified shallow lake	Basins or stormwater ponds that are not high or medium priority
	MPCA-listed as impaired for eutrophication	Has public access	
	Degraded water quality	Directly upstream of a trout stream or an "outstanding resource value water," as designated by the Department of Natural Resources (DNR)	



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- Stream/Watershed Monitoring Station
- Other Waterbody
- ▬ District Legal Boundary
- ▬ Municipal Boundary
- ▬ County Boundary
- Lake or Wetland Monitored in 2021
 - High Priority
 - Medium Priority
 - Low Priority
 - Stormwater pond

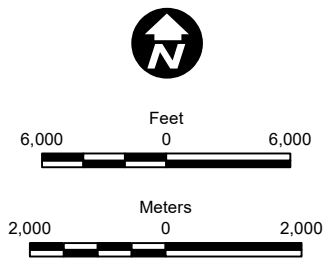


Figure 2-1

**WATERBODIES
MONITORED IN 2021**
Valley Branch Watershed District

Table 2-2 VBWD Basins with Priority Rankings, MPCA Classifications, Impairments, and 2021 Monitoring Summary

	Water Body	VBWD Water Body Priority Ranking	MPCA Classification	MPCA Water Quality Impairments
Monitored in 2021	Acorn (Mud) Lake	Medium priority	Shallow lake	None
	Beutel Pond	Low priority	Wetland	None
	Cloverdale Lake	Medium priority	Shallow lake	None
	Lake DeMontreville	High priority	Deep lake	Mercury
	Downs Lake	High priority	Shallow lake	Eutrophication
	Eagle Point Lake	Medium priority	Wetland	None
	Echo Lake	High priority	Shallow lake	Eutrophication (to be removed)
	Lake Edith	High priority	Deep lake	None
	Lake Elmo	High priority	Deep lake	Mercury and PFOS
	Friedrich's Pond	Low priority	Wetland	None
	Goetschel Pond	Low priority	Wetland	None
	Goose Lake—North	Low priority	Wetland	None
	Goose Lake—South	High priority	Shallow lake	Eutrophication
	Horseshoe Lake	Medium priority	Shallow lake	PFOS (Draft 2022) ⁽¹⁾
	Lake Jane	High priority	Deep lake	Mercury; fish bioassessment (Draft 2022) ⁽¹⁾
	Klawitter Pond	Low priority	Wetland	None
	Legion Pond	Low priority	Wetland	None
	Long Lake	High priority	Shallow lake	None
	McDonald Lake	Medium priority	Shallow lake	Eutrophication (Draft 2022) ⁽¹⁾
	Mergens Pond	Low priority	Wetland	None
	Lake Olson	Medium priority	Shallow lake	None
	Reid Park Pond	Stormwater pond	Wetland	None
	Rest Area Pond	Stormwater pond	Wetland	None
	Rose Lake—North	Low priority	Wetland	None
Rose Lake—South	Low priority	Wetland	None	
Silver Lake	High priority	Shallow lake	Eutrophication (Draft 2022) ⁽¹⁾	

	Water Body	VBWD Water Body Priority Ranking	MPCA Classification	MPCA Water Quality Impairments
	Sunfish Lake	High priority	Shallow lake	Eutrophication
	Sunnybrook Lake	Medium priority	Shallow lake	None
	West Lakeland Storage Site	Stormwater pond	Wetland	None
Not Monitored in 2021	Bay Lake	Low priority	Wetland	None
	Capual's Pond (East)	Low priority	Wetland	None
	Capual's Pond (West)	Low priority	Wetland	None
	Clear Lake	Medium priority	Shallow lake	None
	Fahlstrom Pond (East)	Low priority	Wetland	None
	Fahlstrom Pond (West)	Low priority	Wetland	None
	Kramer Pond	Low priority	Wetland	None
	Weber Pond	Low priority	Wetland	None

Note(s):

- (1) The MPCA has proposed adding the waterbody to the impaired waters list in 2022.

The *VBWD 2015–2025 Watershed Management Plan* defines water quality “action triggers.” VBWD uses these action triggers to help determine which water bodies require management actions based on monitoring data. Action triggers for VBWD lakes, ponds, and wetlands are as follows:

- Inclusion on the MPCA’s impaired waters list
- A statistically significant degrading trend in the summer average of total phosphorus, chlorophyll-*a*, or SDT for water bodies with at least 5 years of water quality data
- Water quality worse than applicable MPCA water quality standards for water bodies with less than 5 years of data

After each year of sampling, the VBWD analyzes trends for each water body, reevaluates the action triggers, and makes appropriate changes. If the lake water quality data is worse than the action trigger, some type of water quality management action will be considered. Table 2-3 (adopted from Table 4.1.6 in the *VBWD 2015–2025 Watershed Management Plan*) summarizes the recommended actions.

Table 2-3 Recommended Water Quality Management Actions for High- and Medium-Priority Water Bodies

Comparison of Most Recent Summer-Average Water Quality to MPCA Standards ⁽¹⁾	95% Confidence Water Quality Trend	Type(s) of Management Action Needed		
		Watershed Management	Water Quality Monitoring	Runoff Water Quality Monitoring
Better than all applicable standards	No trend analysis available, no trend, or improving trend	No action	Continue existing water quality monitoring program	None
	Degrading trend	No action	Perform supplemental monitoring next year	Watershed land-use review ⁽²⁾
At or worse than one or more applicable standards	No trend analysis available, no trend, or improving trend	No action	Perform supplemental monitoring next year	None
	Degrading trend	Comprehensive lake/stream/watershed diagnostic feasibility study	Intensive monitoring (as part of diagnostic feasibility study)	Detailed runoff water quality monitoring as part of diagnostic feasibility study (if necessary)

Note(s): For low-priority lakes and wetlands, the VBWD Managers will review data and implement appropriate actions on a case-by-case basis.

- (1) Applicable standards include total phosphorus and chlorophyll-*a* for all water bodies, as well as SDT for lakes, and biological oxygen demand and total suspended solids for streams.
- (2) Watershed land-use review: Review changes in watershed land use since last trend analysis and review weather/climate conditions.

3.0 2021 Water Quality and Other Monitoring Results

In 2021, the VBWD Managers ordered water quality monitoring for the 26 lake, wetland, and stormwater pond basins shown in Table 3-2. Monitoring was performed by:

- Citizen volunteers (monitoring for five of the lake and wetland basins).
- Metropolitan Council staff (monitoring of Lake Elmo).
- Minnesota Department of Transportation staff (monitoring of Rest Area Pond).
- Ramsey County Public Works staff (contracted by VBWD to monitor Silver Lake).
- WCD staff (contracted by VBWD to monitor 18 lake and wetland basins).

The Metropolitan Council's laboratory analyzed all samples except those from Silver Lake, collected and analyzed by Ramsey County Public Works and funded by VBWD.

VBWD also contracted with WCD to monitor water quality on Valley Creek, Kelle's Creek, and the Rest Area Pond outlet. Other monitoring efforts included aquatic macroinvertebrates (aquatic insects and other invertebrates) and aquatic vegetation surveys. Macroinvertebrate samples were collected by Barr staff at two locations on Valley Creek. Point-intercept plant surveys were conducted by a Barr subcontractor on the following six lakes:

- Long Lake (and Katherine-Abbott Pond immediately north of Long Lake)
- Lake DeMontreville
- Lake Olson
- Lake Jane
- Lake Elmo
- Silver Lake

Results of water quality monitoring and macroinvertebrate monitoring are discussed in the following sections. The results of the aquatic vegetation surveys were presented in the report *2021 Point-Intercept Plant Surveys at Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake* (December 2021).

3.1 Lakes and Wetland Water Quality

Barr obtained final 2021 water quality monitoring data from the Metropolitan Council’s online database. 2021 summer averages (June–September) were calculated for SDT, total phosphorus, and chlorophyll-*a*. Ramsey County provided water quality data for Silver Lake. Figure 3-1 shows the 2021 summer-average SDTs for all basins monitored, grouped by MPCA classification (deep lake, shallow lake, and wetland). For comparison, the MPCA standards for SDT are also included in Figure 3-1. The MPCA has different lake eutrophication standards for deep and shallow lakes in the Central Hardwood Forest ecoregion. There are currently no eutrophication standards for wetlands.

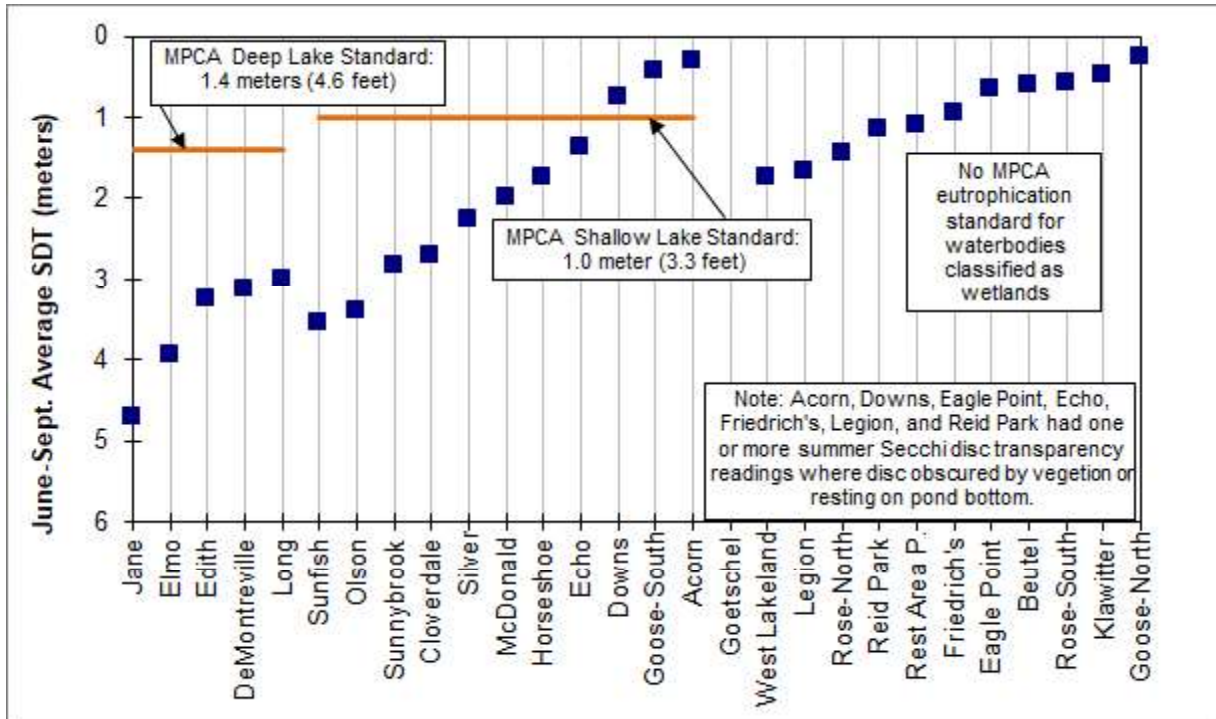


Figure 3-1 Summer Averages of SDT in Lakes and Wetlands, 2021

The 2021 summer averages for chlorophyll-*a* and total phosphorus are shown in Figure 3-2 and Figure 3-3, as well as the MPCA eutrophication standards. Attachment A includes charts of historic summer averages of water quality parameters for each water body monitored in 2021.

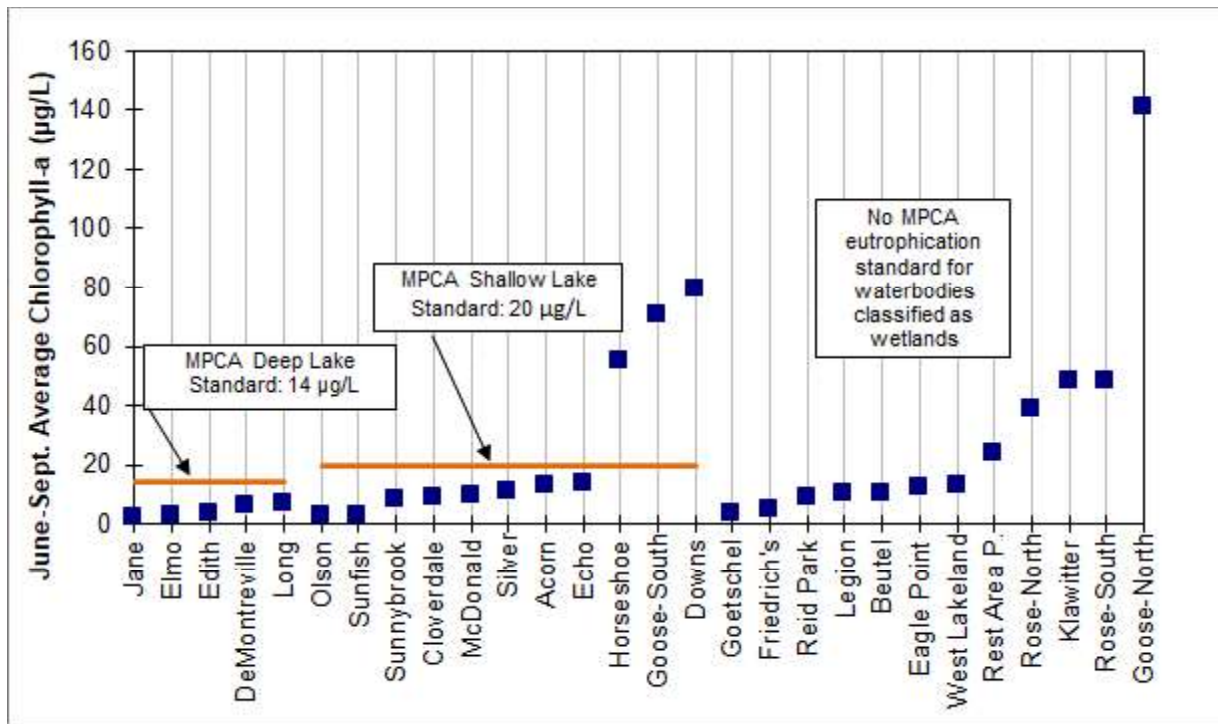


Figure 3-2 Summer Averages of Chlorophyll-a in Lakes and Wetlands, 2021

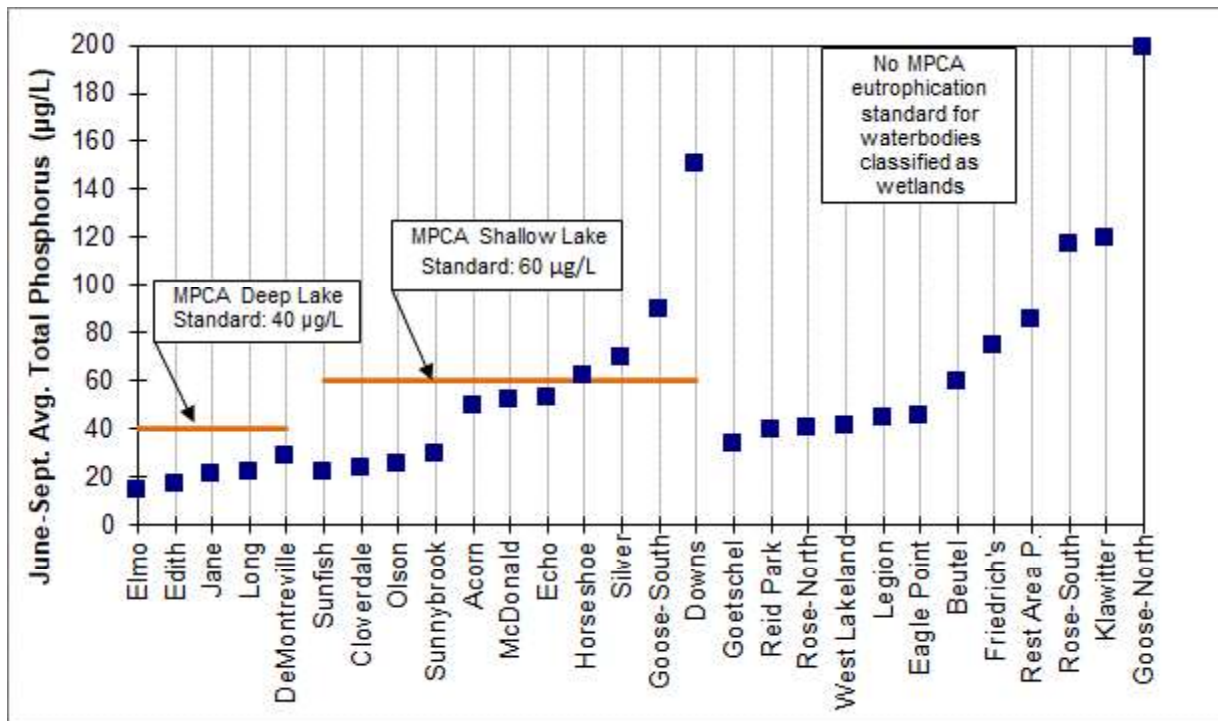


Figure 3-3 Summer Averages of Total Phosphorus in Lakes and Wetlands, 2021

Because the MPCA determines impairment for eutrophication using the most recent 10 years of water quality data, Barr calculated the overall averages for each basin monitored from 2012–2021. These are summarized with the 2021 summer averages in Table 3-1. Results that fail to meet the respective lake eutrophication standards are indicated in bold. As noted in Section 2.0, for a lake to be added to the impaired waters list, the overall summer average for total phosphorus (causal variable) and the overall summer average of either chlorophyll-*a* or SDT (response variables) must be worse than the respective standards.

2021 results were as follows:

- Water quality was better than MPCA eutrophication standards for all five of the deep lakes in VBWD.
- Summer averages for one or more parameters were worse than respective shallow lake eutrophication standards in five lakes: Acorn Lake, Downs Lake, Goose Lake (South), McDonald Lake, and Silver Lake. The summer average of SDT for Acorn Lake is affected by its shallowness (e.g., the Secchi disc often hits the bottom of the lake, which is less than the SDT standard); therefore, the lake would not be impaired for SDT.
- Four shallow lakes monitored in 2021 showed impairments for the most recent 10-year period (2012–2021): Downs Lake, Goose Lake (South), McDonald Lake, and Silver Lake. Clear Lake, last monitored in 2019, would also be considered impaired based on available data collected in the past 10 years.
- Horseshoe Lake had a 10-year average of chlorophyll-*a* worse than the eutrophication standard, and the 2021 summer average of total phosphorus was slightly worse than the standard. Still, the 10-year average for total phosphorus and SDT were better than the eutrophication standards. Horseshoe Lake would, therefore, not be considered impaired based on summer averages for the period of 2012–2021.
- The most recent 10-year period of water quality results does not show eutrophication impairments for Sunfish Lake or Echo Lake.

Barr also examined summer averages for statistically significant trends from 2012–2021; a statistically significant trend (95% confidence) of declining water quality for one or more parameters constitutes a water quality action trigger. Table 3-2 summarizes the results of the statistical trend analyses. Lake Elmo and Klawitter Pond had statistically significant trends of degrading SDT. These were the only two water bodies with trends of degrading water quality for the most recent 10-year period. Six lake and wetland basins showed statistically significant trends of *improving* water quality for one or more parameters: Downs Lake, Eagle Point Lake, Lake Edith, Rest Area Pond, Silver Lake, and Sunfish Lake.

The following paragraphs discuss the noteworthy water quality monitoring results for select lakes.

Table 3-1 Summary of Water Quality for VBWD Basins: Summer Averages (June–Sept.)

Lake Name	Total Phosphorus (µg/L)		Secchi Disc Transparency (m)		Chlorophyll- <i>a</i> (µg/L)		Would MPCA Consider It Impaired?
	2021	2012–2021	2021	2012–2021	2021	2012–2021	
<i>Deep Lake Standard:</i>	40		1.4		14		
Lake DeMontreville	28	20	3.1	3.0	6	8	no
Lake Edith	16	14	3.2	2.8	4	4	no
Lake Elmo	14	20	3.9	4.9	3	2	no
Lake Jane	21	14	4.7	4.4	2	3	no
Long Lake	22	21	3.0	2.9	7	6	no
<i>Shallow Lake Standard:</i>	60		1.0		20		
Acorn Lake	49	50	0.3 ⁽¹⁾	0.4 ⁽¹⁾	13	17	no
Clear Lake	--	248⁽⁵⁾	--	0.9⁽⁵⁾	--	36⁽⁵⁾	yes
Cloverdale Lake	24	33	2.7	2.6	9	11	no
Downs Lake	150	174	0.8	0.5	80	99	yes
Echo Lake	53	42	1.4	1.7	14	10	no ⁽²⁾
Goose Lake (South)	89	93	0.4	0.5	74	69	yes
Horseshoe Lake	62	47	1.8	1.3	55	25	no
McDonald Lake	52	73	2.0	1.2	9	31	yes
Lake Olson	25	20	3.4	3.3	3	6	no
Silver Lake	69	87	2.3	1.5	11	21	yes
Sunfish Lake	22	40	3.5	1.5	3	20	(see note)⁽³⁾
Sunnybrook Lake	29	26	2.8	2.6	8	6	no
<i>Wetland/Pond⁽⁴⁾</i>	None		None		None		
Bay Lake	--	314 ⁽⁵⁾	--	0.6 ⁽⁵⁾	--	104 ⁽⁵⁾	--
Beutel Pond	60	50	0.6	0.7	10	7	--
Capaul's Pond (East)	--	56 ⁽⁵⁾	--	0.8 ⁽⁵⁾	--	19 ⁽⁵⁾	--
Capaul's Pond (West)	--	62 ⁽⁵⁾	--	0.7 ⁽⁵⁾	--	49 ⁽⁵⁾	--
Eagle Point Lake	45	100	0.6	0.8	12	30	--
Fahlstrom (East)	--	277 ⁽⁵⁾	--	0.7 ⁽⁵⁾	--	99 ⁽⁵⁾	--
Fahlstrom (West)	--	226 ⁽⁵⁾	--	0.7 ⁽⁵⁾	--	23 ⁽⁵⁾	--
Friedrich's Pond	75	76	1.0	1.0	5	6	--
Goestchel's Pond	34	35	2.7	2.4	3	9	--
Goose Lake (North)	199	195	0.3	0.4	141	98	--
Klawitter Pond	120	96	0.5	0.7	48	39	--
Kramer Pond	--	886 ⁽⁵⁾	--	0.3 ⁽⁵⁾	--	191 ⁽⁵⁾	--
Legion Pond	44	44	1.7	1.6	10	10	--
Mergens Pond	--	63 ⁽⁵⁾	--	1.4 ⁽⁵⁾	--	17 ⁽⁵⁾	--
Rest Area Pond	85	94	1.1	1.0	24	35	--
Rose Lake (North)	40	36	1.4	1.4	39	25	--
Rose Lake (South)	117	117	0.6	0.5	48	56	--
Weber Pond	--	37 ⁽⁵⁾	--	0.6 ⁽⁵⁾	--	5 ⁽⁵⁾	--

Notes

Bold indicates result does not meet the Minnesota lake eutrophication water quality standard.

- (1) Secchi disc sometimes rests on lake bottom or dense vegetation. Therefore, SDT readings may not be representative of water clarity.
- (2) Echo Lake is currently listed as impaired for eutrophication.
- (3) For the MPCA to add a lake to the impaired waters list for eutrophication, total phosphorus (the causal parameter) and one or more response parameters (SDT or chlorophyll-*a*) must fail to meet the respective standards. However, Sunfish Lake is already listed as impaired due to previous years of high phosphorus concentrations; as such, the MPCA may be hesitant to remove it from the impaired waters list without further improvement in SDT and/or reductions in chlorophyll-*a*.
- (4) There are no Minnesota eutrophication standards for wetlands or stormwater ponds.
- (5) Water quality not measured in this basin in 2021; the average is for the period 2011–2020.

Table 3-2 VBWD Basins with Statistically Significant Trends in Summer-Average Water Quality for Years 2012–2021

Water Body	2012–2021 SDT Trend? (95% Confidence)	2012–2021 Chlorophyll- <i>a</i> Trend? (95% Confidence)	2012–2021 Total Phosphorus Trend? (95% Confidence)
Downs Lake	No trend	Improving	Improving
Eagle Point Lake	No trend	No trend	Improving
Lake Edith	Improving	No trend	No trend
Lake Elmo	Degrading	No trend	No trend
Klawitter	Degrading	No trend	No trend
Rest Area Pond	No trend	Improving	Improving
Silver Lake	Improving	No trend	No trend
Sunfish Lake	No trend	Improving	Improving

Lakes not listed had no statistically significant summer average water quality trends for 2012–2021.

3.1.1 Acorn Lake

Acorn Lake 2021 summer averages of total phosphorus (49 µg/L) and chlorophyll-*a* (13 µg/L) were both better than the shallow lake standards (60 µg/L and 20 µg/L, respectively), and showed a significant decrease compared to 2020 summer averages (79 µg/L and 41 µg/L). The Secchi disc often rests on the lake bottom or is obscured by lake vegetation in Acorn Lake; therefore, SDT is not representative of water clarity. The summer averages of total phosphorus and chlorophyll-*a* were consistently better than the shallow lake standard from 2003–2019 (monitoring was sporadic over this period, and the lake was not monitored all years). Variations in water quality, and relatively worse water clarity in 2020 compared to previous years, may have been due to increased precipitation and runoff, with above-average precipitation in 2019–2020. Precipitation was below average in 2021, and the decrease in stormwater runoff reaching the lake likely explains the year-over-year improvement in water quality. Acorn Lake is shallow with dense aquatic plant growth. Variability in plant growth from year to year could also affect water quality, as plants compete with algae for nutrients and light. The 10-year averages of water quality parameters (2012–2021) are better than the shallow lake standards, and Acorn Lake would not be considered impaired.

3.1.2 Lake DeMontreville

The 2021 summer average of Secchi disc transparency (3.1 meters [10.2 feet]) for Lake DeMontreville was better than the 2020 summer average (2.5 meters [8.2 feet]) and the best since 2016. The 2021 summer average of total phosphorus (28 µg/L) was the highest since 2011 but similar to 2020 (27 µg/L) and still better than the deep lake standard of 40 µg/L. The 2021 summer average of chlorophyll-*a* was 5.9 µg/L, the lowest since 2016, and well below the deep lake standard of 14 µg/L. Lake DeMontreville's water quality from 2011–2021 has been better than the previous period (2003–2010). In recent years, the variability in Lake DeMontreville's water quality may be due to several years of above-average precipitation. There were no statistically significant trends in water quality over the most recent 10-year period (2012–2021), and Lake DeMontreville's water quality continues to be better than the deep lake eutrophication standards.

3.1.3 Downs Lake

Downs Lake is currently on the MPCA's impaired waters list for eutrophication. Of all the shallow lakes monitored in the VBWD, this lake often has the worst summer averages of SDT, chlorophyll-*a*, and total phosphorus; however, the lake has been trending towards substantially better water quality in recent years. Although 2021 water quality was worse than 2020, overall, there were statistically significant trends (95% confidence) of total phosphorus and chlorophyll-*a* improvement for the most recent 10-year period (2012–2021).

In 2021 Downs Lake failed to meet the MPCA shallow lake standards for total phosphorus, chlorophyll-*a*, and SDT. The 2021 summer average of total phosphorus was 150 µg/L, a substantial increase over the 2020 summer average of 98 µg/L, and worse than the shallow lake standard of 60 µg/L. The 2021 summer average of chlorophyll-*a* (80 µg/L) was more than double the 2020 summer average (38 µg/L, the best on record) and is worse than the shallow lake standard (20 µg/L). The SDT also worsened in 2021 (0.8 m [2.6 ft]) compared to 2020 (1.3 m [4.3 ft]) and was worse than the shallow lake standard (1.0 m).

Several recent years of above-average precipitation have likely contributed to the overall improved water quality of Downs Lake, a landlocked basin with no outlet. Lake levels have fluctuated by 2–3 feet over the past decade, with periods of high water levels in 2013–2014 and 2019–2020. Several shallow, landlocked lakes in VBWD have experienced improving water quality in recent years as lake levels and lake volumes have increased. Many of these lakes have high internal phosphorus loading from the sediment during warm summer months; the increased lake volume dilutes the impact of the internal loading of nutrients.

The high water levels in Downs Lake and nearby ponds required pumping in 2020 to prevent flooding. Water was pumped from Reid Park Pond to Downs Lake (1.8 acre-feet total from July 20–July 31 and August 1–August 28) and from Eden Park Pond to Downs Lake (81 acre-feet in June). Water was also pumped from Downs Lake to Horseshoe Lake (184 acre-feet total in June–July). No pumping occurred to or from Downs Lake in 2021, as precipitation was below average.

3.1.4 Echo Lake

From 1972–2010, summer averages for SDT, total phosphorus, and chlorophyll-*a* consistently failed to meet the MPCA’s current eutrophication standards for shallow lakes, and Echo lake was added to the impaired waters list for eutrophication. But from 2013 to 2021, Echo Lake has consistently had water quality better than the shallow lake water quality standards, and the MPCA has proposed to remove it from the impaired waters list in 2022. 2021 summer averages of total phosphorus (53 µg/L), chlorophyll-*a* (14 µg/L), and SDT (1.4 meters [4.6 feet]) were all better than the MPCA shallow lake standards, indicating good water quality.

The 2021 summer averages were better than the 2020 summer averages for chlorophyll-*a* (17 µg/L in 2020) and SDT (1.3 meters [4.3 feet] in 2020). The 2021 summer average of total phosphorus was worse than in 2020 (47 µg/L), the highest since 2012, and is almost double the summer average of 2018 (28 µg/L). There were no statistically significant trends (95% confidence) in water quality from 2012–2021 for Echo Lake; however, total phosphorus concentrations have increased over the past 3 seasons.

3.1.5 Lake Edith

Lake Edith continued to have excellent water quality in 2021. The summer averages of chlorophyll-*a* (3.7 µg/L) and SDT (3.2 meters [10.5 feet]) were just slightly worse than in 2020, which had the best summer averages on record (2 µg/L and 3.5m [11.5 ft], respectively). The summer average of total phosphorus (16 µg/L) was comparable to recent years. Water quality data for the most recent 10-year period shows a statistically significant trend (95% confidence) of improvement for SDT; there were no statistically significant trends in chlorophyll-*a* or total phosphorus for the same period.

3.1.6 Lake Elmo

Lake Elmo continued to have excellent water quality in 2021. The summer averages of SDT (3.9 meters [12.8 feet]) and total phosphorus (14 µg/L) were better than all other VBWD lakes, and the summer average of chlorophyll-*a* (2.8 µg/L) was comparable to Lake Edith. There is a statistically significant trend (95% confidence interval) of degrading Secchi disc transparency for the most recent 10-year period; there were no statistically significant trends for total phosphorus or chlorophyll-*a* for the same period. Despite the statistically significant trend of degrading Secchi disc transparency, water quality remains excellent in Lake Elmo.

Although precipitation was below average in 2021, other recent years have had above-average precipitation, with 2019–2020 being especially wet. The increased runoff may have contributed to declining water clarity in recent years. Although many shallow landlocked basins have seen improved water quality during recent high-precipitation years (due to increased lake depths and volumes), a large, deep lake like Lake Elmo might see a temporary decline in water quality during a period of above-average precipitation. Unlike the shallow land-locked basins that experienced large increases in lake volume, the volume of Lake Elmo did not increase substantially. Increased stormwater runoff during high precipitation years, as well as increased flow from upstream shallow lakes, increased phosphorus loads to Lake Elmo.

It's worth noting that water clarity is affected by factors other than algal turbidity, and these factors can become more important when algal turbidity is very low, such as in Lake Elmo. Increased precipitation and runoff could be increasing concentrations of fine sediment in Lake Elmo, as well as dissolved organic carbon from wetlands and terrestrial sources. The bog-stained lakes common in northern Minnesota are an example of water clarity decreasing from dissolved organic carbon originating in wetlands.

3.1.7 Goose Lake

Goose Lake consists of two basins separated by a roadway. The south basin is larger and is classified as a shallow lake, while the smaller north basin is classified as a wetland. There is no outlet to Goose Lake, and high water levels in 2020 nearly overtopped the roadway separating the two basins. Goose Lake (South) is currently on the MPCA's impaired waters list for eutrophication impairments. The Goose Lake (South) 2021 water quality was similar to other recent years, and there were no statistically significant trends for the most recent 10-year period. The 2021 summer average of total phosphorus for Goose Lake (South) was 89 µg/L, which is the highest since 2016 but considerably better than the summer-average total phosphorus of 396 µg/L observed in 2009. Except for 2014, the summer average of total phosphorus has consistently failed to meet the MPCA shallow lake standard of 60 µg/L. The 2021 summer averages for SDT (0.4 meters) and chlorophyll-*a* (71 µg/L) were worse than the MPCA shallow lake standards.

As is typical, Goose Lake (North), the wetland basin connected via culvert to Goose Lake (South), had worse water quality than Goose Lake (South) in 2021. The summer-average total phosphorus concentration was 199 µg/L in 2021, slightly higher than in other recent years; the summer averages of SDT and chlorophyll-*a* were 0.3 meters (1.0 foot) and 141 µg/L. There were no statistically significant trends for the most recent 10-year period. Because Goose Lake (North) is classified as a wetland, it would not be assessed for impairments related to MPCA lake eutrophication standards.

As with Sunfish Lake, the wet weather and higher-than-normal lake levels in recent years may have improved water quality in Goose Lake (South) and Goose Lake (North) compared to 2008–2012. The water surface elevation was at record highs in Goose Lake in 2019 and 2020, and Washington County pumped 75.2 acre-feet of water from Goose Lake (North) to Eagle Point Lake from June 30 to July 8 in 2020, to prevent flooding at 10th Street North and Keats Avenue. The 2019–2020 water level in Goose Lake was approximately 7 feet higher than in 2010, which had some of the worst water quality for Goose Lake (South) and Goose Lake (North).

3.1.8 Horseshoe Lake

The 2021 summer average for total phosphorus was 62 µg/L, which is slightly worse than the shallow lake water quality standard of 60 µg/L and the highest since 2012. The 2021 summer average of chlorophyll-*a* (55 µg/L) was the worst since 1986 and well above the shallow lake water quality standard of 20 µg/L. Conversely, the 2021 summer average SDT (1.8 meters [5.9 feet]) was the best since 2011 and better than the water quality standard of 1.0 meter. The 2020 Horseshoe Lake summer averages of total phosphorus (34 µg/L), SDT (1.7 m [5.6 feet]), and chlorophyll-*a* were all better than the shallow lake standards. There were no statistically significant trends for the most recent 10-year period. Summer averages have generally varied and failed to meet the MPCA shallow lake eutrophication standards for one or more

parameters in 5 out of the last 10 years: twice for phosphorus, three times for SDT, and five times for chlorophyll-*a*.

Horseshoe Lake receives substantial flows from Eagle Point Lake and Lake Elmo. Water level readings indicate both lakes discharged to Horseshoe Lake continuously during the 2019 and 2020 monitoring periods, while flow to Horseshoe Lake was less in 2021. Eagle Point Lake, classified as a wetland, often has very high phosphorus concentrations that can negatively impact water quality in Horseshoe Lake; however, concentrations in Eagle Point Lake have been lower during recent higher precipitation years. Eagle Point Lake had relatively good water quality in 2015–2017 (total phosphorus summer averages of 82–119 µg/L); in years 2018–2020, water quality was uncharacteristically good (total phosphorus summer averages ranging from 34 to 44 µg/L).

In 2019 and 2020, the lake also received water pumped from flooding lakes:

- VBWD pumped Downs Lake, which conveyed floodwaters directly to Horseshoe Lake.
- Washington County pumped Goose Lake in 2019 and 2020, which conveyed water to Eagle Point Lake.
- Washington County also pumped Rose Lake in 2020, which conveyed water directly to Horseshoe Lake.
- In 2020, VBWD pumped Legion Pond to Lake Elmo, Reid Park Ponds to Downs Lake, and Friedrich's Pond to Eagle Point Lake.

Even with all the pumping, Horseshoe Lake had some of the lowest observed summer-average total phosphorus concentrations in recent years (38 µg/L in 2018, 41 µg/L in 2019, 34 µg/L in 2020). Although years with above-average precipitation likely increase the total mass of phosphorus exported from Eagle Point Lake to Horseshoe Lake, the increased water volume relative to the mass of phosphorus lowers phosphorus concentrations in the lake and improves water quality. A decrease in flows to Horseshoe Lake in 2021, relative to previous years with wet conditions, may have created more favorable conditions for the internal loading of phosphorus from Horseshoe Lake sediments.

3.1.9 Lake Jane

Lake Jane continued to have excellent water quality in 2021 and had the best SDT and chlorophyll-*a* 2021 summer averages of all VBWD lakes. Only Lake Elmo and Lake Edith had better summer averages of total phosphorus. The 2021 summer averages of SDT (4.7 m [15.4.5 ft]) and chlorophyll-*a* (2 µg/L) were some of the best on record. The 2021 total phosphorus (21 µg/L) was slightly worse than other recent years but still well below the water quality standard for deep lakes (40 µg/L). There are no statistically significant trends in Lake Jane water quality.

3.1.10 Long Lake

There are no statistically significant trends in Long Lake summer-average water quality parameters, and water quality remains good. The 2021 summer average of total phosphorus (22 µg/L) was similar to other

recent years and is substantially better than the MPCA deep lake standard (40 µg/L). The 2021 summer average of SDT (3.0 meters [9.8 feet]) was similar to recent years and is substantially better than the MPCA deep lake standard (1.4 meters). Summer averages of total phosphorus, chlorophyll-*a*, and SDT were often worse than the water quality standards in years prior to 2007, but have consistently been better than standards from 2007–2021. This suggests that VBWD alum treatments in 2008 and 2009 have effectively reduced internal phosphorus loading from lake sediment and have continued to be effective. Efforts to improve Long Lake’s water quality, including the alum treatment, have prevented it from being added to the MPCA’s impaired waters list.

3.1.11 McDonald Lake

McDonald Lake had the best summer average SDT (2.0 meters[6.6 feet]) and chlorophyll-*a* (9.4 µg/L) on record. The 2021 summer average of total phosphorus was 52 µg/L, and although not the best on record, it was a substantial improvement over the 2020 summer average (118 µg/L). It is unclear why phosphorus concentrations nearly doubled in 2020 compared to previous years (2017–2019) and dropped again in 2021. The lake level rose by more than 5.6 feet from 2010 to its highest recorded level in 2020, and the increase in depth and water volume appeared to improve water quality in recent years, with the exception of year 2020. There were no statistically significant trends in water quality for the most recent 10-year period; there had been a statistically significant trend in improving phosphorus concentrations for the period from 2010–2019. Although 2021 summer averages of total phosphorus, chlorophyll-*a*, and SDT were better than the shallow lake water quality standards, the lake has frequently had summer averages of total phosphorus and chlorophyll-*a* worse than water quality standards. SDT has occasionally been worse than water quality standards as well. McDonald Lake is not currently listed as impaired, but the MPCA has proposed adding the lake to the impaired waters list for eutrophication in 2022.

3.1.12 Silver Lake

The 2021 water quality of Silver Lake was overall the best since 2006 but still considerably worse than the period spanning 1998–2006. The 2021 summer average for SDT (2.3 meters [7.5 feet]) was considerably better than the MPCA shallow lake eutrophication standard of 1.0 meter, and there was a statistically significant trend (95% confidence) of improving water clarity for the most recent 10-year period. The 2021 summer average of chlorophyll-*a* (11 µg/L) was also better than the shallow lake standard 20 µg/L. The 2021 summer-average total phosphorus was 69 µg/L, similar to recent years but worse than the MPCA’s eutrophication standard of 60 µg/L. There were no statistically significant trends for total phosphorus or chlorophyll-*a* from 2012–2021.

The water quality of Silver Lake had declined rapidly from 2007–2013 before recovering somewhat over the last eight seasons of monitoring. The water quality has not returned to levels observed in the late 1990s and early 2000s, and total phosphorus concentrations remain worse than the eutrophication standard. Summer averages for total phosphorus have failed to meet the MPCA’s shallow lake standard 8 of the last 10 years, and summer averages of chlorophyll-*a* have failed to meet the standard 4 of the past 10 years. SDT summer averages have failed to meet the MPCA standard twice in the last 10 years. Silver Lake is not currently listed as impaired, but the MPCA has proposed adding the lake to the impaired waters list for eutrophication in 2022.

Silver Lake's degraded water quality from 2007 to the present is most likely due to whole-lake herbicide treatments for Eurasian watermilfoil and curly-leaf pondweed in 2007–2008. Prior to 2007, Silver Lake had a dense community of aquatic plants. The whole-lake herbicide treatments diminished the aquatic plant community, resulting in a rapid increase in algae (i.e., phytoplankton). The elevated concentrations of algae reduced water clarity and the light reaching aquatic plants, which reduced plant growth.

Reductions in phosphorus, whether from internal (e.g., sediment) or external (e.g., runoff) sources, are expected to reduce phytoplankton concentrations and increase water clarity. This would allow more light to reach aquatic plants and the plant community to recover—effectively shifting the lake back to a plant-dominated system and further reducing phytoplankton concentrations during the growing season. Although summer-average total phosphorus concentrations remain worse than the water quality standard, water clarity (as measured by SDT) has been trending better recently. Aquatic plant surveys conducted in recent years have shown a recovery in the native plant community relative to years immediately after the whole-lake herbicide treatments of 2007–2008; however, water quality has not recovered to conditions observed from 1985–2006. Improvements to water quality due to recovery of the aquatic plant community may have been countered by increased phosphorus loading from the watershed. The VBWD has improved the Silver Lake Bioretention Basin and added a spent-lime facility; however, recent road reconstruction projects adjacent to and surrounding the lake and above-average precipitation (e.g., 2019–2020) may have offset those stormwater quality improvements.

The Minnesota Department of Natural Resources conducted a fish survey of Silver Lake in 2017. The survey indicated that the predominant species are northern pike, largemouth bass, and bluegill. Common carp, which can degrade water quality, were not found during the survey. The survey did record a small number of black bullhead, a bottom-feeding fish that can negatively impact water quality; however, the numbers observed in 2017 were not enough to suggest they are negatively affecting water quality. Walleye have been stocked in Silver Lake every year from 2011–2019.

Additionally, Silver Lake was stocked with many adult yellow perch in 2019 (2,205 adults, weighing 630 pounds). At the time this report was prepared, no information was available on the DNR's Lake Finder webpage for Silver Lake indicating stocking had occurred in 2020 or 2021. The 2017 survey indicated that the number of bluegill in Silver Lake was within the high end of the normal range expected for a shallow lake in this region. However, the average weight was just 0.1 pound, below the normal weight for bluegill. Small bluegills consume zooplankton; heavy predation by small bluegills may reduce zooplankton that consumes phytoplankton. Larger bluegills prefer larger prey, including insects, snails, and crayfish. Maintaining a healthy population of larger predatory fish (bass, northern pike, walleye) that feed on small bluegill will reduce their numbers and increase zooplankton, which would feed on phytoplankton and could increase water quality.

Ramsey County currently owns and operates an aerator in Silver Lake that was built in 1987. The county, VBWD, and Cities of Maplewood and North St. Paul are in discussions regarding the future operation and maintenance of the aerator. While VBWD has no analytical data to show the benefit of the aerator, Ramsey County and others report that winter fish kills were common in Silver Lake prior to 1986.

3.1.13 Sunfish Lake

The water quality of Sunfish lake continued to improve in 2021, with the best results on record for SDT, total phosphorus, and chlorophyll-*a*. The 2021 summer-average total phosphorus was 22 µg/L, which is considerably better than the MPCA shallow lake standard of 60 µg/L. The 2021 summer average for chlorophyll-*a* (3 µg/L) was also substantially better than the shallow lake standard (20 µg/L). The 2021 summer average SDT (3.5 meters [11.5 feet]) improved by 0.8 meters since 2020 and was substantially better than the shallow lake standard (1.0 m). There were statistically significant trends (95% confidence) of improving water quality in summer averages of total phosphorus and chlorophyll-*a* for the most recent 10-year period.

In 2016, the MPCA completed and approved a total maximum daily load (TMDL) study of Sunfish Lake, which is on the agency's impaired waters list for eutrophication. The water quality of Sunfish Lake has improved dramatically in recent years, and the summer average of total phosphorus has been worse than the shallow lake standard just once in the past 10 years (61 µg/L in 2012). The most recent 10-year averages of total phosphorus, chlorophyll-*a*, and SDT now meet the shallow lake water quality standard. If Sunfish Lake continues to have water quality similar to the last several years, it could soon be removed from the impaired waters list.

Sunfish Lake is landlocked, with no surface outflow under normal conditions. The lake level and volume fluctuate with changes in precipitation. In the summer of 2010, Sunfish Lake's water level dropped to its lowest since the 1970s and steadily increased 10 feet by 2019, reaching its 100-year flood level. The lake continued to rise in 2020 by another 1.85 feet, an increase of nearly 12 feet since 2010. 2021 saw below-average precipitation, and lake levels stabilized but remain relatively high. The increased water volume, which dilutes the concentration of nutrients, may improve water quality as long as the increased depths do not exacerbate internal loading mechanisms. Water quality in Sunfish Lake is typically worse in late summer due to internal loading of phosphorus from the lake's sediment. Recent years have shown little or no increase in phosphorus at the lake surface in late summer.

3.2 Aquatic Vegetation Surveys

On behalf of the VBWD Managers, Barr hired a qualified contractor to conduct aquatic vegetation surveys of the following lakes in July 2021:

- Long Lake
- Lake DeMontreville
- Lake Elmo
- Lake Jane
- Lake Olson
- Silver Lake

Barr presented the results of the vegetation surveys to the VBWD Managers in a December 2021 report.

3.3 Stream and Watershed Outlet Water Quality

The Managers contracted with WCD to conduct water quality monitoring on three streams in 2021: Valley Creek, Kelle's Creek, and the outlet of Rest Area Pond. The monitoring programs for the streams are briefly described below, and results of phosphorus monitoring and bacteria monitoring are summarized for Valley Creek and Kelle's Creek. The results of macroinvertebrate monitoring for Valley Creek are also summarized.

3.3.1 Valley Creek Monitoring

Several monitoring activities were conducted on Valley Creek in 2021, including monitoring bacteria (*E. coli*), water chemistry, and macroinvertebrates.

3.3.1.1 Valley Creek Bacteria Monitoring

The VBWD contracted with the WCD in 2021 to collect bacteria samples at three locations (Figure 2-1) on Valley Creek in 2021. The main stem of Valley Creek was sampled at the Watershed Outlet Monitoring Program (WOMP) station, which has been monitored annually since 2001. The other two monitoring locations, representing the North Branch and South Branch of Valley Creek, have been monitored less frequently.

As discussed in Section 3.2, the MPCA uses *E. coli* as an indicator of bacteria in surface waters. *E. coli* is a subgroup of fecal coliform bacteria—a group of bacteria that generally originate in the intestines of warm-blooded animals. *E. coli* measured with standard testing will not necessarily cause illness in humans, nor does testing include all fecal pathogens that can cause illness. However, *E. coli* testing is an affordable method for identifying fecal contamination in surface waters. The MPCA standards for *E. coli* that apply to Valley Creek include both a maximum of individual readings and a monthly geometric mean:

- (1) Maximum values not to exceed 1,260 colony-forming units per 100 milliliters (cfu/100mL) in 10% or more of individual samples in a calendar month, or
- (2) Monthly geometric means not to exceed 126 cfu/100mL in a calendar month

E. coli standards apply to the warmer months of April through October, when people are more likely to contact the water. The water quality standard refers to colony-forming units (cfu), while laboratories often report results as most probable number (MPN). The units of cfu/100mL and MPN/100mL are used interchangeably in the discussion below, comparing monitoring results to the standard. Water quality impairments are determined by calculating geometric means for aggregated data for each calendar month (e.g., calculating the geometric mean for combined June data from multiple years of monitoring). MPCA guidance places greater emphasis on monitoring from June–September.

The results of 2021 *E. coli* monitoring are plotted in Figure 3-4; the MPCA standard for the monthly geometric mean is included for comparison. The highest observed result in 2021 was 261 MPN/100mL on July 7, 2021, measured at the WOMP station on the main stem. Measurements of *E. coli* were also above the 126 cfu/100mL standard for several measurements on the South Branch in June and July, while measurements on the North Branch remained below the standard throughout the 2021 monitoring

season. While 2021 results were noticeably lower on the South Branch compared to the North Branch and WOMP station results, previous years of monitoring *E. coli* at the North Branch and South Branch were more variable, with the North Branch often having higher *E. coli* than the South Branch. No bacteria measurements in Valley Creek exceeded the maximum individual standard of 1,260 cfu/100mL in 2021. June and July typically have the highest concentrations of *E. coli* each season, and concentrations have been variable from year to year recently. Concentrations in June-July were generally higher in 2020-2021 compared to years 2018-2019, while 2017 had the highest concentrations of the past decade.

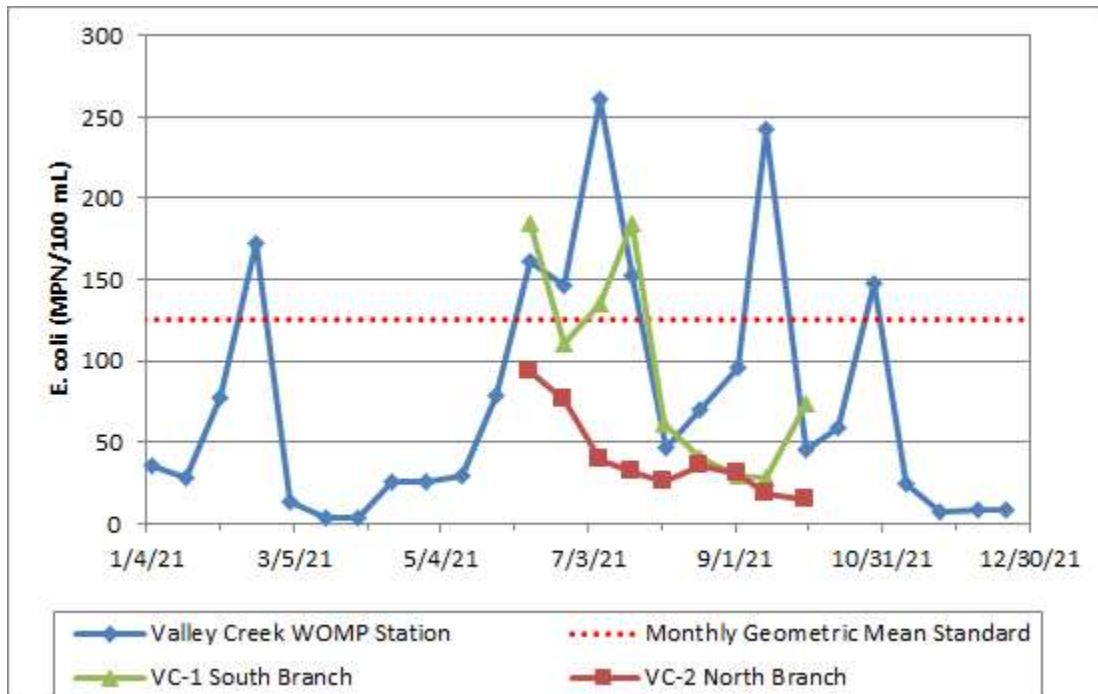
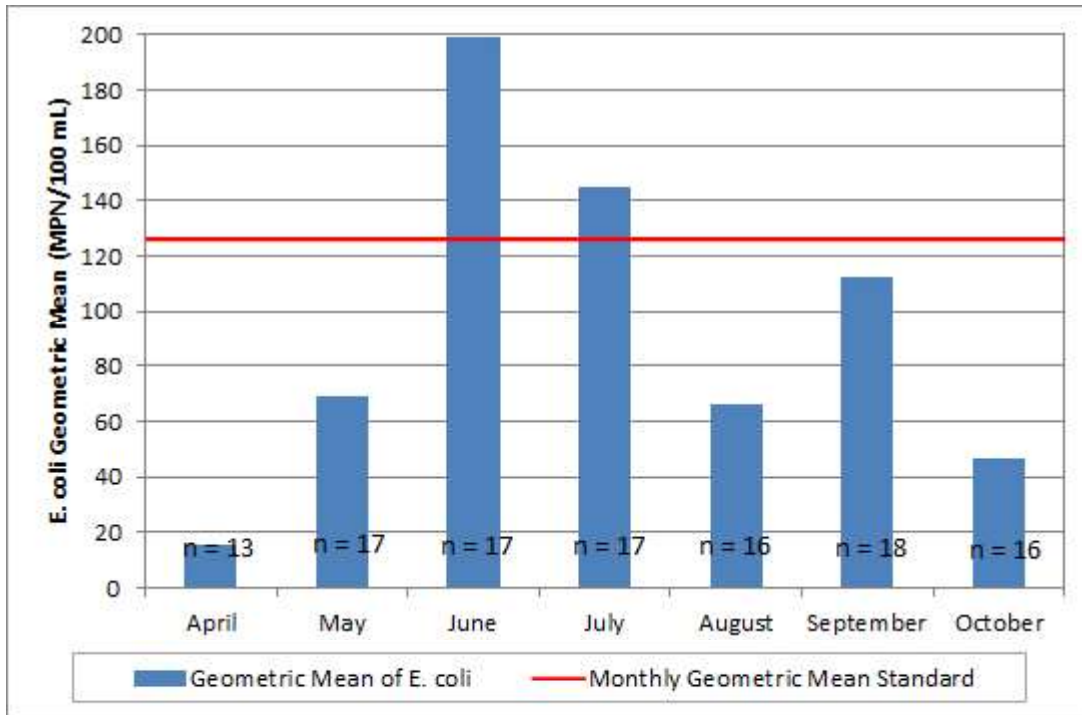


Figure 3-4 Valley Creek 2021 *E. coli* Monitoring Results

Barr calculated the aggregated geometric means of *E. coli* for the WOMP station on the Main Branch of Valley Creek for 2012–2021. Geometric means of *E. coli* are shown in Figure 3-5, along with the MPCA’s standard for aggregated monthly geometric means. The geometric means of *E. coli* for June and July do not meet the MPCA standard. Additionally, 12% of June measurements for the same 10-year period were greater than 1,260 MPN/100mL, which would exceed the MPCA’s bacteria standard (no more than 10% of aggregated values for a calendar month can exceed 1,260 MPN/100mL). This data indicates that Valley Creek is impaired for *E. coli*. The MPCA has added Valley Creek to the Draft 303(d) Impaired Waters List for bacteria and is expected to be officially added to the Impaired Waters List in 2022.



Notes: Includes data collected at WOMP station on the Main Branch of Valley Creek for years 2012–2021.
 “n = 8” indicates the number of samples used to calculate the geometric mean for each month.

Figure 3-5 Geometric Means of E. coli in Valley Creek (Main Branch) by Calendar Month, 2012–2021

3.3.1.2 Valley Creek Watershed Outlet Monitoring Program (WOMP)

VBWD funds the collection of water quality and continuous-flow monitoring at the Metropolitan Council’s WOMP station at the Putnam Boulevard crossing of Valley Creek. The VBWD contracts with the WCD to operate the WOMP monitoring station. Water samples are sent to the Metropolitan Council Environmental Services (MCES) laboratory for water chemistry analyses, including concentrations of phosphorus, nitrate, nitrite, ammonia, total suspended solids, and several metals. Previously, Valley Creek monitoring results were detailed in an annual report prepared by the St. Croix Watershed Research Station (SCWRS) of the Science Museum of Minnesota. The SCWRS last reported on Valley Creek water quality for the 2013 monitoring year.

The MPCA adopted new RES in 2015 (see Section 2.0), including summer-average phosphorus standards for streams and rivers. Phosphorus is most often the limiting nutrient for algal growth in Minnesota water bodies, including streams and rivers. The MPCA’s RES are different for different state regions, and Valley Creek is within the South River Nutrient Boundary. Summer averages of total phosphorus in the Main Branch of Valley Creek are compared to the South River Nutrient Boundary RES (150 µg/L) in Figure 3-6. Summer averages for total phosphorus in Valley Creek were better than the South River Nutrient Boundary RES for all years. Summer averages for chlorophyll-*a* are also consistently better than the South River Nutrient Boundary RES of 35 µg/L. This data indicates that Valley Creek is not impaired for eutrophication.

Water quality monitoring in Valley Creek shows high phosphorus concentrations during high flows following storm events. Although these high phosphorus concentrations are not causing eutrophication impairments, the phosphorus load from Valley Creek contributes to the overall load to the St. Croix River/Lake St. Croix and the Mississippi River and Lake Pepin farther downstream. Lake St. Croix and Lake Pepin are both impaired for excess nutrients (i.e., phosphorus). Therefore, efforts to manage stormwater and reduce phosphorus loads in Valley Creek and other streams should continue.

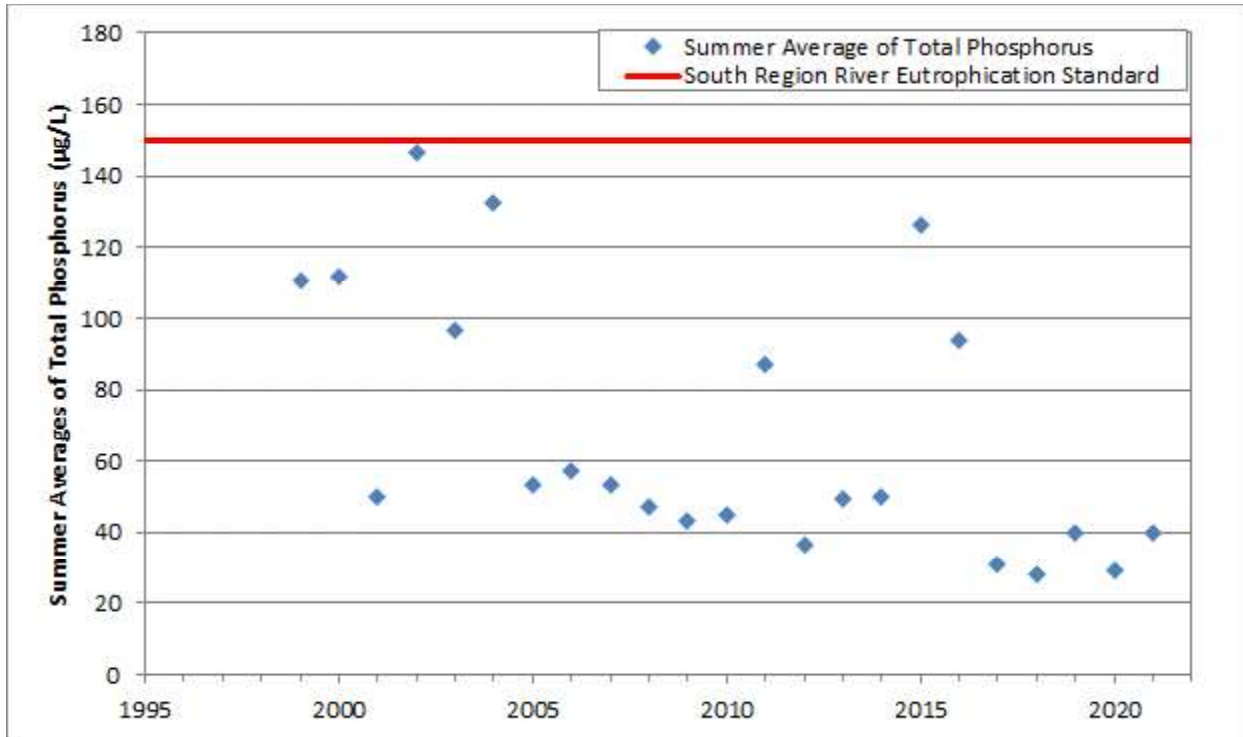


Figure 3-6 Valley Creek (Main Branch) Summer Averages of Total Phosphorus

3.3.1.3 Valley Creek Macroinvertebrate Monitoring

The VBWD contracts with Barr to conduct annual macroinvertebrate monitoring in Valley Creek at two locations (Figure 3-7). Samples are collected by dislodging organisms from submerged rocks, logs, or other surfaces and capturing them in a net. The samples are sent to a taxonomist for identification, and the data is used to calculate indices of aquatic biota integrity. Some organisms are associated with better water quality and healthier streams, and others indicate poor water quality and degraded streams. The Hilsenhoff Biotic Index (HBI) is commonly used to assess water quality as related to organic pollution and dissolved oxygen availability. The HBI results for Valley Creek in 2021 indicate “Very Good” to “Excellent” water quality for Site B and Site C, respectively. “Excellent” is the best HBI category possible, and Site C was last rated Excellent in 2007, while Site B has not rated Excellent since 2011. Both Site B and Site C had large numbers of the mayfly species *Baetis brunneicolor*, with a “Very Good” HBI designation. Site B and Site C also had good numbers of the caddisfly species *Hydropsyche alhedra*, which have “Very Good” HBI designations. Site C was able to score Excellent due to the large presence of the caddisfly species *Brachycentrus occidentalis*. These caddisflies were also present at Site B, although in lower numbers. Site B

had high numbers of insects in the family Chironomidae (non-biting midges), and there were several different species identified. Most Chironomidae identified have HBI ratings of Good, Fair, and Fairly Poor; Site C had very few Chironomidae in 2021. Black fly (sometimes called a buffalo gnat) in the insect family Simuliidae were present at both sites in moderate numbers in 2021. The black flies have an HBI rating of Fairly Poor and can result in a worse HBI score when present in high numbers. Black fly numbers tend to be highly variable at the Valley Creek monitoring sites.

Over the past decade, Valley Creek HBI scores have varied, with scores in the “Very Good” and “Excellent” categories most years (Figure 3-8). The 2021 HBI score at Site B was similar to recent years, while the HBI score for Site C improved to “Excellent” after thirteen years of scoring “Good” to “Very Good”. Improvements in habitat conditions due to lower stream flows in 2021 relative to previous years likely contributed to the improved score at Site C. Rocky bottom, woody debris, undercut banks, and submerged vegetation (including overhanging stream bank vegetation) are high-quality habitats sampled for macroinvertebrates, while silt and sand are poor-quality habitats. Field staff conducting the macroinvertebrate sampling reported silt and sand covering portions of the rocky bottom at Site C in 2019 and 2020. However, good quality woody debris and submerged vegetation were also present at Site C each year. Less sand and silt covering quality substrates were observed in 2021, and field staff reported overall better rocky substrate habitat in 2021. High water levels in the St. Croix River in recent years (2019–2020) had created periods with a backwater effect at Site C. This caused the water to deepen, slowed water velocities, and allowed sediment to accumulate over the rocky bottom substrates. The accumulation of sediment on the rocky substrates can result in lower overall numbers of aquatic insects that live on the rocks, and cause a shift from species that are sensitive to pollution and siltation to more pollution tolerant organisms. Photographs of the woody debris and rock riffles at Site B (Figure 3-9 and Figure 3-10) and Site C (Figure 3-11 and 3-12) taken during the 2021 sampling event are included below.



Barr Footer: ArcGIS 10.7.1, 2021-03-08 16:37 File: H:\Client\BWD\District\Work Orders\Annual Reporting\Maps\2020 Annual WO Report\Maps\Fig3-7 Aquatic Biota Monitoring Locations.mxd User: mbs2

-  Macroinvertebrate Monitoring Reach
-  Valley Creek Downstream Stabilization
-  Trout Habitat Improvement Project
-  Stream Alignment

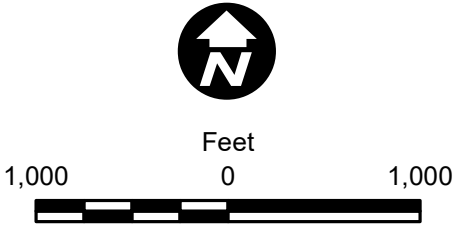


Figure 3-7

**VALLEY CREEK
AQUATIC BIOTA
MONITORING LOCATIONS**
Valley Branch Watershed District

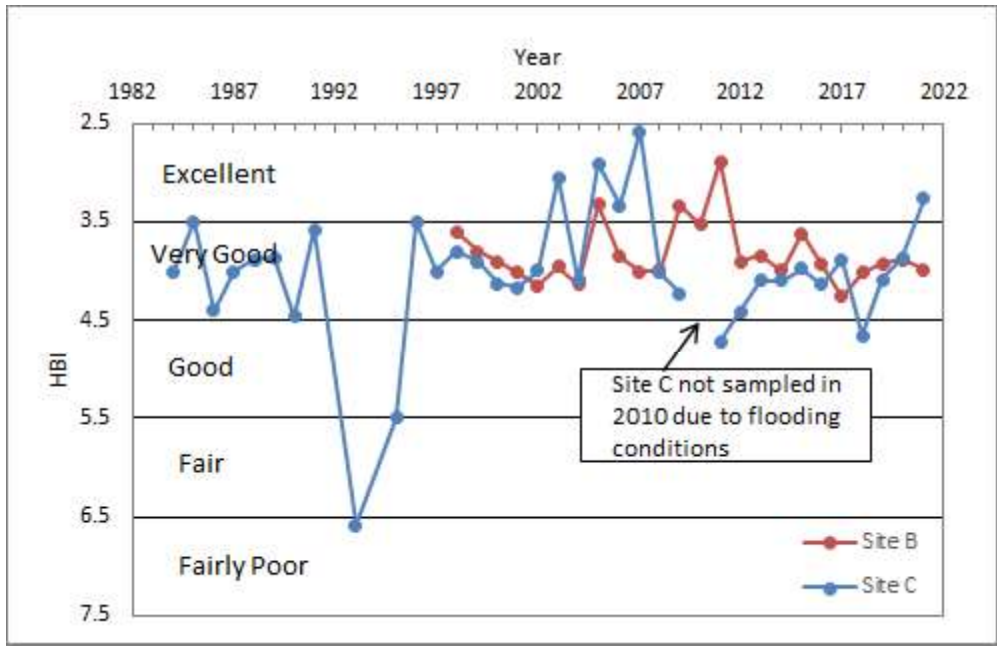


Figure 3-8 HBI Scores for Valley Creek



Figure 3-9 Valley Creek Macroinvertebrate Site B, Rock Riffle



Figure 3-10 Valley Creek Macroinvertebrate Site B, Woody Debris



Figure 3-11 Valley Creek Macroinvertebrate Site C, Rock Riffle



Figure 3-12 Valley Creek Macroinvertebrate Site C, Woody Debris

3.3.2 Kelle's Creek Monitoring

The VBWD contracted with the WCD to conduct water quality and flow monitoring in Kelle's Creek in 2021. The monitoring station is operated following the methodologies of the MCES WOMP. Monitoring activities include the collection of water samples for laboratory analyses and continuous flow monitoring. Parameters analyzed include nutrients, metals, and bacteria.

Barr compared the summer averages of total phosphorus in Kelle's Creek to the MPCA's South River Nutrient Boundary RES (150 µg/L total phosphorus). The 2021 summer average for all total phosphorus samples (grab and composite) was 1,360 µg/L, well above the RES. The total phosphorus concentrations in grab samples collected during the 2021 summer months (June–September) ranged from 41 to 175 µg/L, while the composite samples collected ranged from 3,820 to 4,620 µg/L. Concentrations of phosphorus in Kelle's Creek are typically an order of magnitude higher (or more) in composite samples collected during storm events compared to grab samples collected during normal or base-flow conditions. Other RES parameters (e.g., chlorophyll-*a*, biological oxygen demand) were not measured in Kelle's Creek, so a full assessment of eutrophication impairments cannot be made. To be considered impaired for eutrophication, a stream must exceed both the RES for total phosphorus and a second "response" parameter, such as chlorophyll-*a*.

Kelle's Creek is on the MPCA's impaired waters list for bacteria (*E. coli*). Results of *E. coli* monitoring in 2021 are shown in Figure 3-13. *E. coli* levels in 2021 were highest in mid-September, with a concentration of 1,426 MPN/100 mL on September 16, 2021, worse than the MPCA's standard for individual samples

(1,260 cfu/100mL). The highest *E. coli* values in Kelle's Creek typically occur during the warm summer months of June–September. Barr calculated geometric means for each calendar month for the most recent 10-year period. The results are included in Figure 3-14, along with the MPCA's monthly geometric mean standard (126 cfu/100mL) for comparison. The months of June, July, August, and September all have 10-year geometric means that are worse than the MPCA's standard. July has the highest 10-year geometric mean: 627 MPN/100mL.

Results indicate Kelle's Creek continues to be impaired for *E. coli*. The 10-year geometric mean of *E. coli* concentrations for the summer months of June–September are approximately three times the MPCA's standard of 126 MPN/100mL. The MPCA prepared a TMDL study for the creek in 2015, which the EPA approved in 2016. The TMDL study identifies improved management of livestock pastures and subsurface sewage treatment systems (SSTS) as strategies to meet *E. coli* standards.

VBWD has conducted surveys of residences within the Kelle's Creek watershed to identify SSTS that are not in compliance with county ordinances and has implemented a cost-share program for upgrades of non-compliant systems. From 2016 through 2018, 23 septic system inspections were completed as part of the VBWD's Kelle's Creek septic system inspection program. The grant for the inspections ended in 2018, and no inspections were conducted in 2019, 2020, or 2021. Additionally, according to the Washington County database, 16 system inspections were completed within the Kelle's Creek watershed between 2012 and 2017 (as the result of home sales, property expansions, etc.). Of the 39 inspections (approximately 25% of septic systems in the watershed), 22 SSTS (56%) were non-compliant, a higher rate than estimated during the TMDL development. Reasons for noncompliance included tank integrity and soil separation concerns; however, no systems inspected were flagged as an imminent threat to public health. After the inspections, 10 landowners applied to participate in the VBWD cost-share replacement program. Additionally, since 2012, six other systems were replaced separate from the VBWD cost-share program, and 13 septic systems were removed and connected to the City of Afton community septic system.

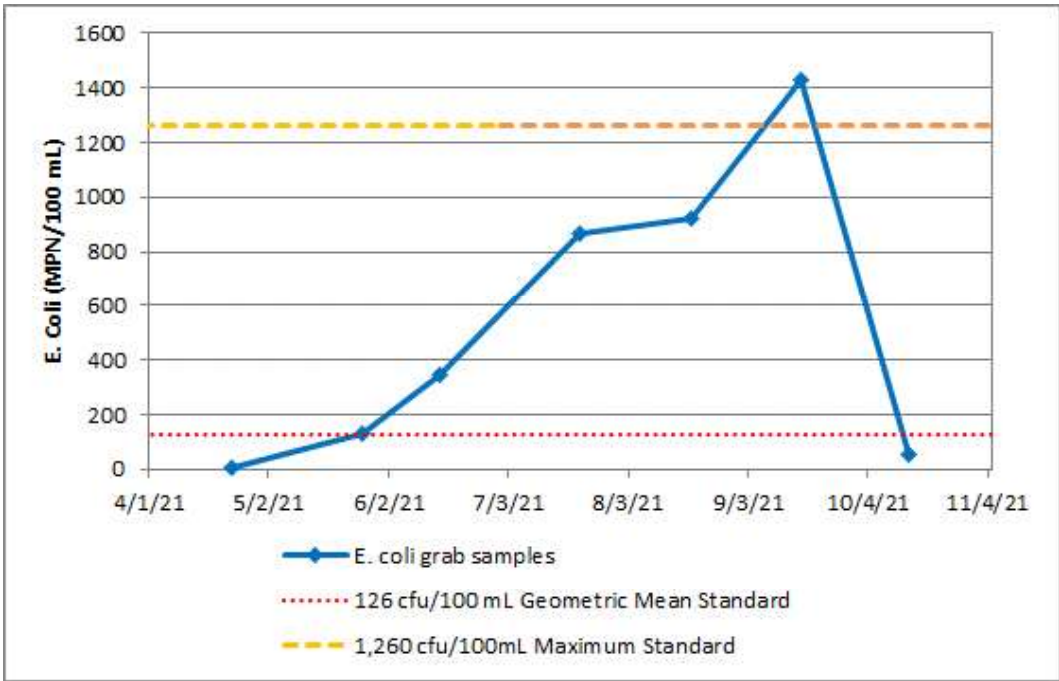
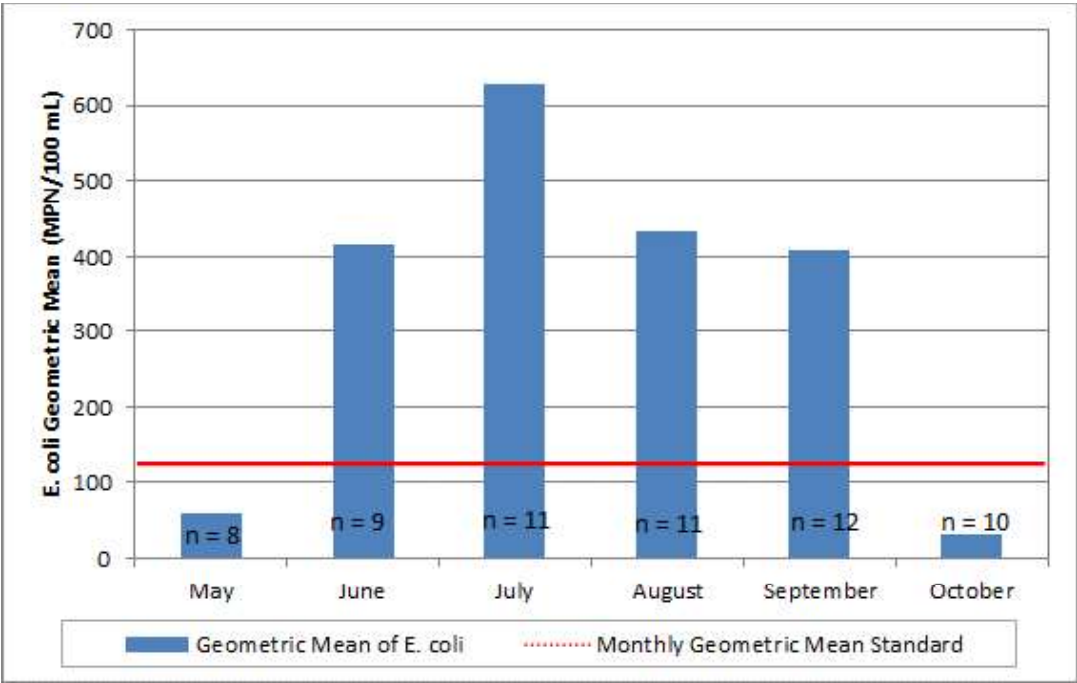


Figure 3-13 Kelle's Creek 2021 *E. coli* Monitoring



Note: "n = 8" indicates the number of samples used in the calculation of geometric mean for each month

Figure 3-14 Geometric Means of *E. coli* in Kelle's Creek by Calendar Month, 2012–2021

3.3.3 Rest Area Pond Outlet Monitoring

The VBWD contracts with the WCD to monitor water quality and flow at the Rest Area Pond outlet. This outlet typically has intermittent flows; for example, while there was no outflow during the 2015 monitoring season, there has been continuous flow throughout most of the monitoring seasons in recent years (excluding 2021). In 2019 and 2020, high flow at Rest Area Pond created unsafe conditions where field staff needed to enter the outlet structure to install an area-velocity meter for continuous flow monitoring. Therefore, no flow monitoring occurred in 2019 and 2020. A water-level sensor was installed in the outlet structure on April 21, 2021, for continuous logging of water level, which can be used to estimate the Rest Area Pond outflow. Water levels were monitored from April 21, 2021, to July 12, 2021, when the water level sensor malfunctioned and stopped recording water levels. It is estimated that water levels rose above the outlet elevation again following a rain event on August 24, 2021, and outflow resumed at that time, as field staff visually observed outflow on August 30, 2021. A small amount of outflow was observed by field staff on October 18, 2021.

4.0 Conclusions

The 2021 water quality of VBWD's lakes, wetlands, and streams was similar to recent years, with several shallow, landlocked basins continuing to experience better water quality due to relatively high lake levels and volumes. Although 2021 had below-average precipitation, several prior years of above-average precipitation elevated lake levels and stream flows. Several small landlocked lakes and ponds required pumping to alleviate or prevent flooding in 2019–2020. Some of these landlocked lakes have seen water levels rise several feet over the last decade. The increased water volumes have likely improved water quality for several shallow lakes.

Lakes and Wetlands

- Deep Lakes: Overall, water quality in the VBWD deep lakes remained good in 2021, with summer averages better than eutrophication standards for all deep lakes monitored. Lake Edith had a statistically significant trend of improving water quality for SDT for 2012–2021. Lake Elmo was the only VBWD water body with a statistically significant trend of degrading water quality from 2012–2021. There was a statistically significant trend of degrading SDT but no trends in summer averages of total phosphorus and chlorophyll-*a* for Lake Elmo.
- Shallow Lakes, Wetlands, and Stormwater Ponds: While some shallow lakes showed improvement trends for the most recent 10-year period, several still have worse water quality than Minnesota's eutrophication standards.
 - Downs Lake, Rest Area Pond, and Sunfish Lake showed statistically significant trends of improving total phosphorus and chlorophyll-*a*.
 - Eagle Point Lake showed statistically significant trends of improving total phosphorus
 - Silver Lake showed a statistically significant trend of improving SDT.
 - Klawitter Pond was the one shallow lake with a statistically significant trend of degrading water quality, as there was a statistically significant trend of degrading SDT.
 - Downs Lake, Goose Lake (South), Horseshoe Lake, and Silver Lake all had summer-average total phosphorus concentrations worse than the shallow lake eutrophication standard in 2021. Downs Lake, Goose Lake (South), Horseshoe Lake, and McDonald Lake had chlorophyll-*a* worse than the shallow lake standard. Downs Lake and Goose Lake (South) had SDT worse than the shallow lake standard.
 - The MPCA has proposed adding McDonald Lake and Silver Lake to the impaired waters list for eutrophication in 2022 and removing Echo Lake.
- The MPCA continues to conduct studies on PFOS contamination in surface water and groundwater in the East Metro and has proposed adding a PFOS impairment status for Eagle Point Lake and H.J. Brown Pond.

- High Water Levels: Several shallow lakes and wetlands that have shown improved water quality (i.e., lower phosphorus concentrations) have experienced an increase in surface water elevation and lake volume due to increased overall precipitation. Years 2018 and 2020 were above-average years for precipitation, and 2019 was record-setting. Although 2021 had below-average precipitation, lake levels remained high. The greater water depth and volume in these shallow basins may be lessening the effects of internal phosphorus loading from lake sediments. The greater water depth may reduce sediment resuspension from wind and wave action or reduce the mixing of phosphorus-rich water from the lake bottom to the lake surface during the summer. The increase in lake volume also dilutes the internal phosphorus load.

Streams

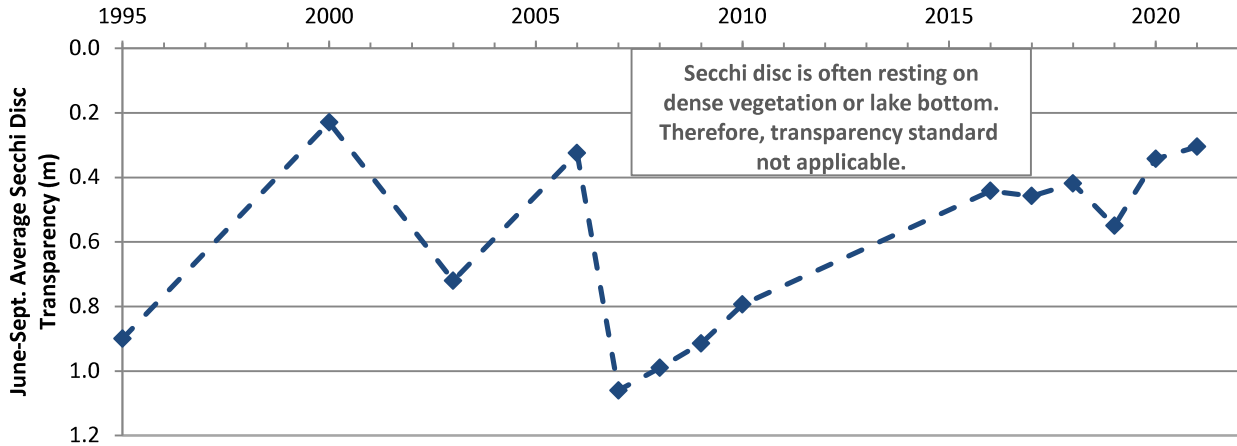
Water quality monitoring of Valley Creek in 2021 demonstrated that phosphorus concentrations remain below Minnesota's RES. In macroinvertebrate monitoring, using the Hilsenhoff Biotic Index, the aquatic biota community continues to be rated "Good" to "Very Good" in recent years. Site C was rated "Excellent" in 2021, one grade above Very Good. Valley Creek samples analyzed for *E. coli* continue to indicate that Valley Creek is at times impaired for fecal coliform bacteria during the warmer summer months. The MPCA has proposed adding Valley Creek to the impaired waters list in 2022.

Kelle's Creek 2021 water quality monitoring continues to show impairments for fecal coliform bacteria, and *E. coli* results remain above the standard for monthly geometric mean during the summer months. The September sample was also above the standard for individual samples. Phosphorus concentrations in Kelle's Creek also remain high during storm events, while samples collected during normal or base-flow conditions are better than MPCA stream eutrophication standards.

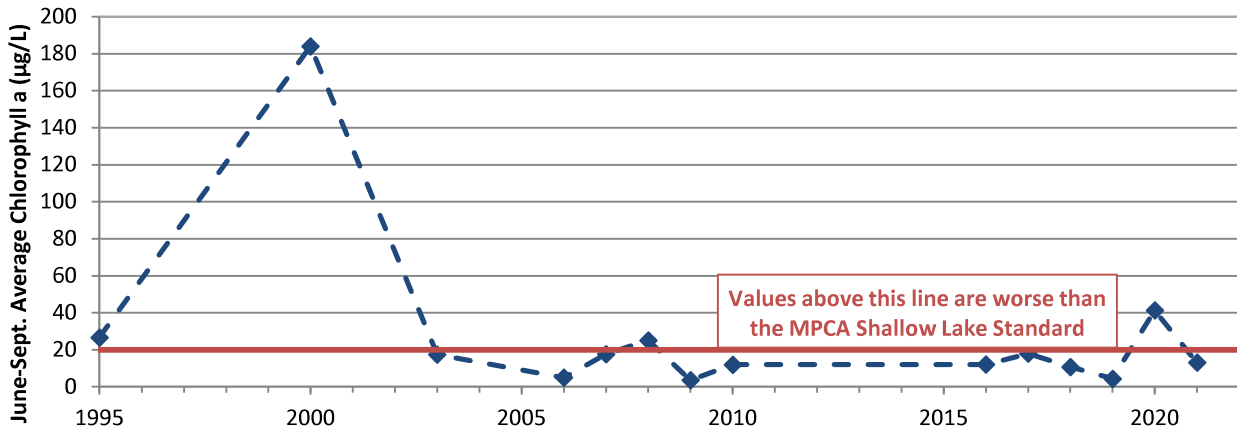
Attachment A

Summer Averages of Water Quality Parameters for VBWD Lakes and Wetlands

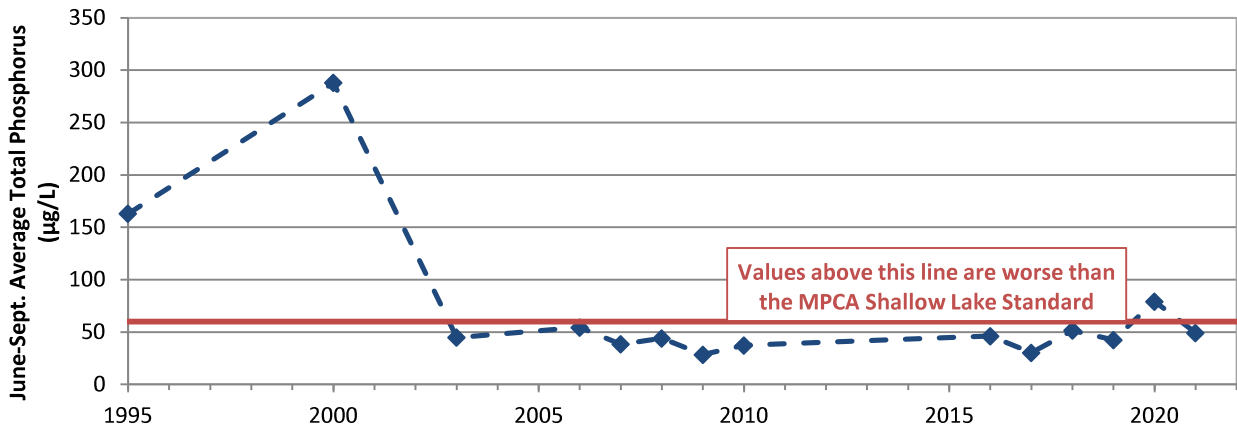
Acorn Lake June-Sept. Secchi Disc Transparency



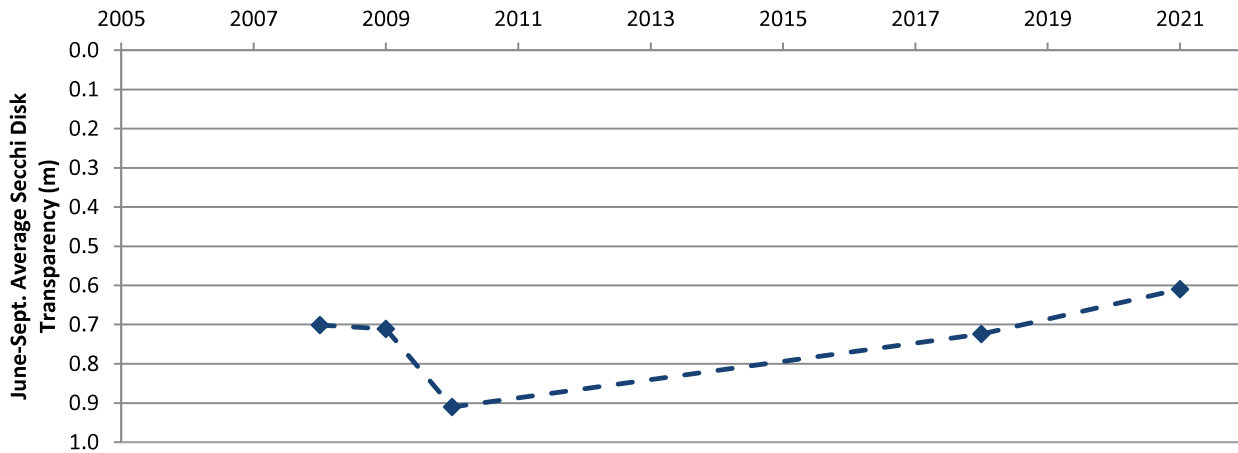
Acorn Lake June-Sept. Average Chlorophyll α



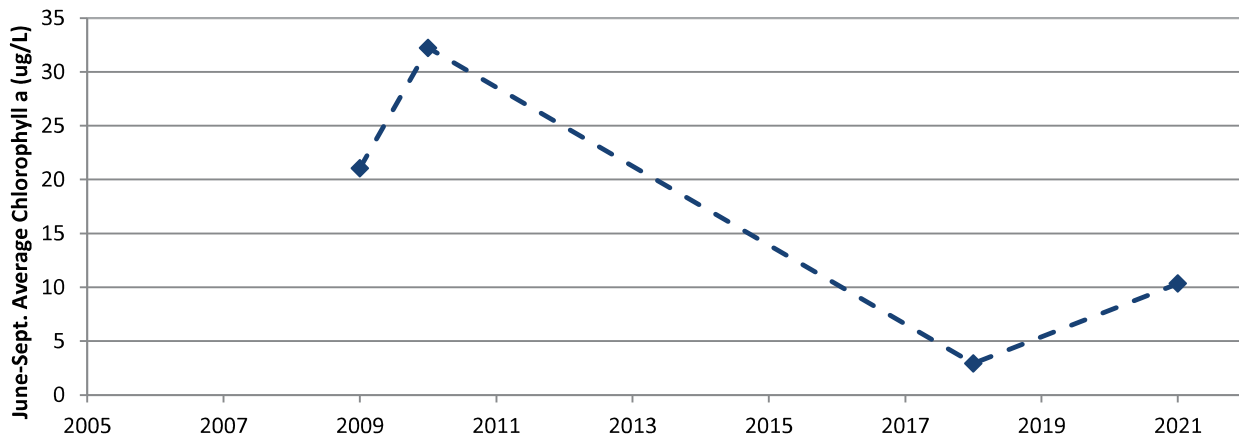
Acorn Lake June-Sept. Average Total Phosphorus



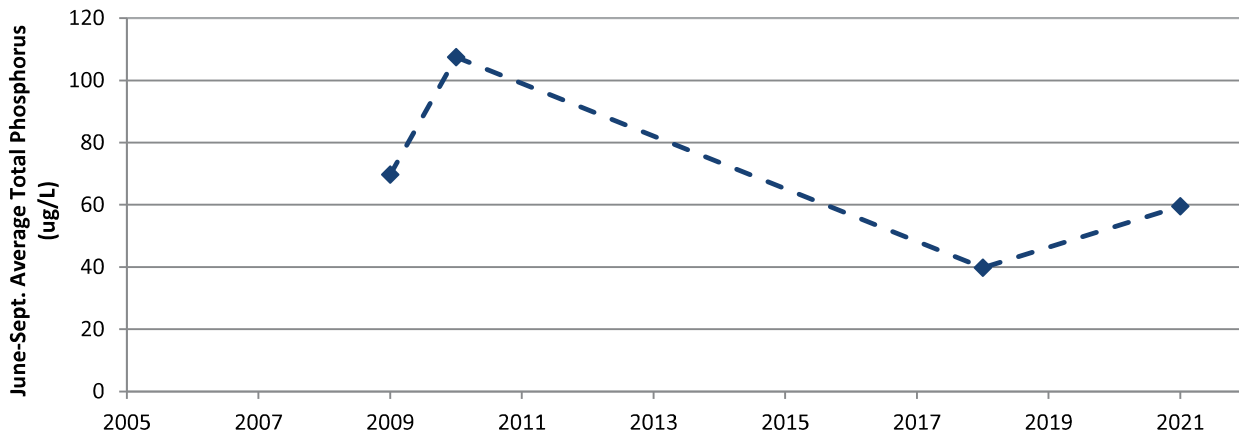
Beutel Pond June-Sept. Secchi Disk Transparency



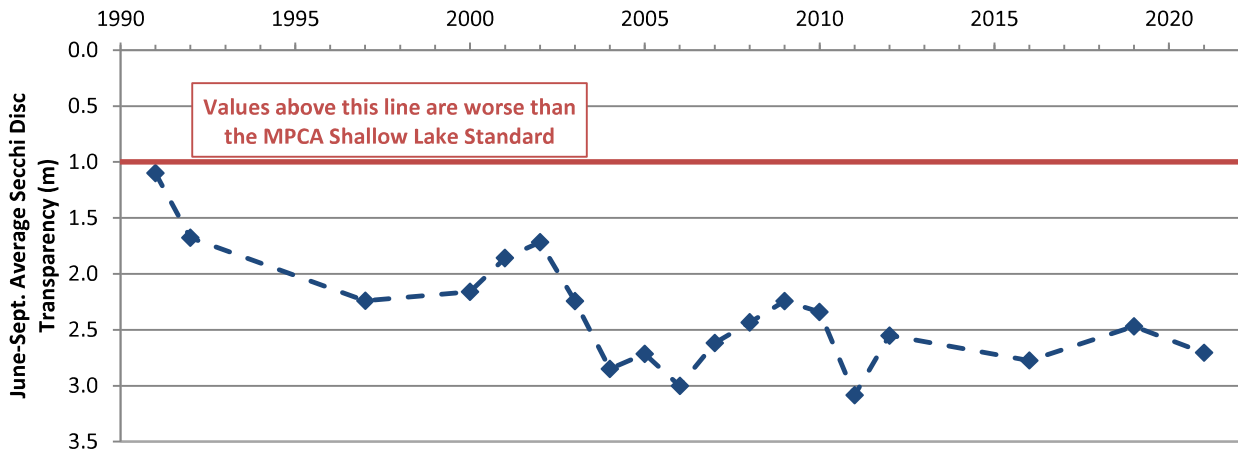
Beutel Pond June-Sept. Average Chlorophyll *a*



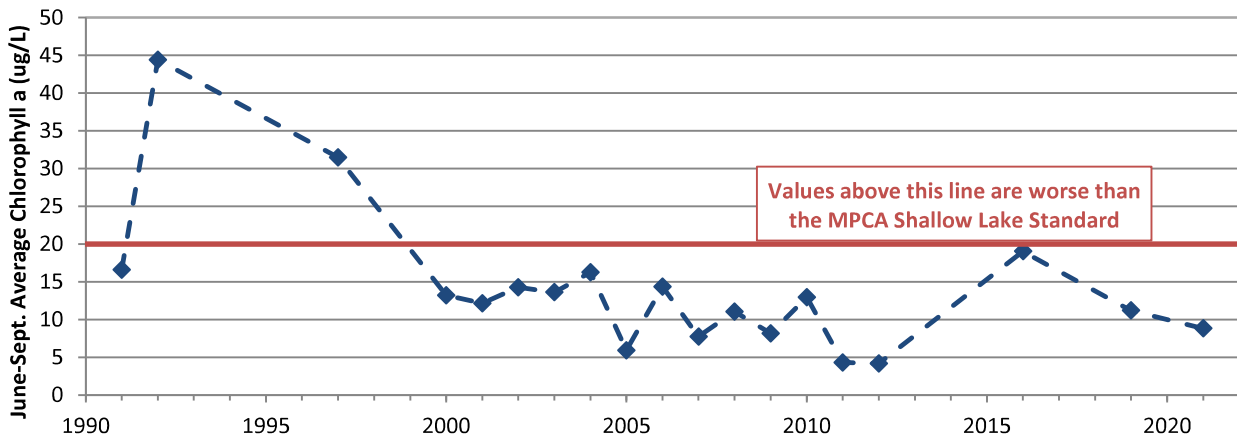
Beutel Pond June-Sept. Average Total Phosphorus



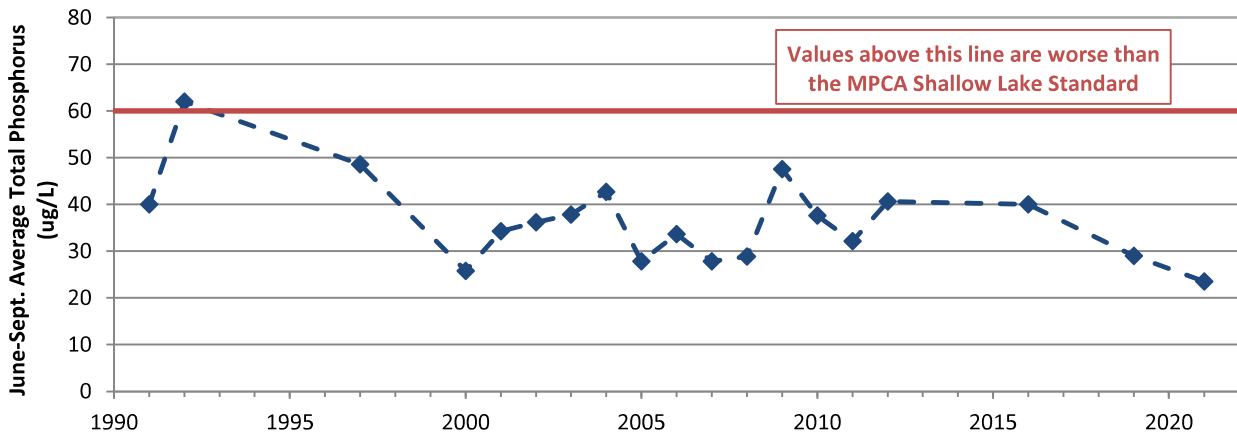
Cloverdale Lake June-Sept. Secchi Disc Transparency



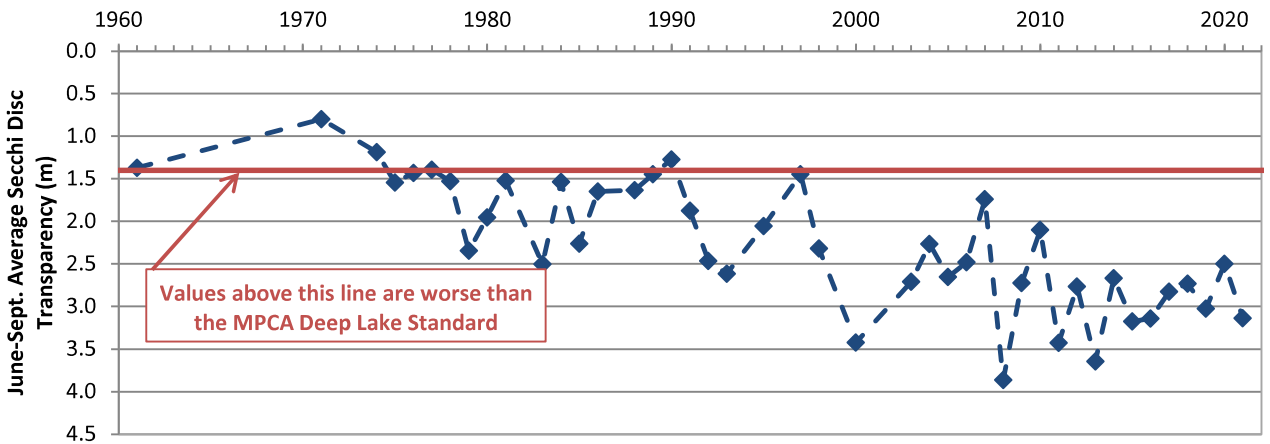
Cloverdale Lake June-Sept. Average Chlorophyll a



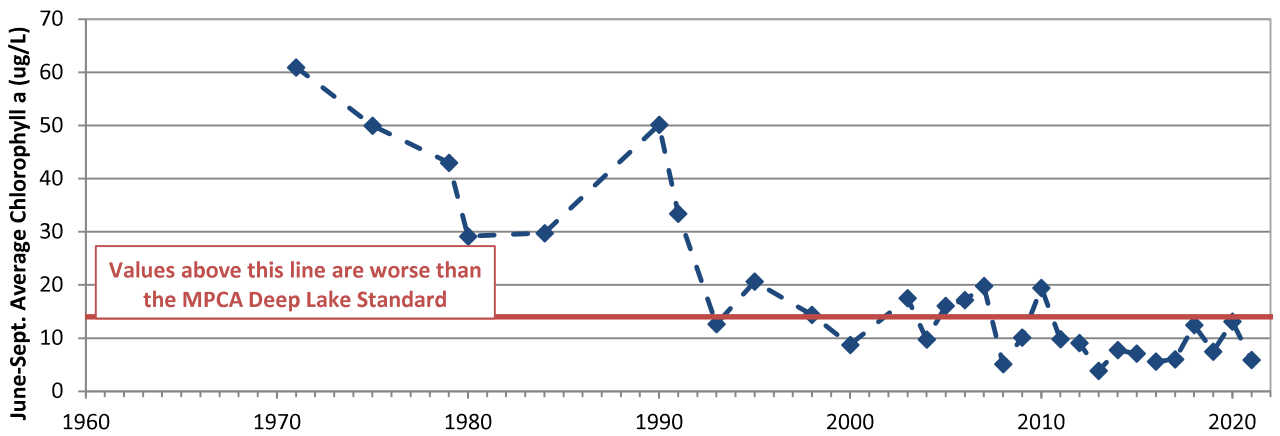
Cloverdale Lake June-Sept. Average Total Phosphorus



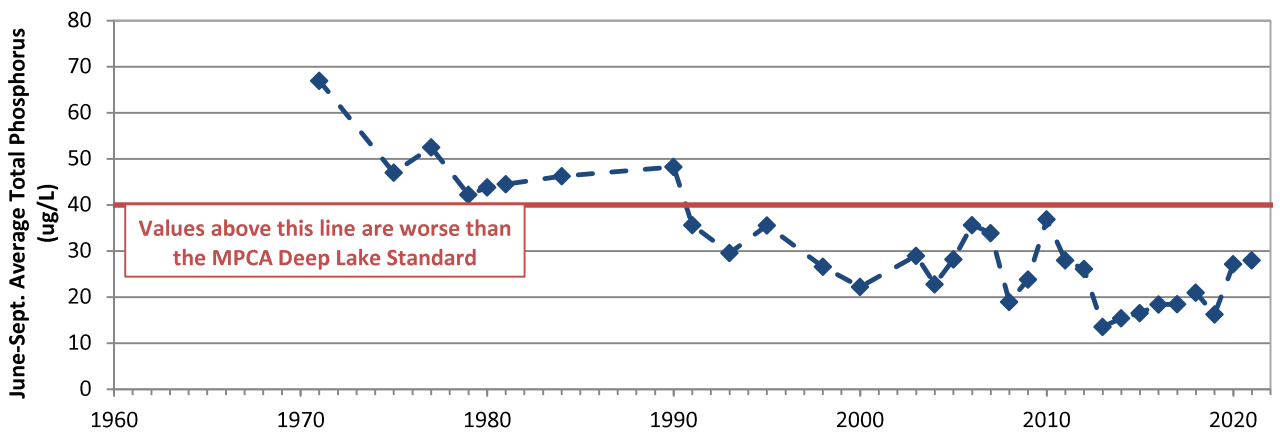
Lake DeMontreville June-Sept. Secchi Disc Transparency



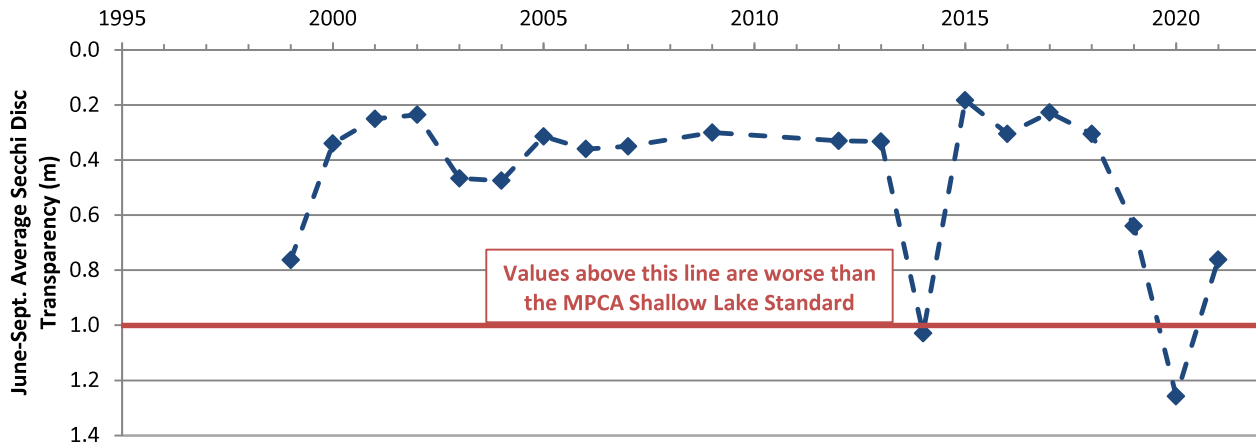
Lake DeMontreville June-Sept. Average Chlorophyll α



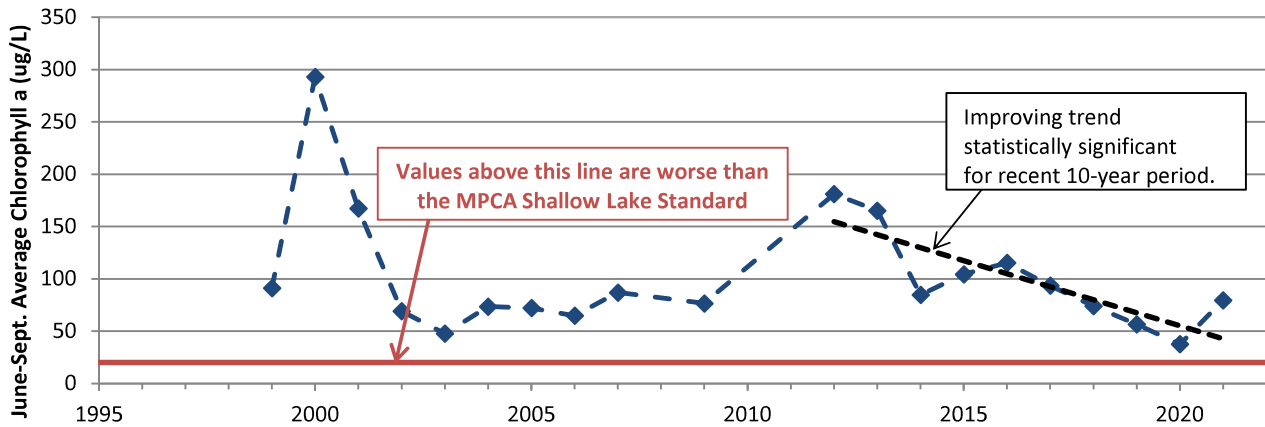
Lake DeMontreville June-Sept. Average Total Phosphorus



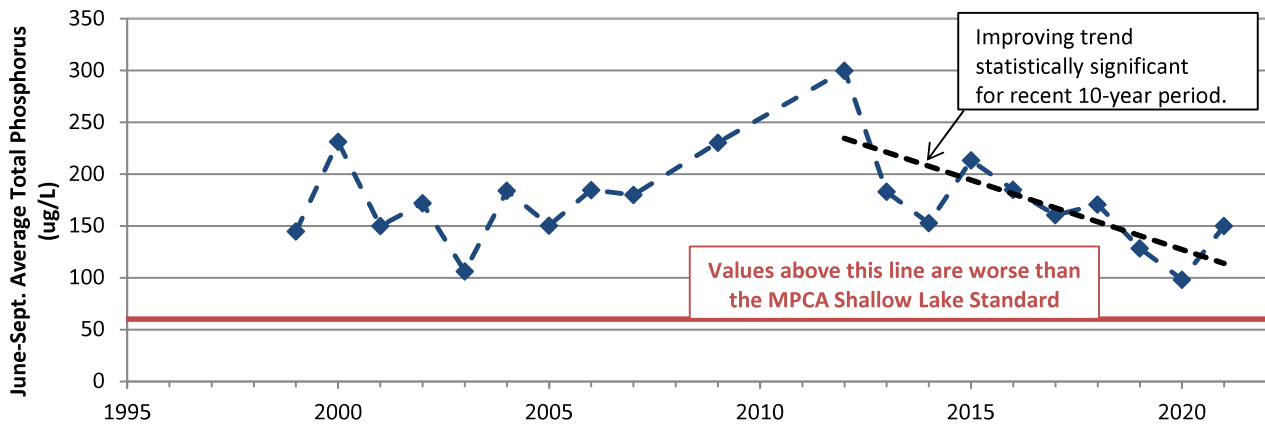
Downs Lake June-Sept. Secchi Disc Transparency



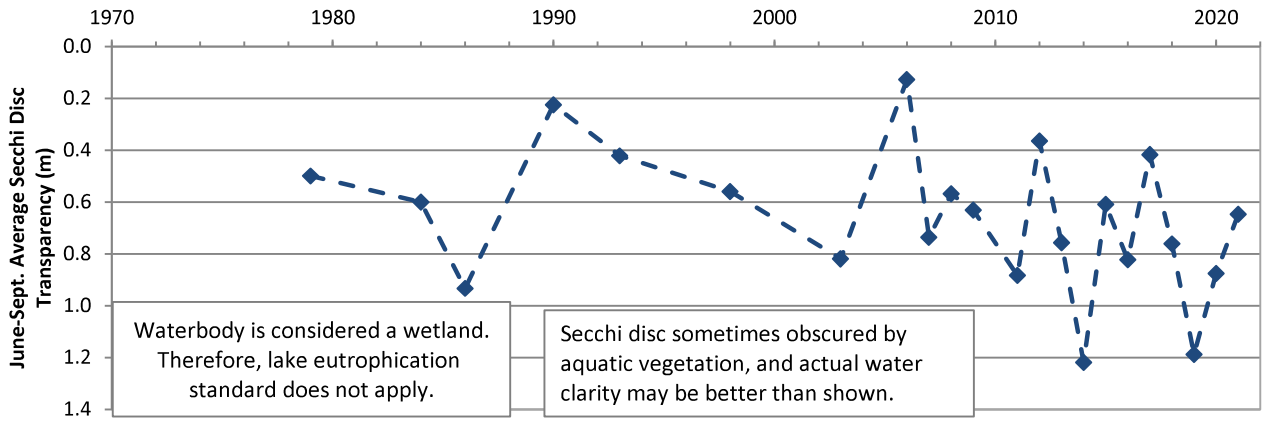
Downs Lake June-Sept. Average Chlorophyll *a*



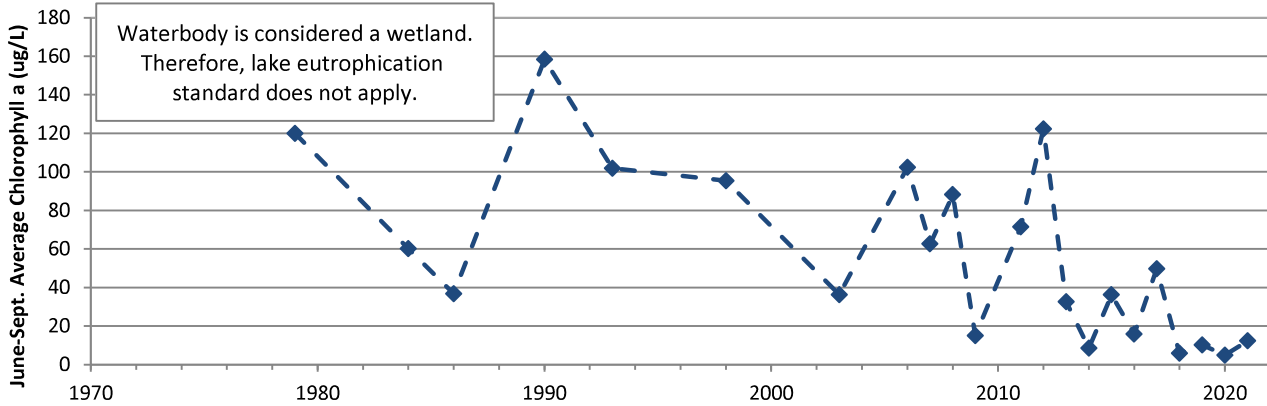
Downs Lake June-Sept. Average Total Phosphorus



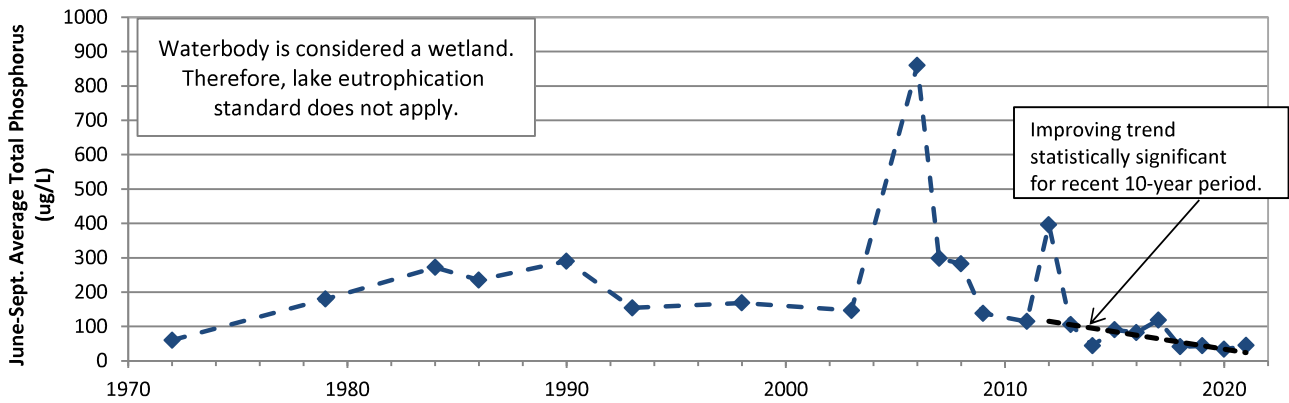
Eagle Point Lake June-Sept. Secchi Disc Transparency



Eagle Point Lake June-Sept. Average Chlorophyll *a*

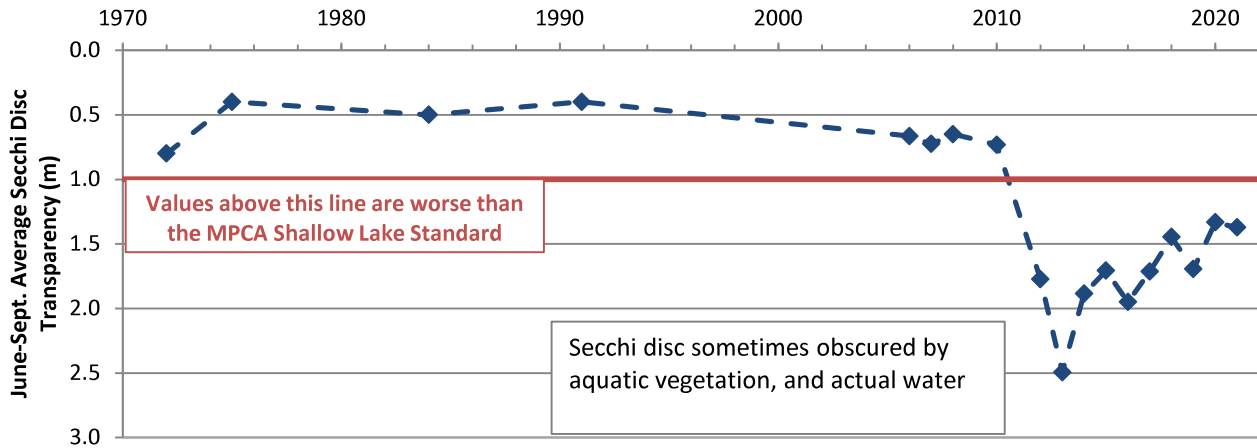


Eagle Point Lake June-Sept. Average Total Phosphorus

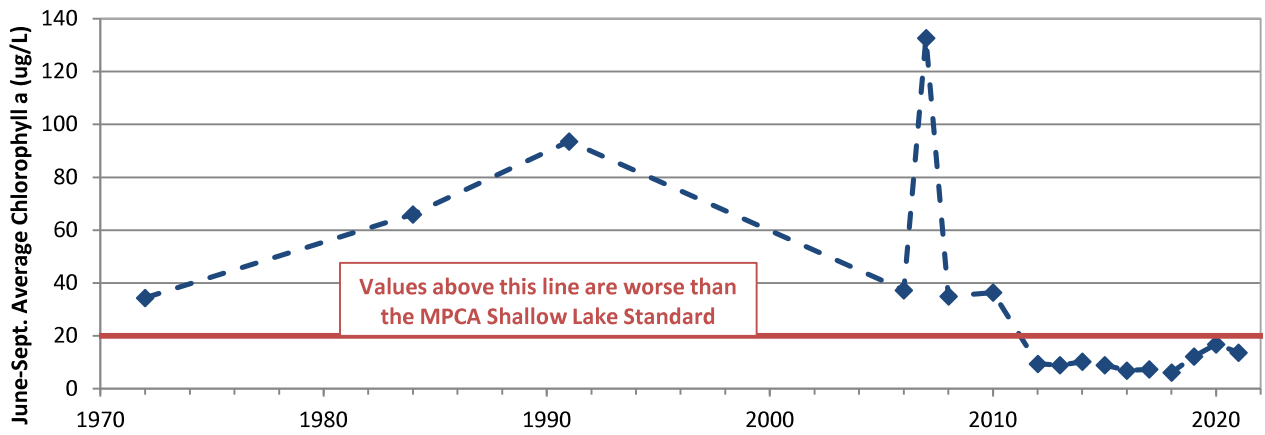


Eagle Point Lake Water Quality
Valley Branch Watershed District

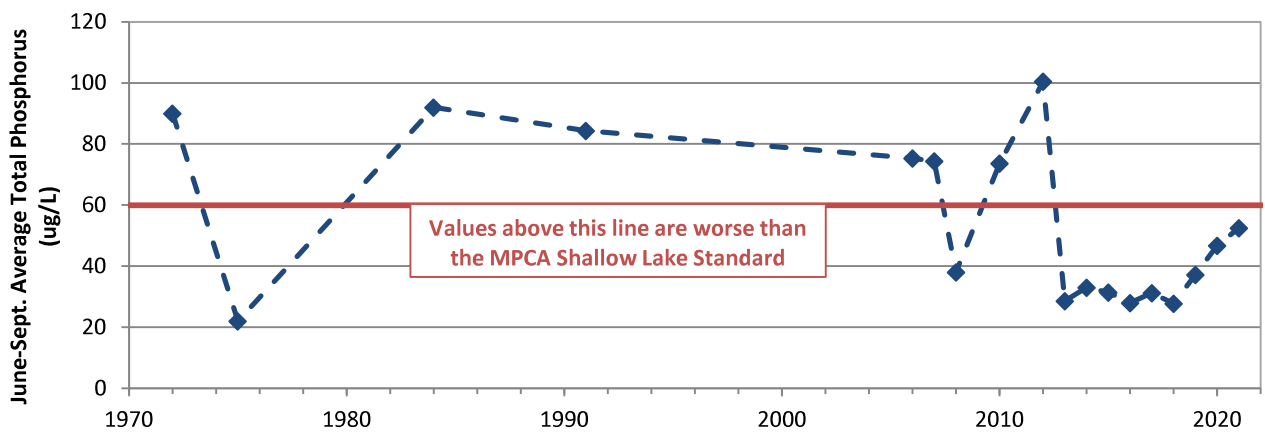
Echo Lake June-Sept. Secchi Disc Transparency



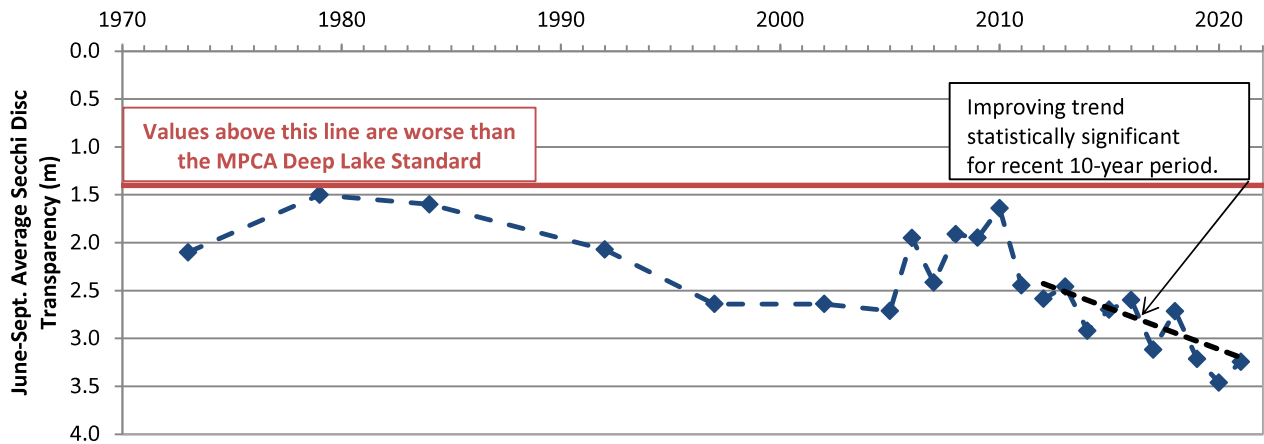
Echo Lake June-Sept. Average Chlorophyll *a*



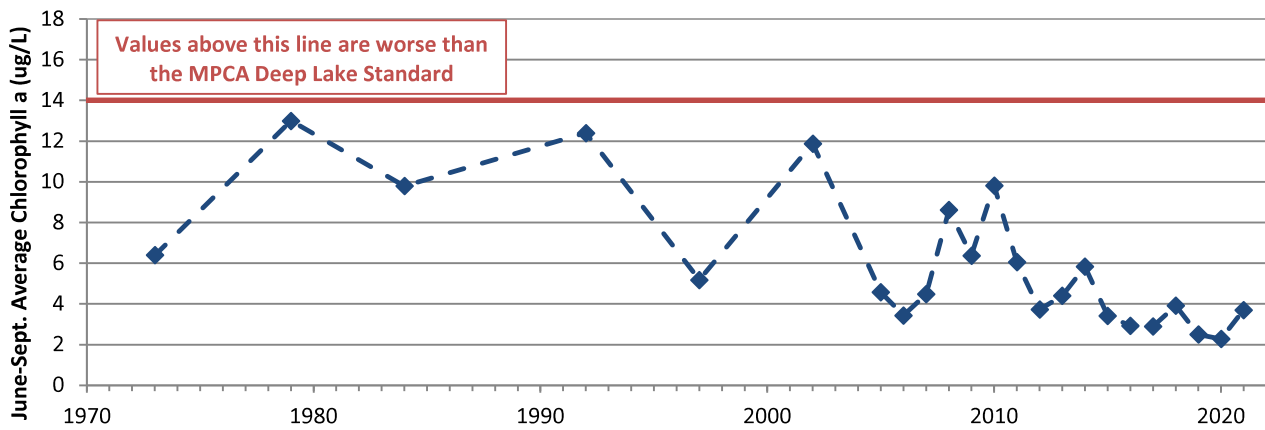
Echo Lake June-Sept. Average Total Phosphorus



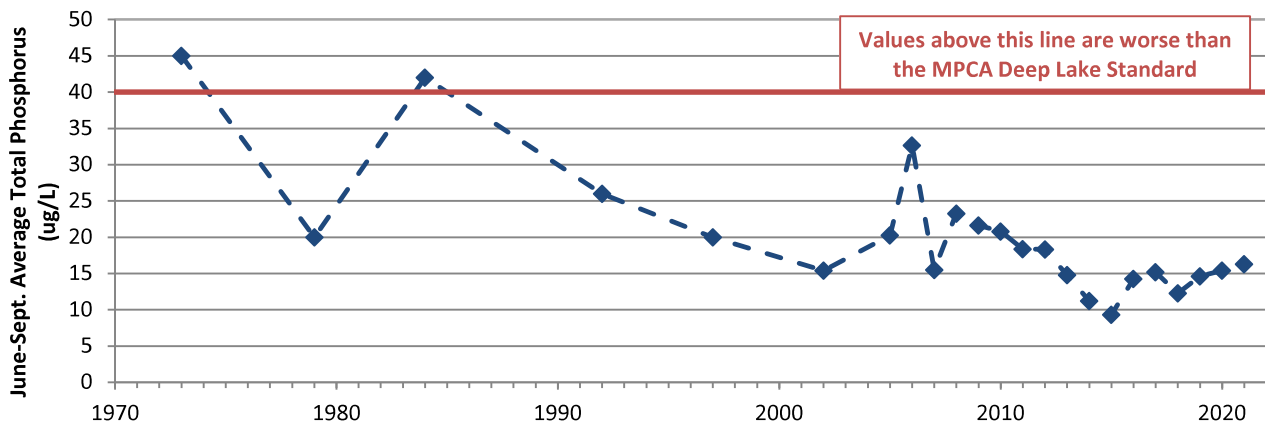
Lake Edith June-Sept. Secchi Disc Transparency



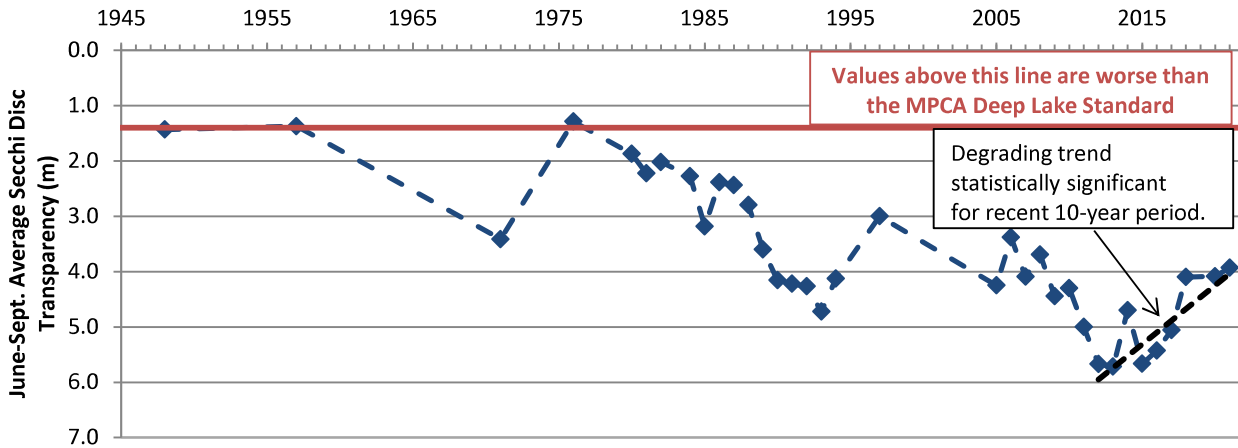
Lake Edith June-Sept. Average Chlorophyll *a*



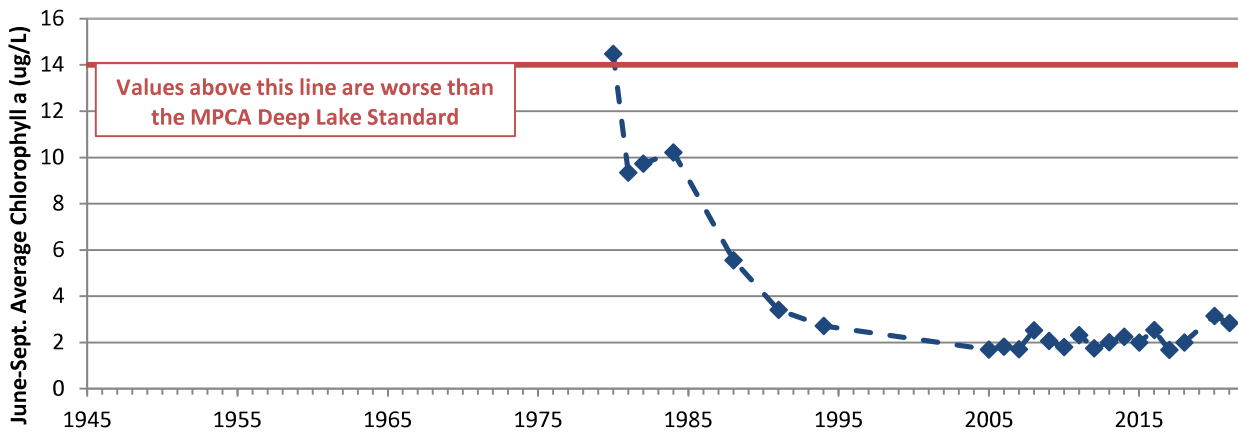
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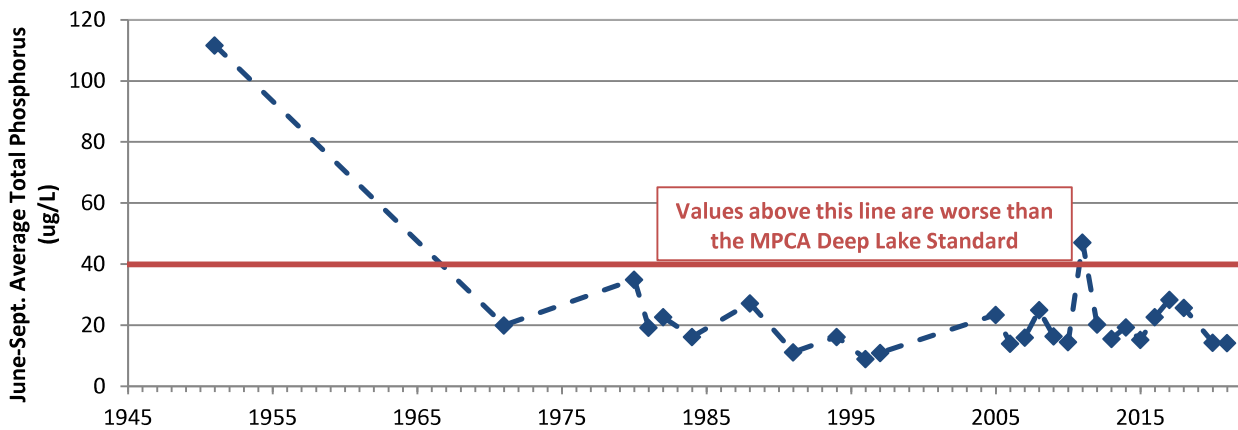
Lake Elmo June-Sept. Secchi Disc Transparency



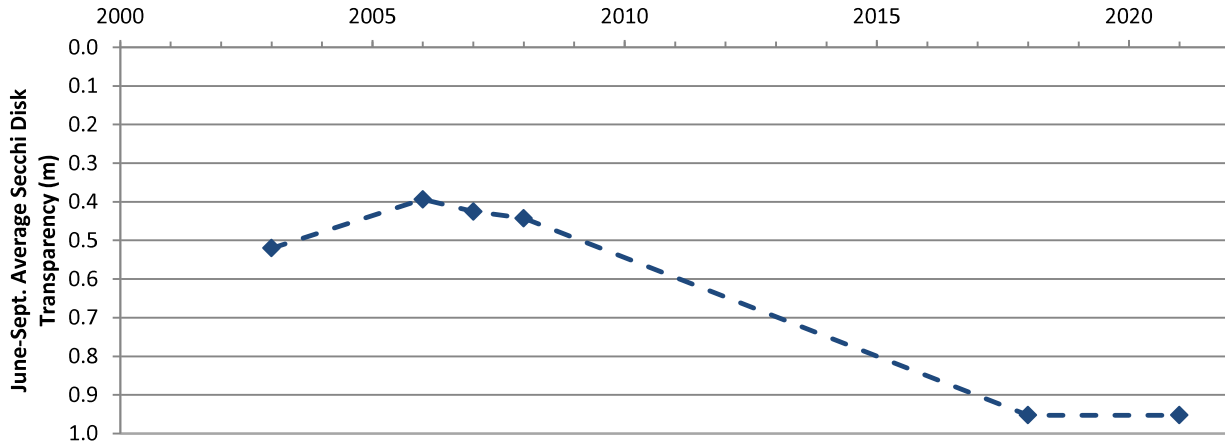
Lake Elmo June-Sept. Average Chlorophyll *a*



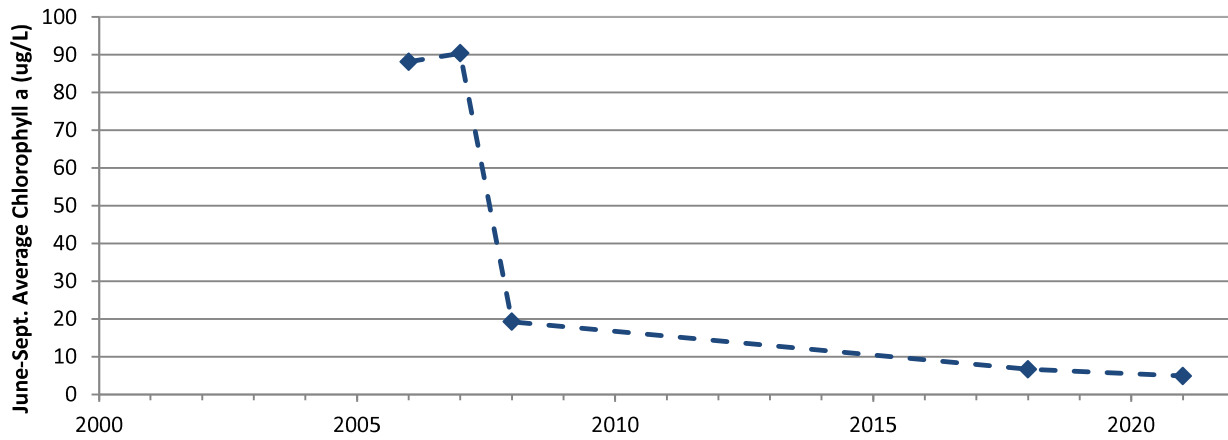
Lake Elmo June-Sept. Average Total Phosphorus



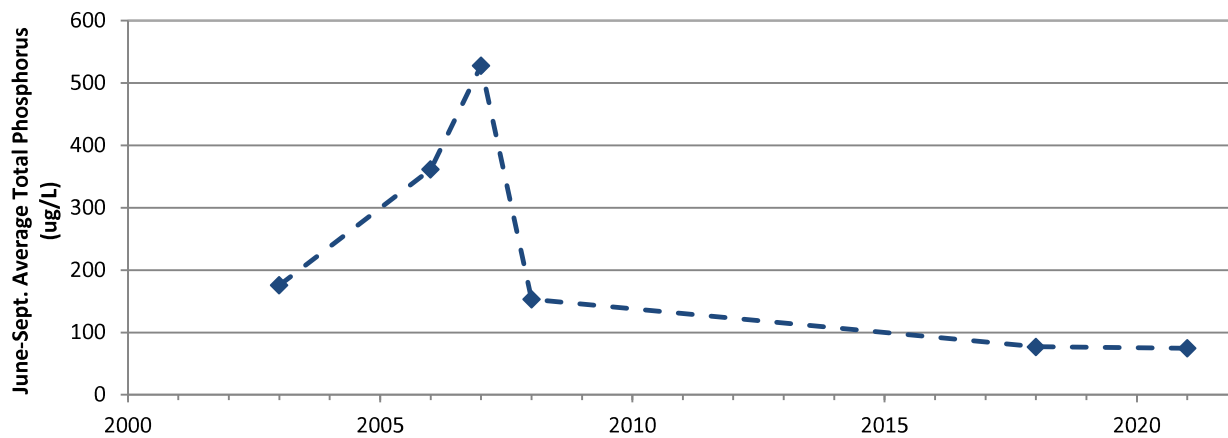
Friedrich's Pond June-Sept. Secchi Disk Transparency



Friedrich's Pond June-Sept. Average Chlorophyll *a*

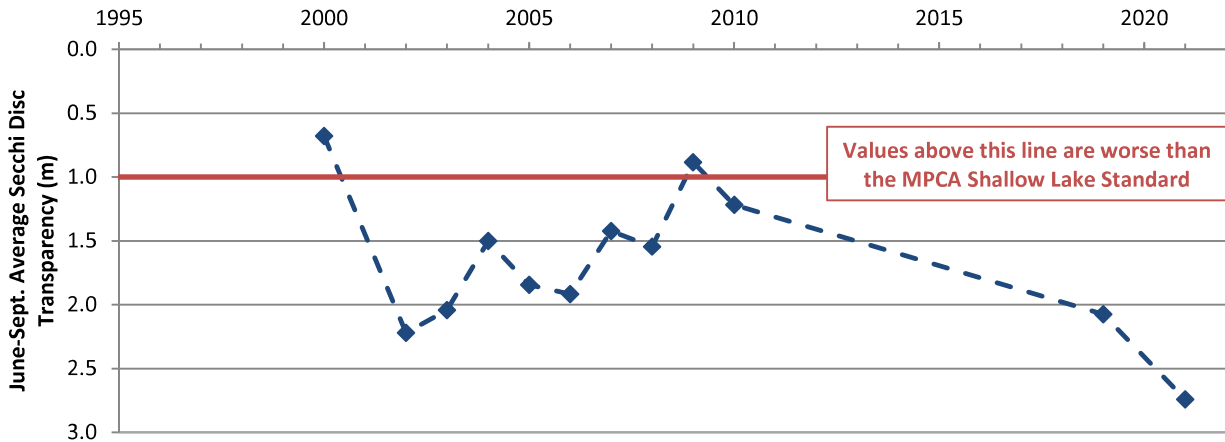


Friedrich's Pond June-Sept. Average Total Phosphorus

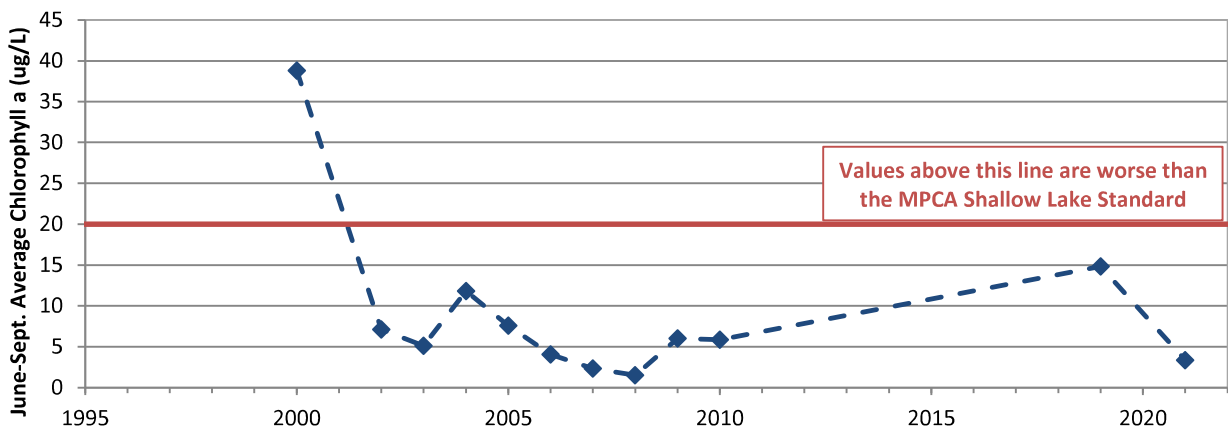


Friedrich's Pond Water Quality
Valley Branch Watershed District

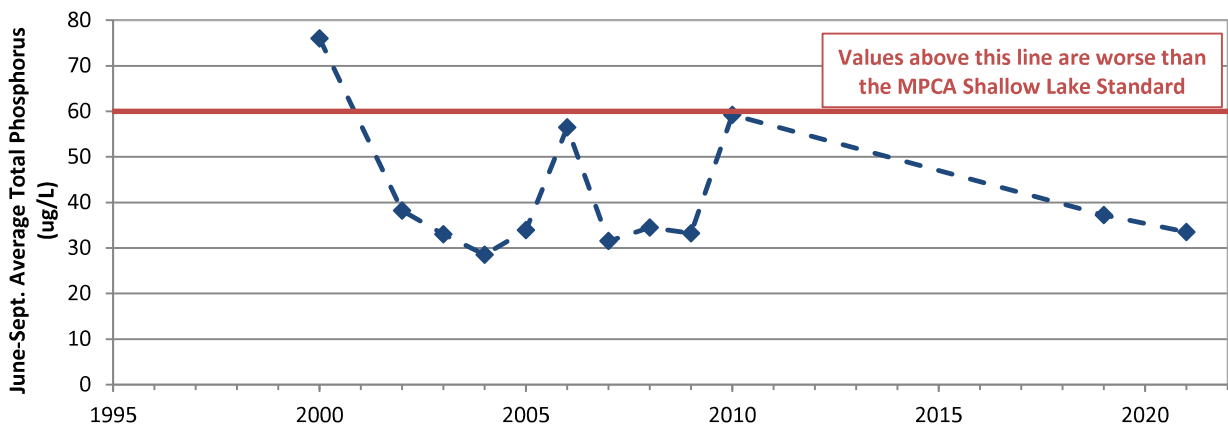
Goetschel Pond June-Sept. Secchi Disc Transparency



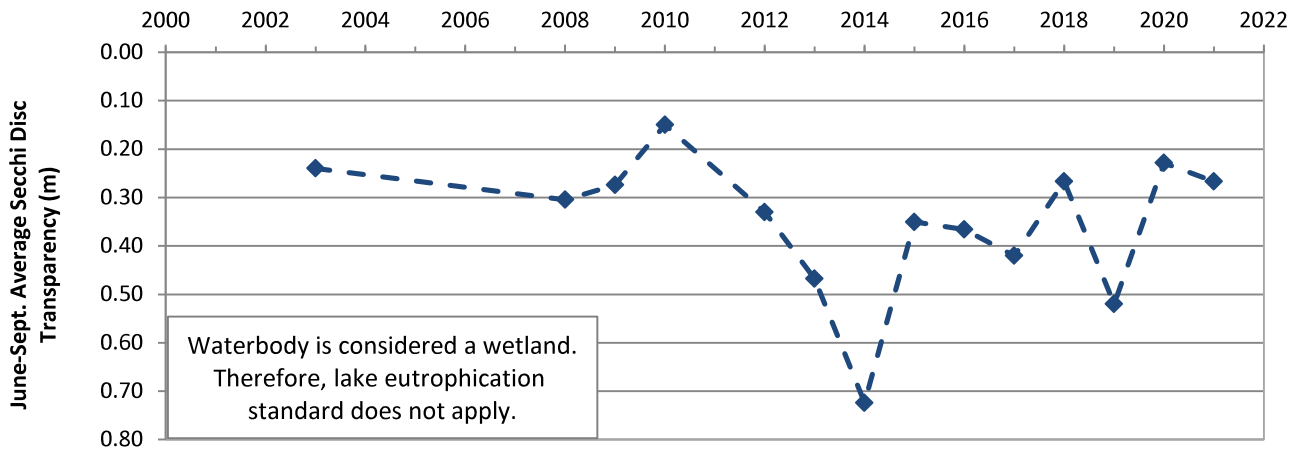
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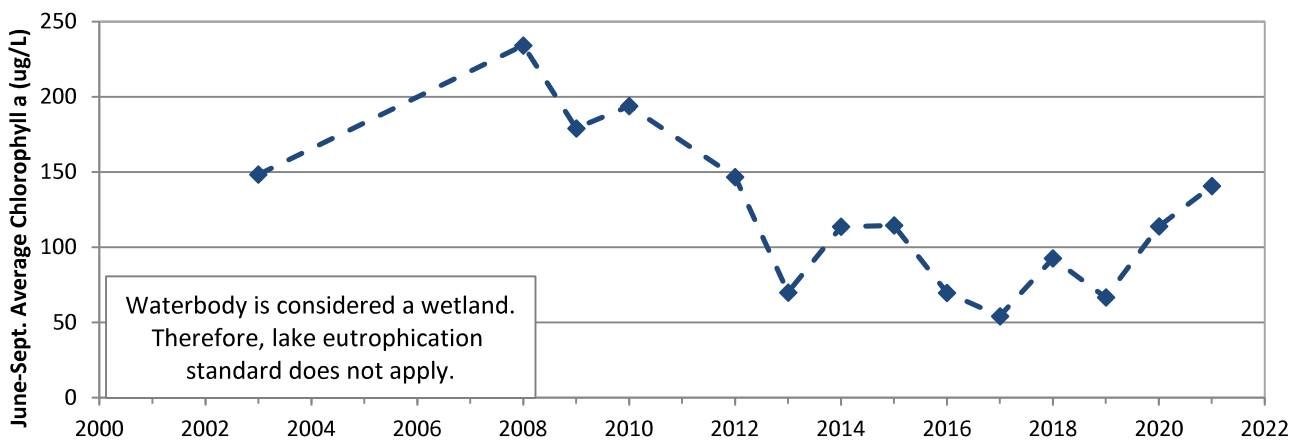
Goetschel Pond June-Sept. Average Total Phosphorus



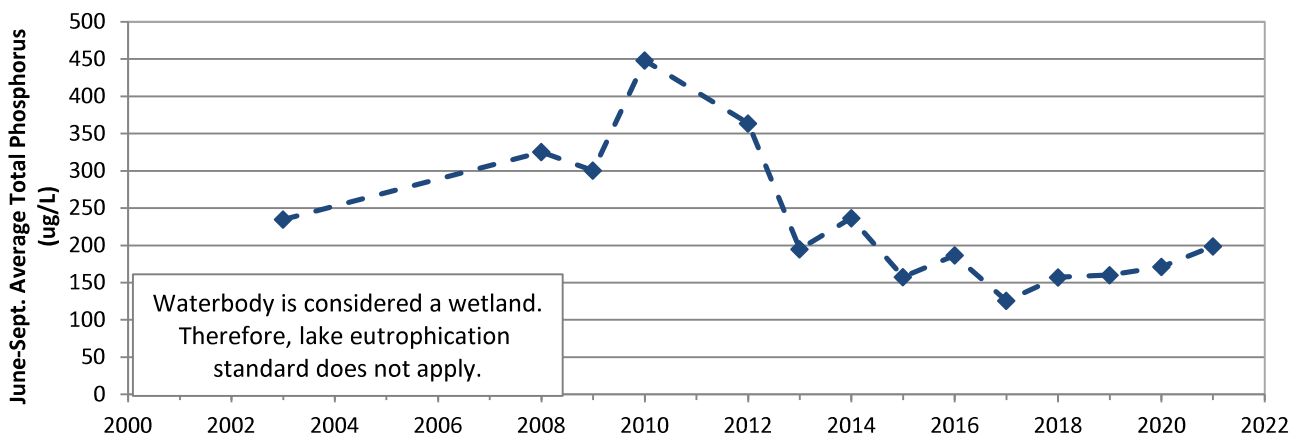
Goose Lake (North) June-Sept. Secchi Disc Transparency



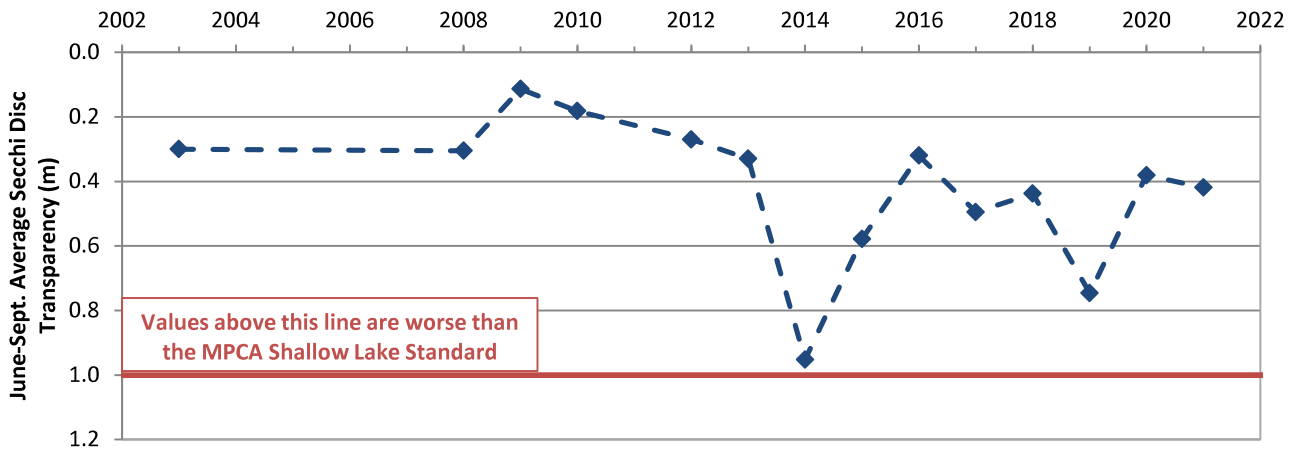
Goose Lake (North) June-Sept. Average Chlorophyll *a*



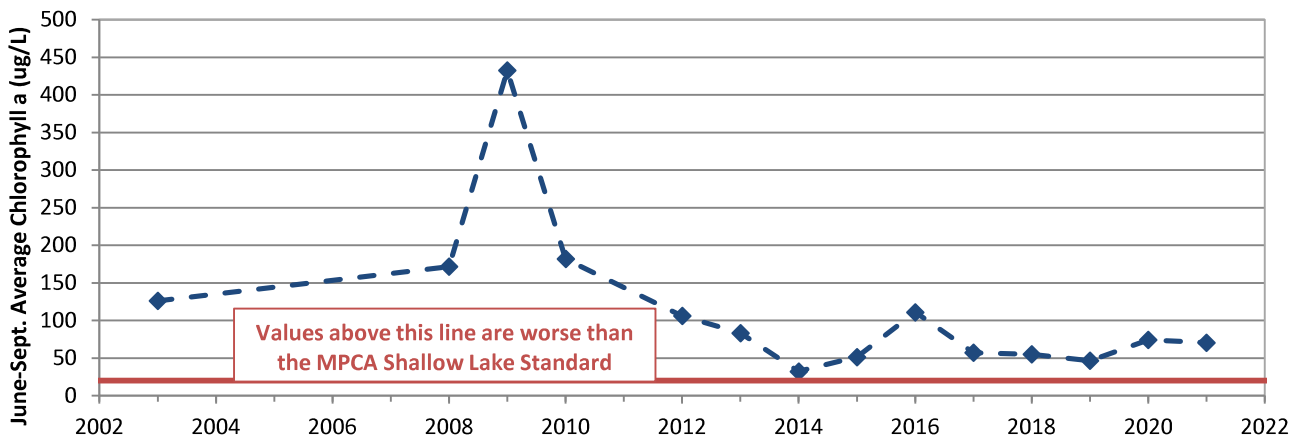
Goose Lake (North) June-Sept. Average Total Phosphorus



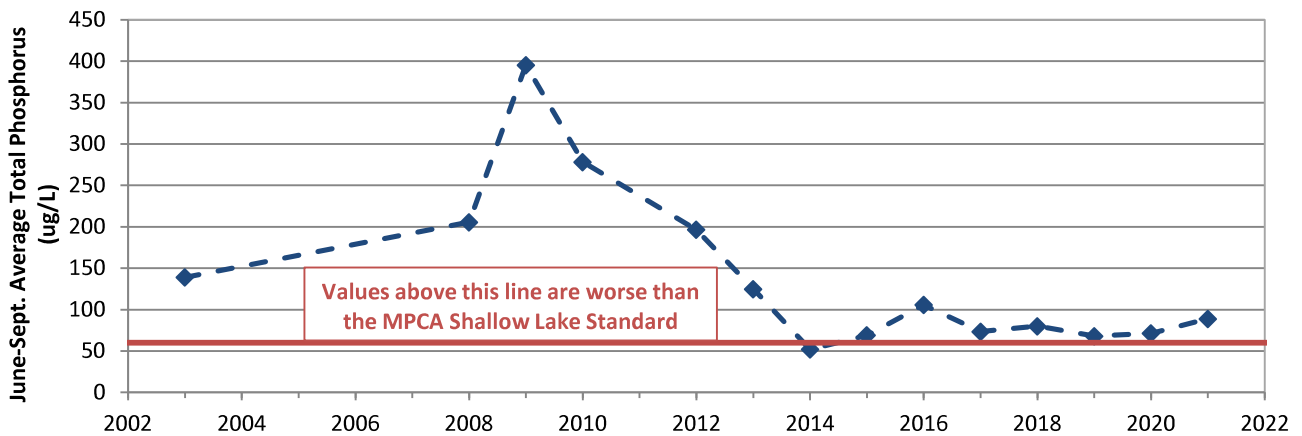
Goose Lake (South) June-Sept. Secchi Disc Transparency



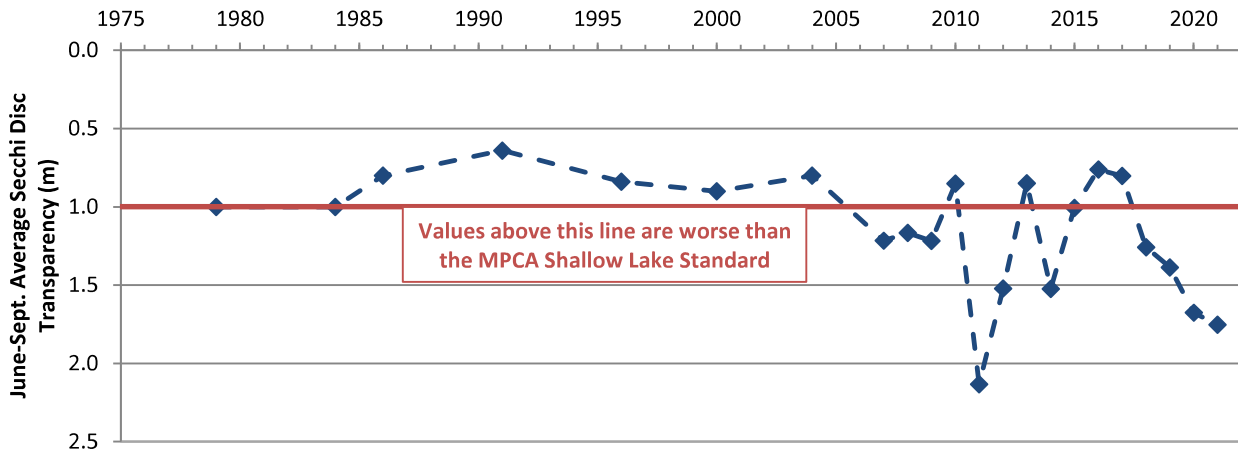
Goose Lake (South) June-Sept. Average Chlorophyll a



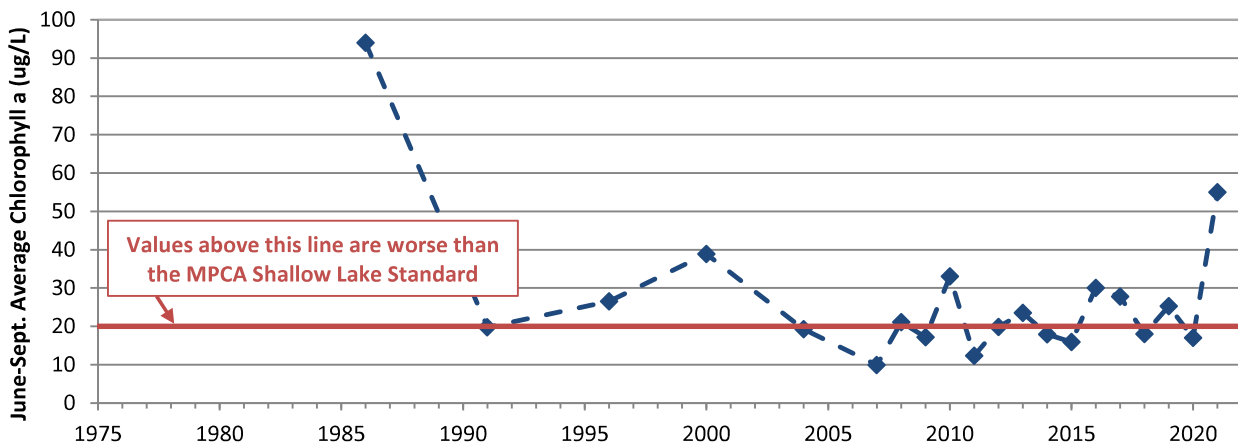
Goose Lake (South) June-Sept. Average Total Phosphorus



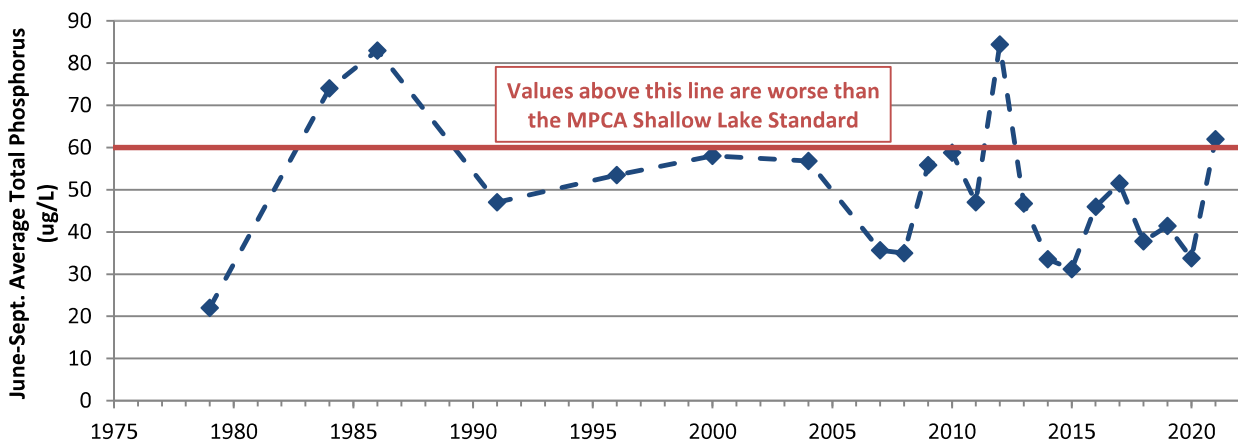
Horseshoe Lake June-Sept. Secchi Disc Transparency



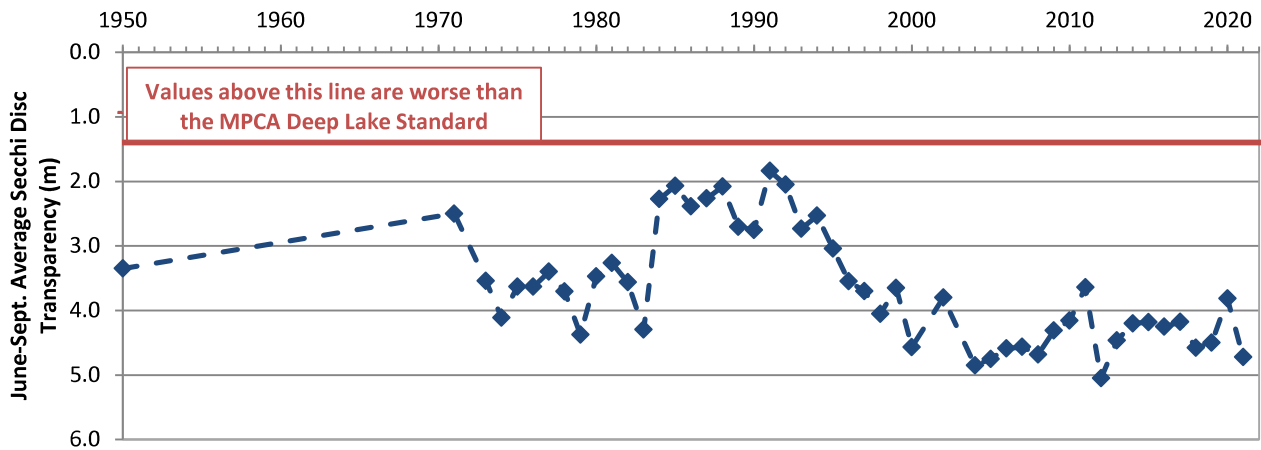
Horseshoe Lake June-Sept. Average Chlorophyll *a*



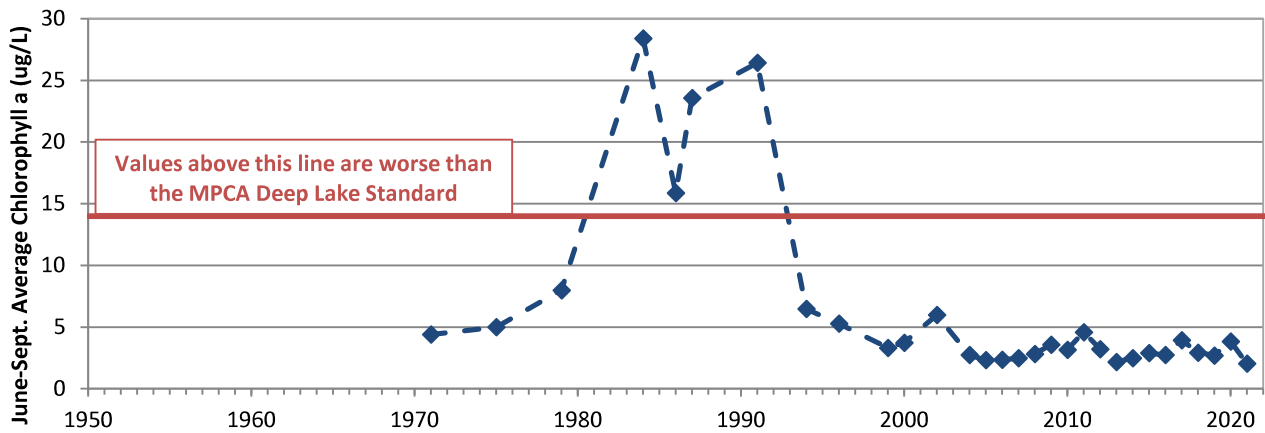
Horseshoe Lake June-Sept. Average Total Phosphorus



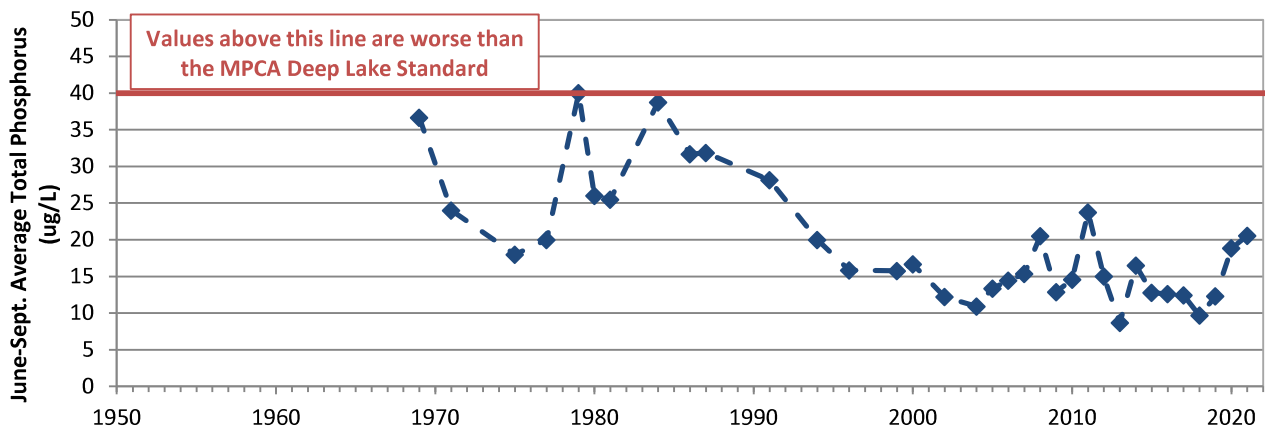
Lake Jane June-Sept. Secchi Disc Transparency



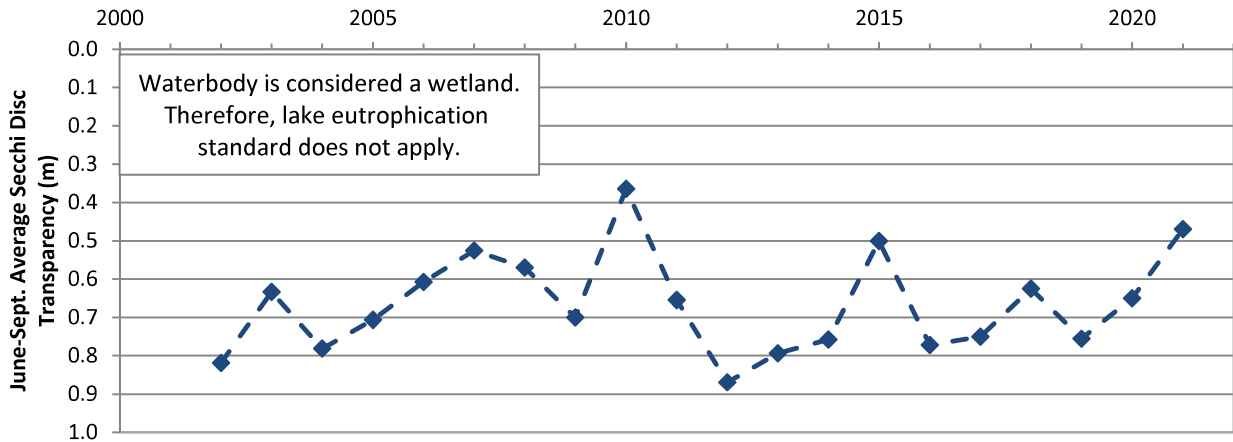
Lake Jane June-Sept. Average Chlorophyll *a*



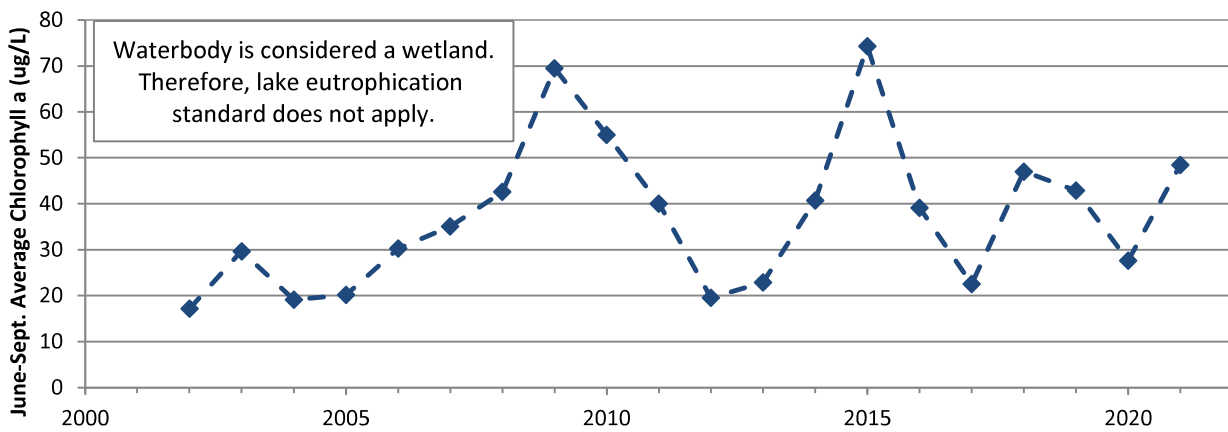
Lake Jane June-Sept. Average Total Phosphorus



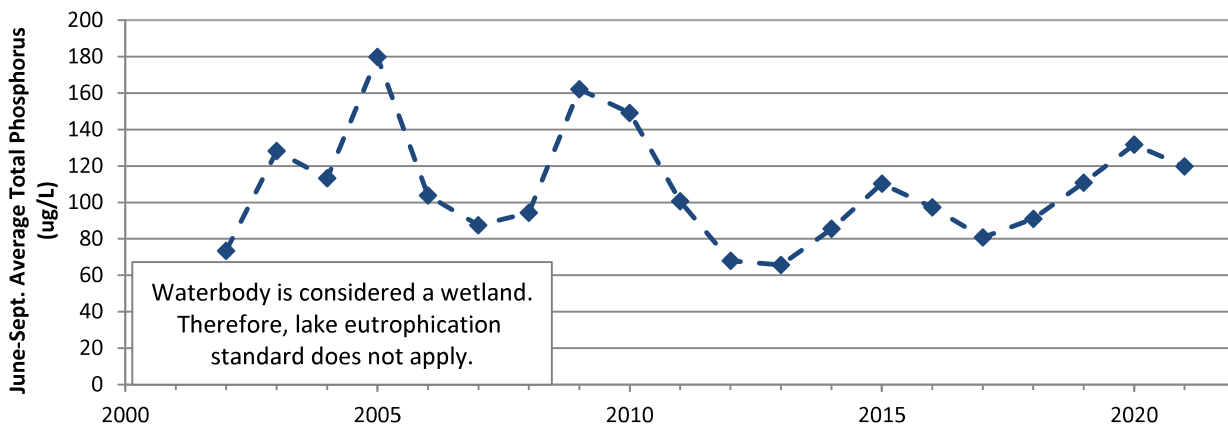
Klawitter Pond June-Sept. Secchi Disc Transparency



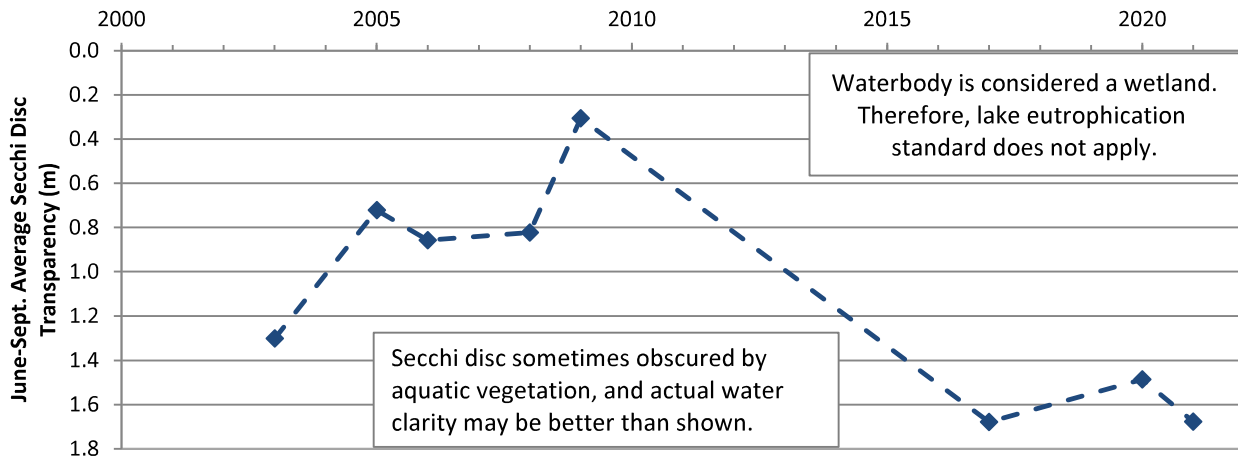
Klawitter Pond June-Sept. Average Chlorophyll *a*



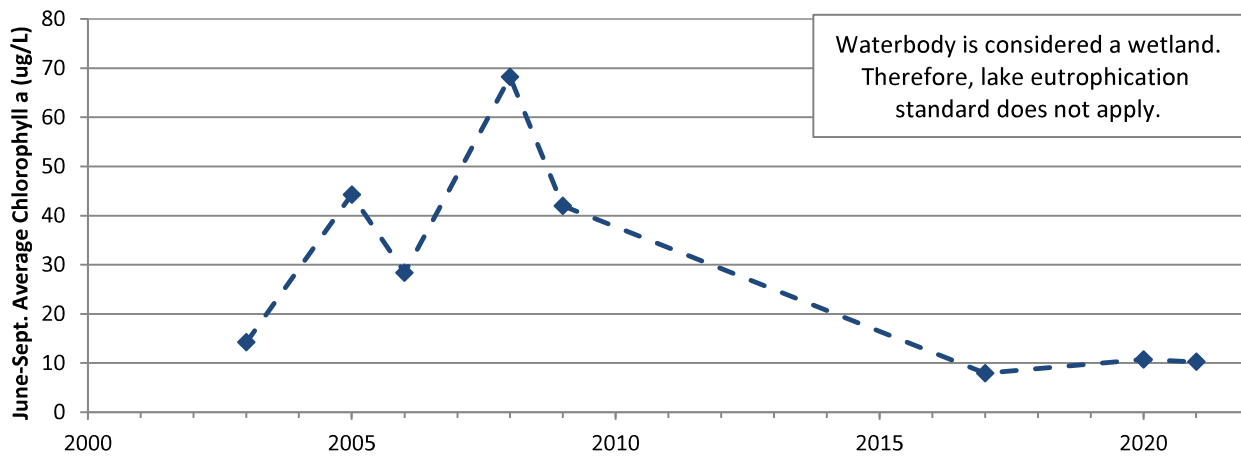
Klawitter Pond June-Sept. Average Total Phosphorus



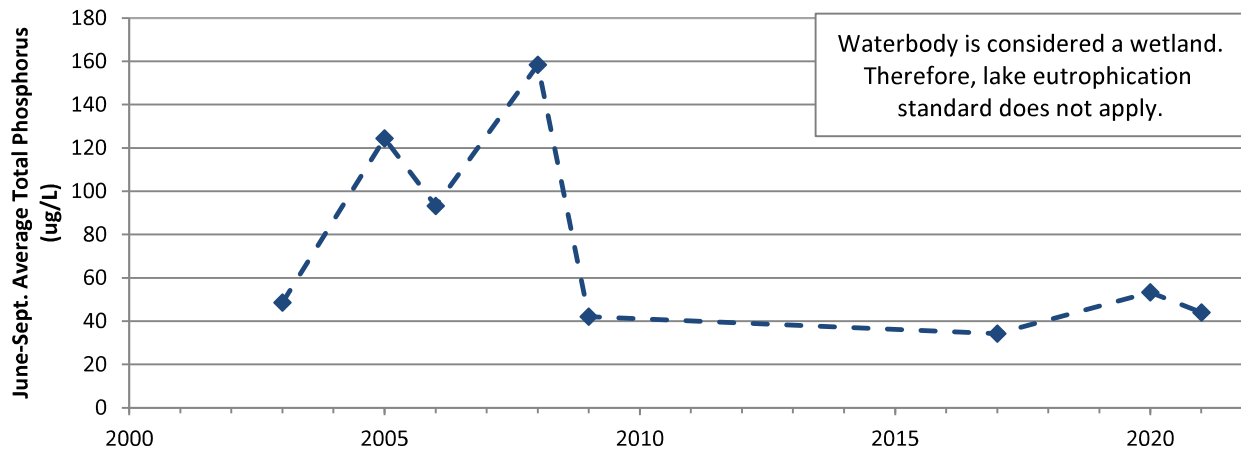
Legion Pond June-Sept. Secchi Disc Transparency



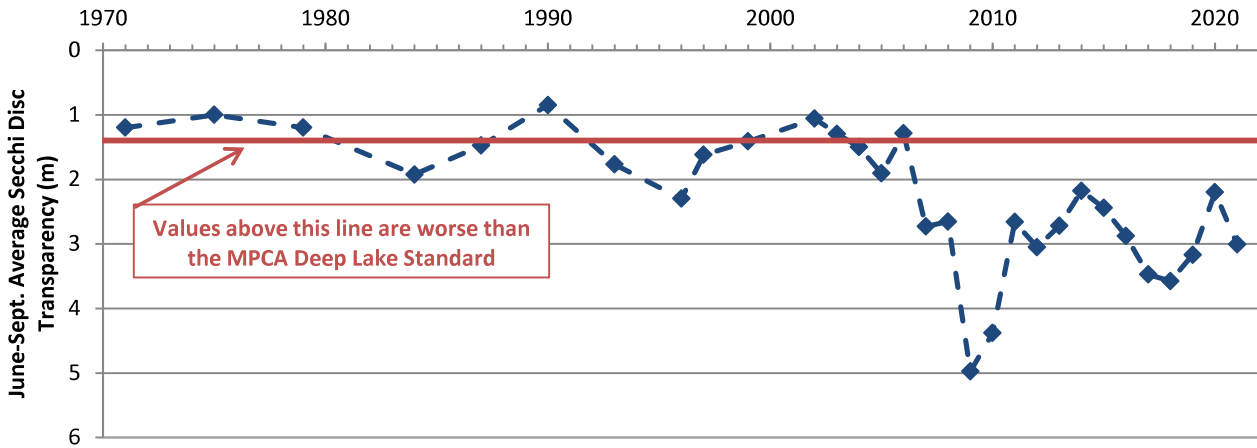
Legion Pond June-Sept. Average Chlorophyll *a*



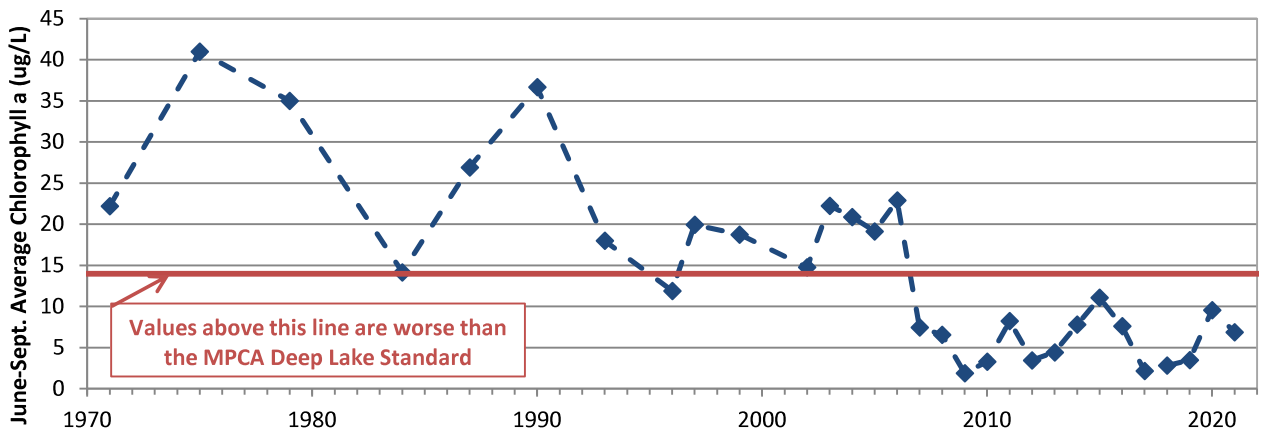
Legion Pond June-Sept. Average Total Phosphorus



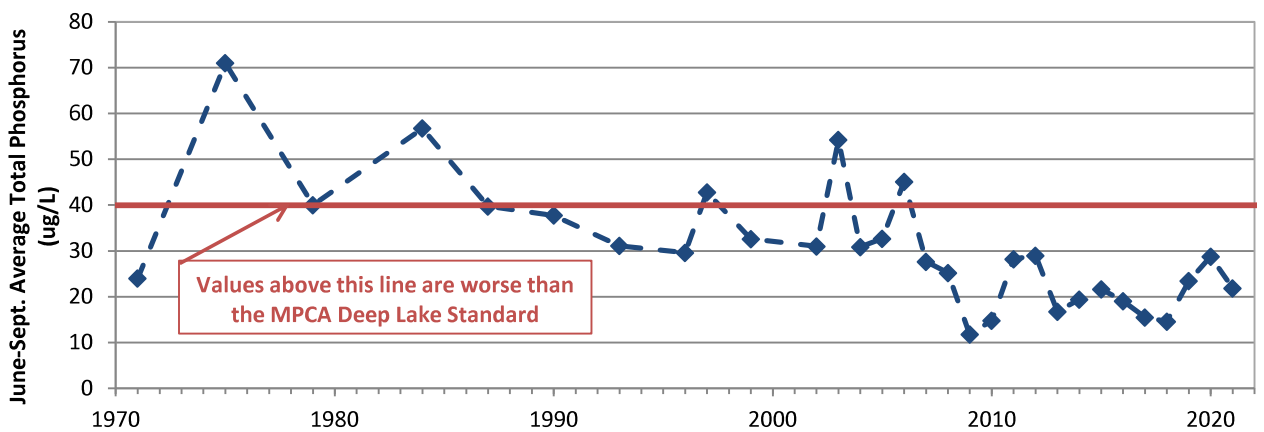
Long Lake June-Sept. Secchi Disc Transparency



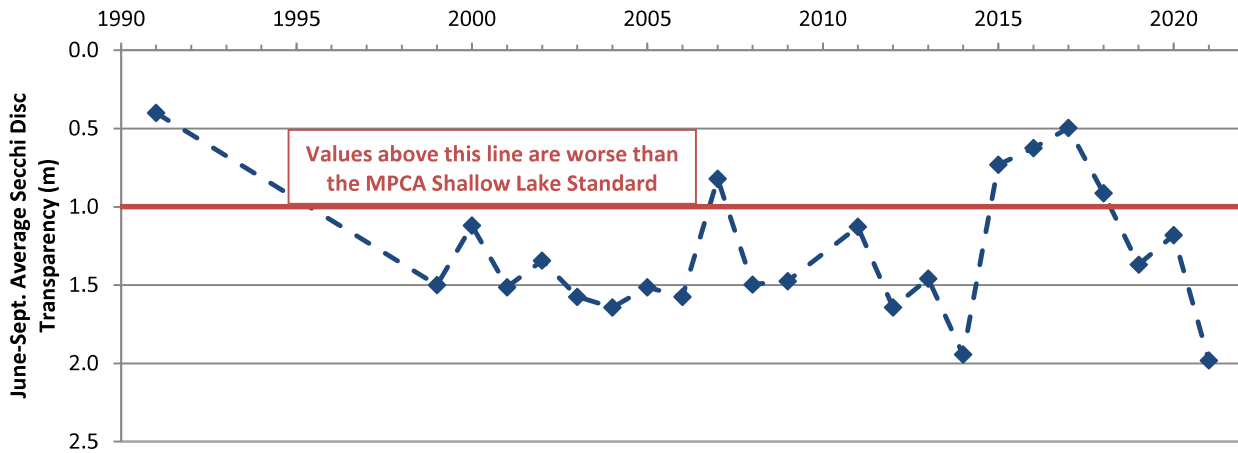
Long Lake June-Sept. Average Chlorophyll *a*



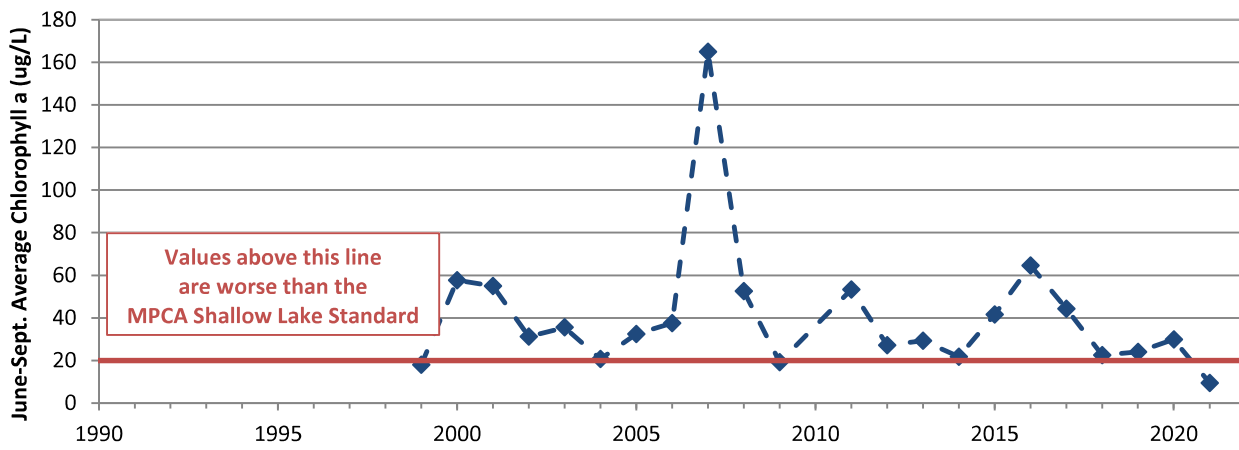
Long Lake June-Sept. Average Total Phosphorus



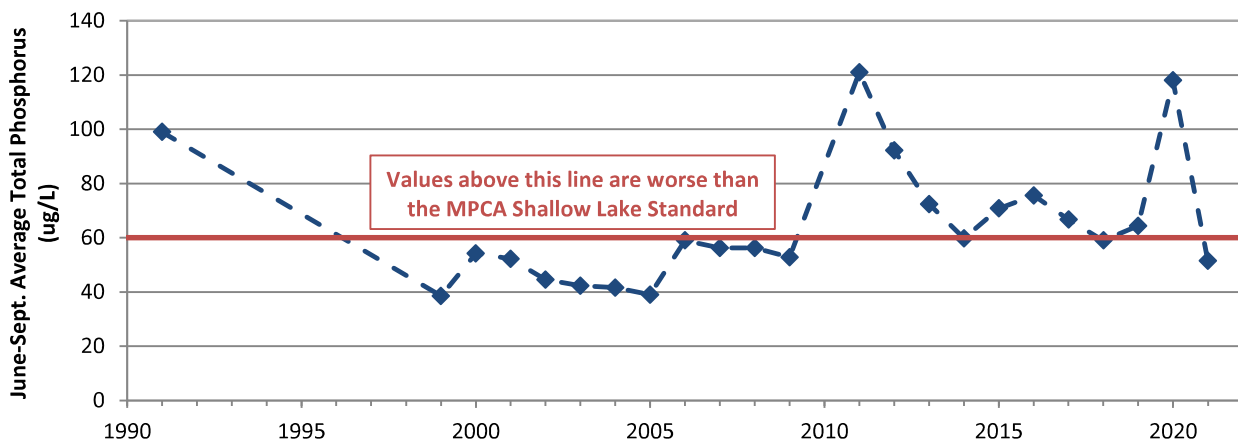
McDonald Lake June-Sept. Secchi Disc Transparency



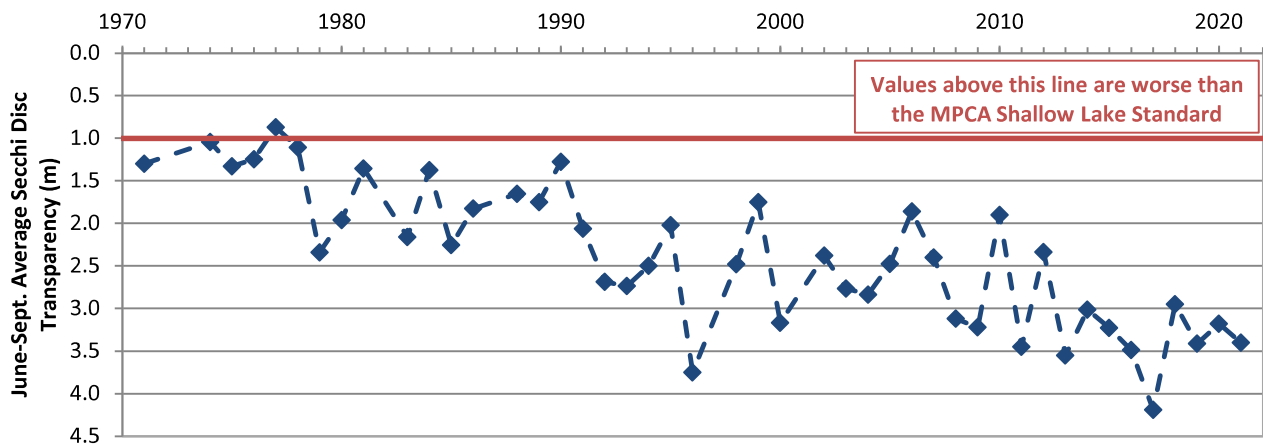
McDonald Lake June-Sept. Average Chlorophyll *a*



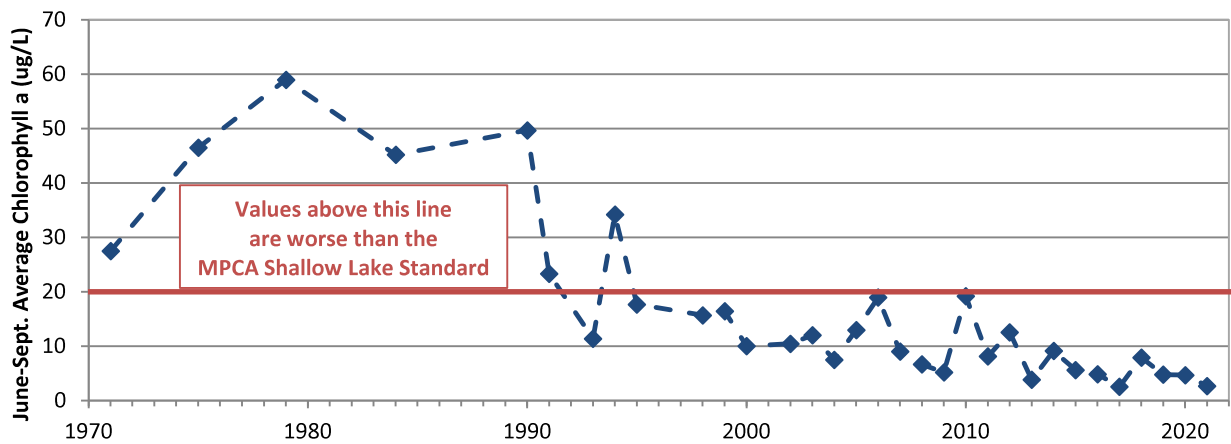
McDonald Lake June-Sept. Average Total Phosphorus



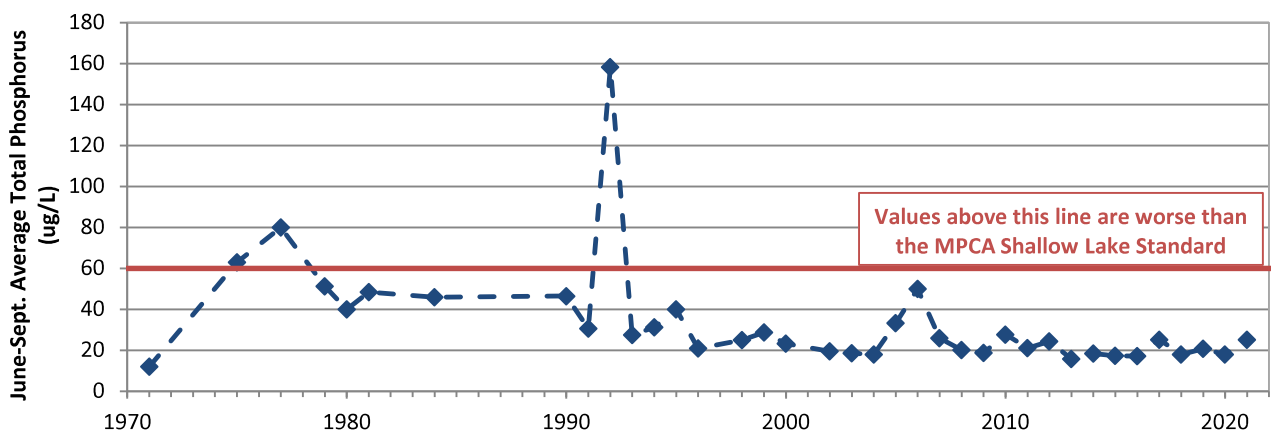
Lake Olson June-Sept. Secchi Disc Transparency



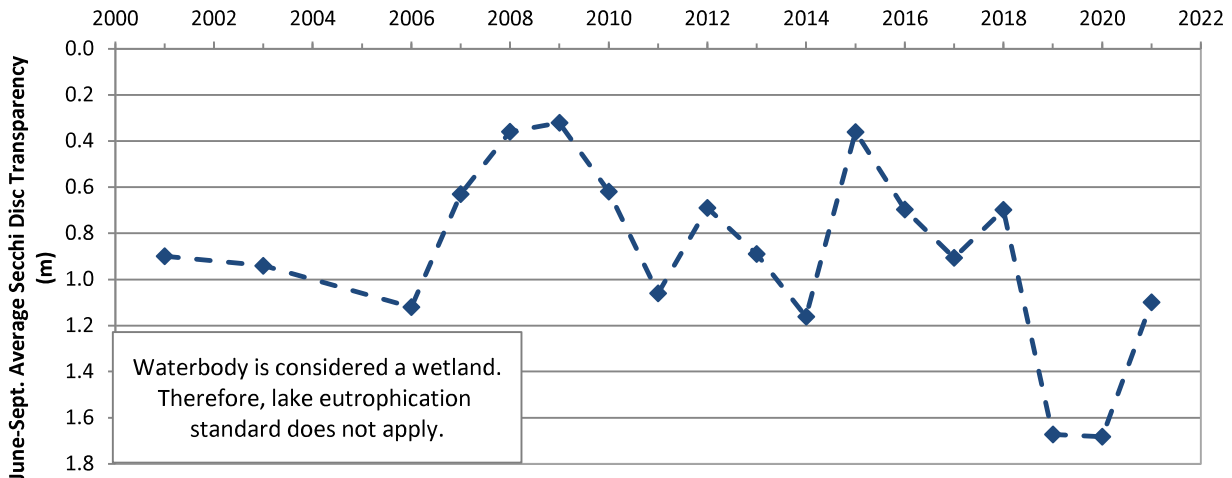
Lake Olson June-Sept. Average Chlorophyll a



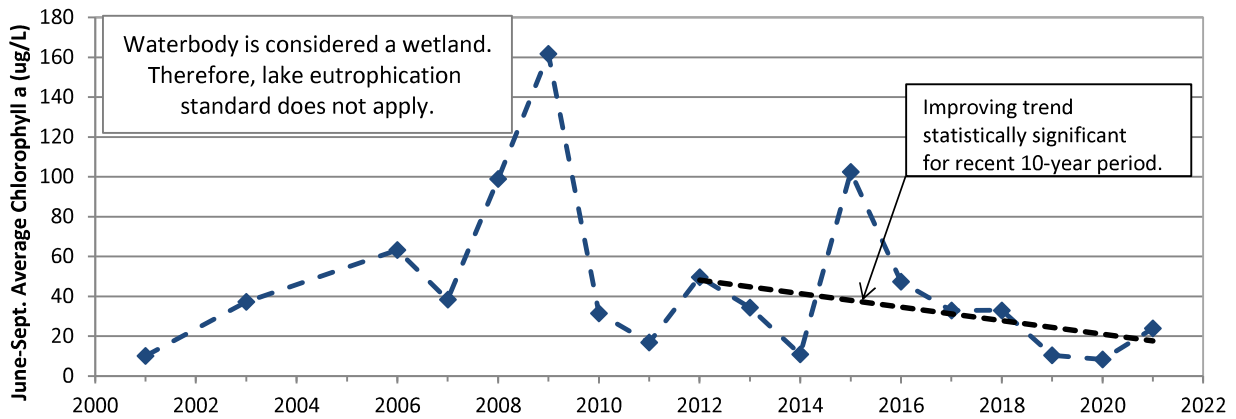
Lake Olson June-Sept. Average Total Phosphorus



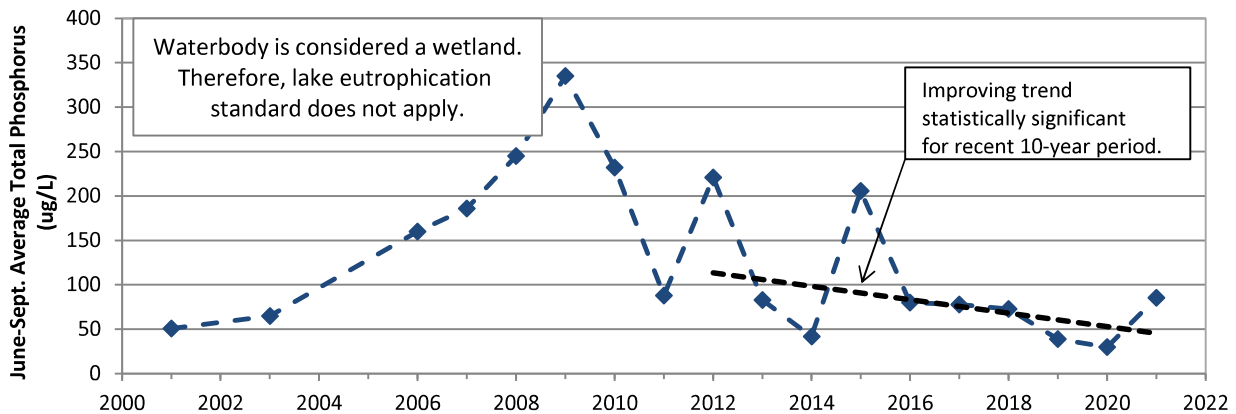
Rest Area Pond June-Sept. Secchi Disc Transparency



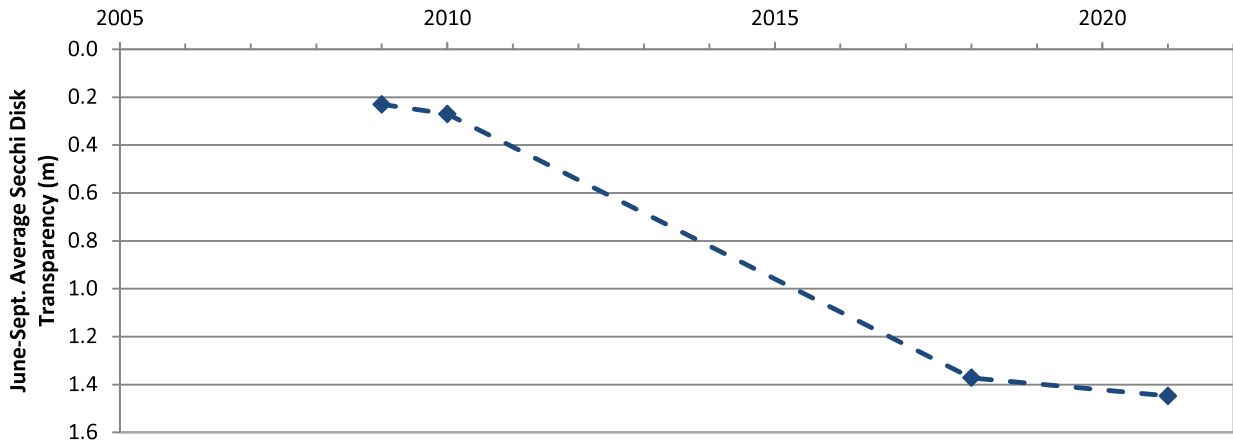
Rest Area Pond June-Sept. Average Chlorophyll *a*



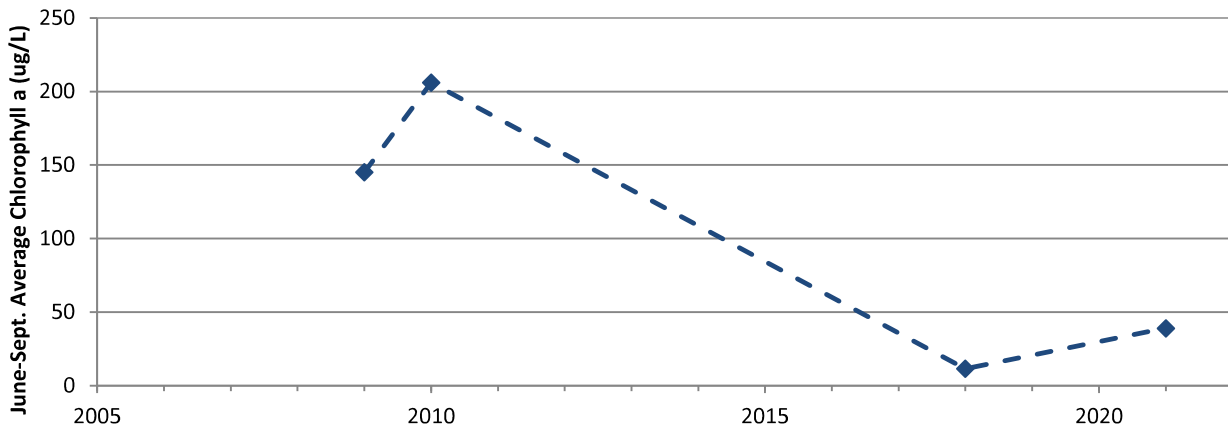
Rest Area Pond June-Sept. Average Total Phosphorus



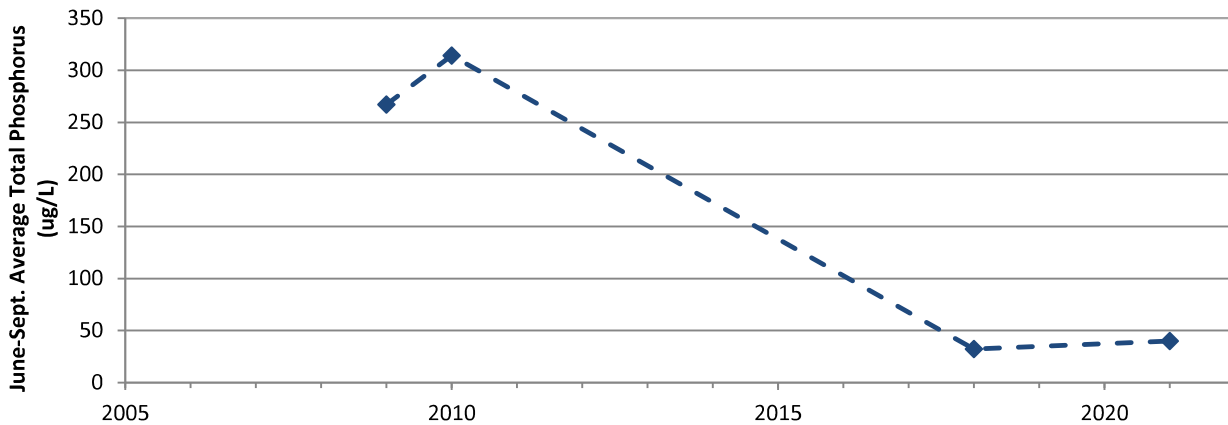
Rose Lake (North) June-Sept. Secchi Disk Transparency



Rose Lake (North) June-Sept. Average Chlorophyll α

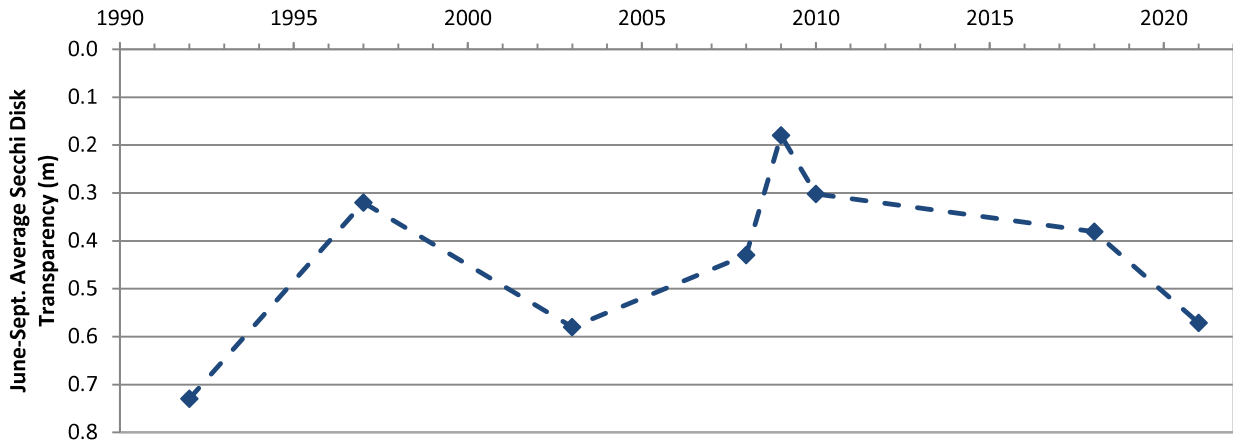


Rose Lake (North) June-Sept. Average Total Phosphorus

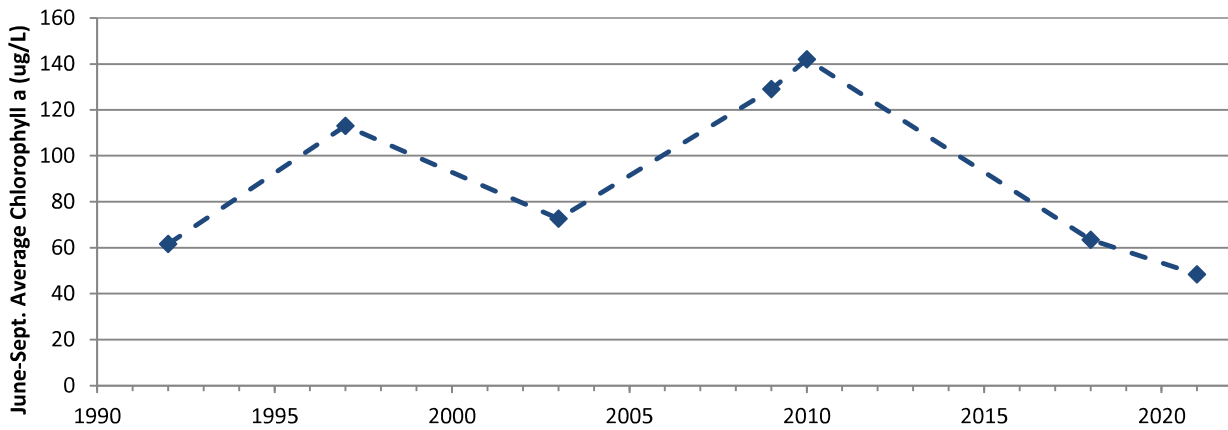


Rose Lake (North) Water Quality
Valley Branch Watershed District

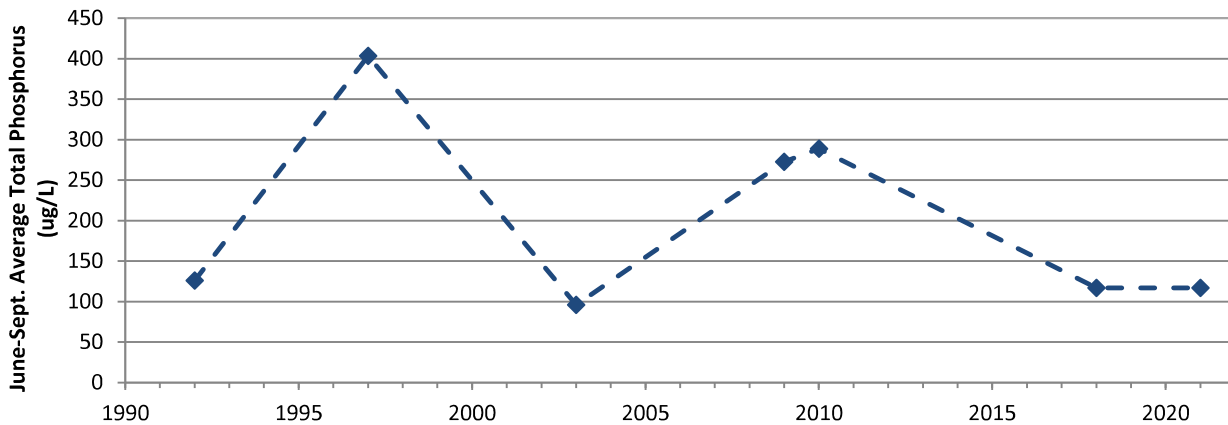
Rose Lake (South) June-Sept. Secchi Disk Transparency



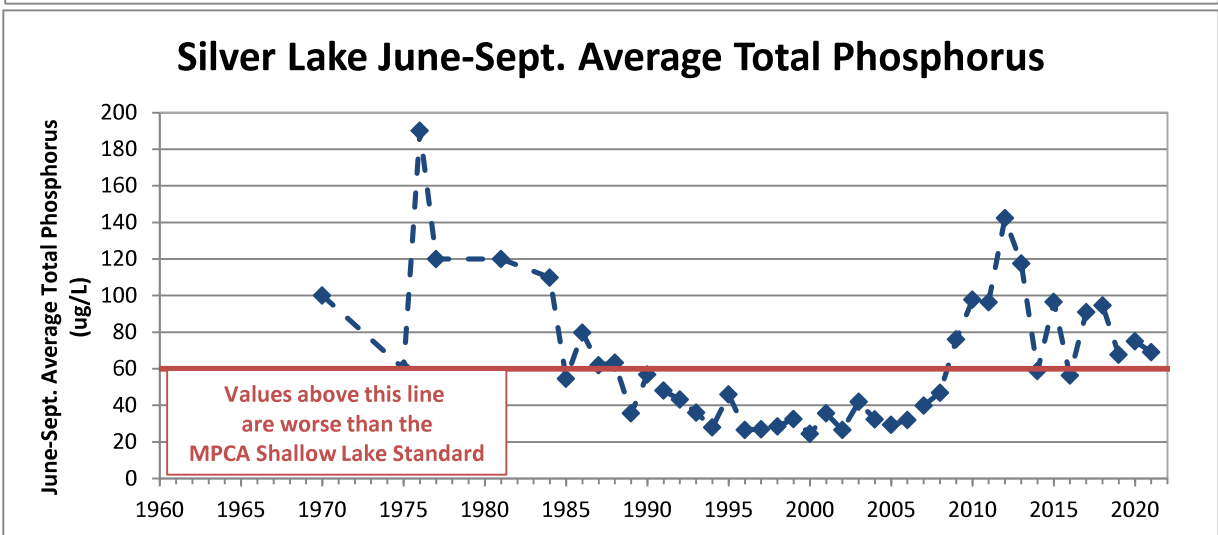
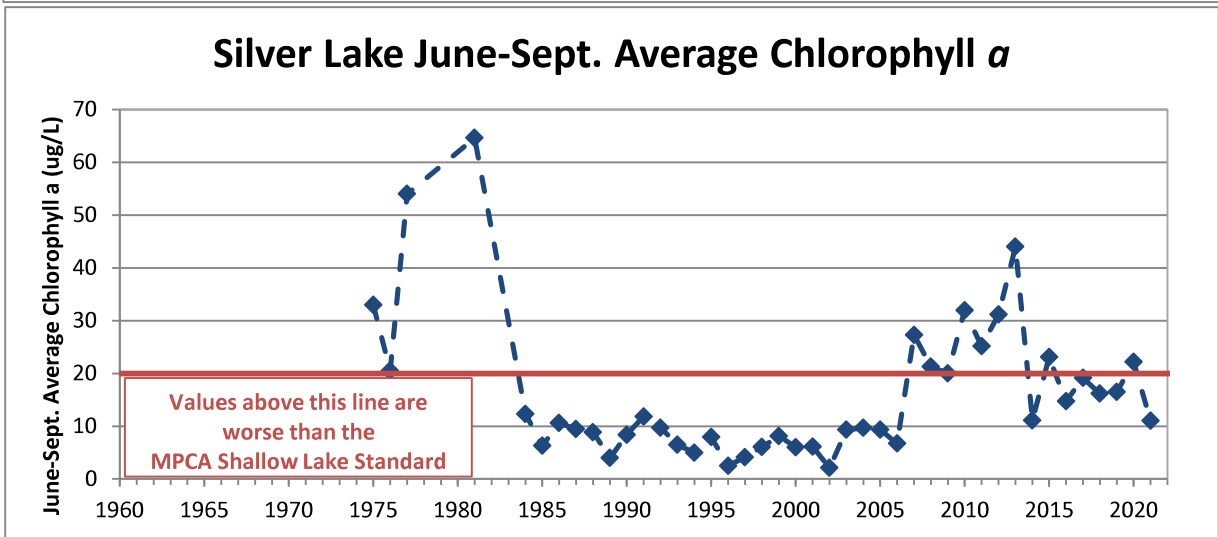
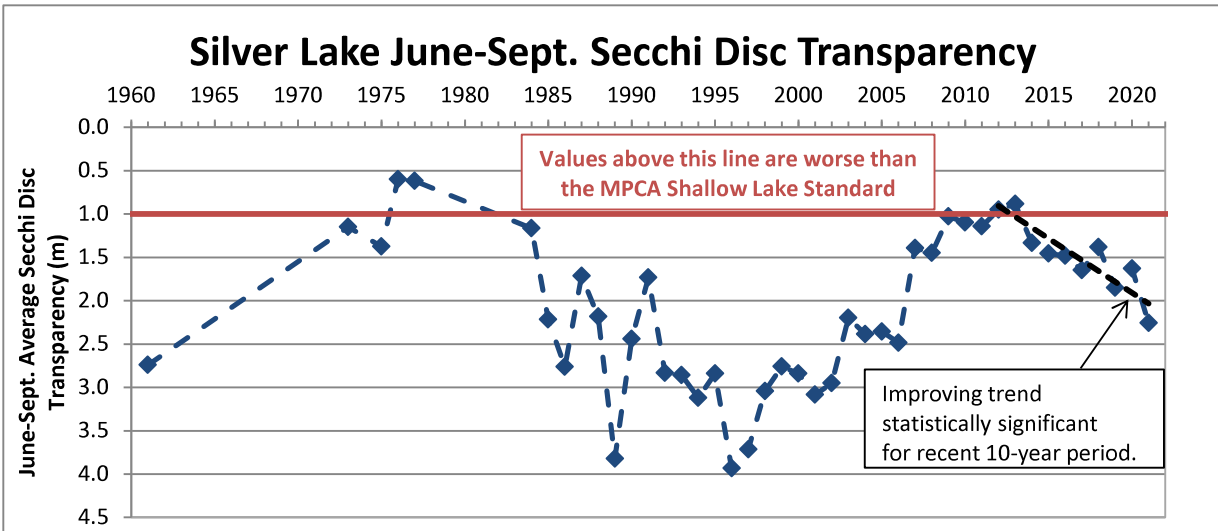
Rose Lake (South) June-Sept. Average Chlorophyll α



Rose Lake (South) June-Sept. Average Total Phosphorus

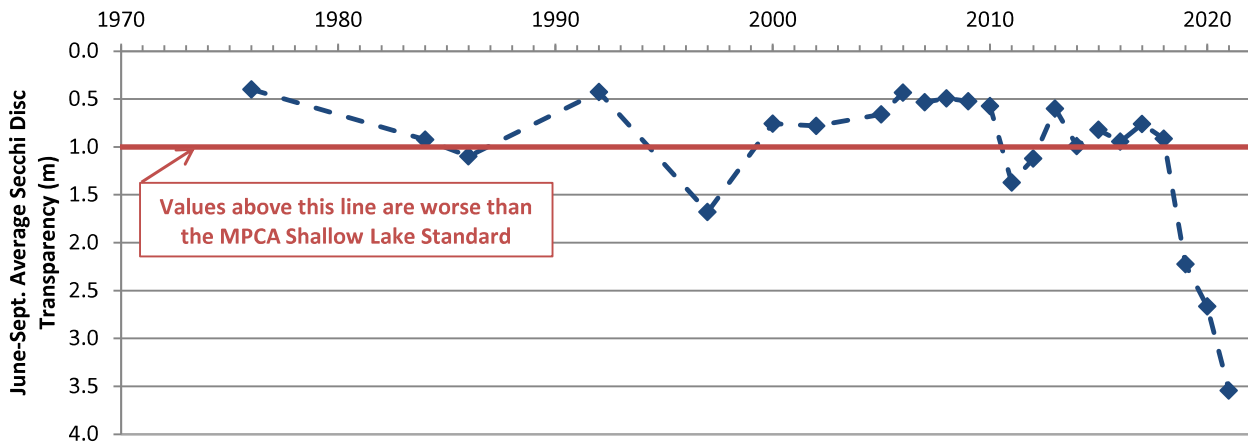


Rose Lake (South) Water Quality
Valley Branch Watershed District

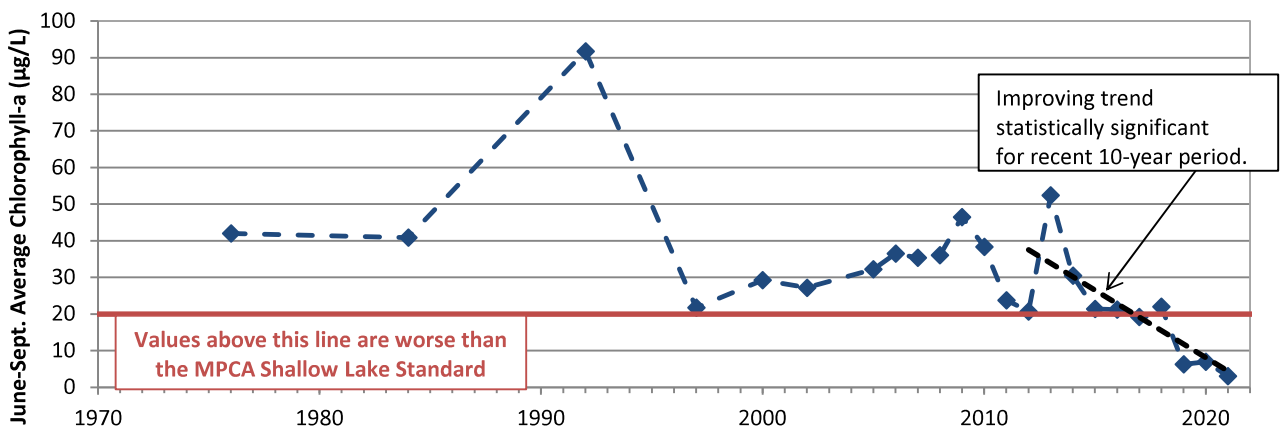


**Silver Lake Water Quality
Valley Branch Watershed District**

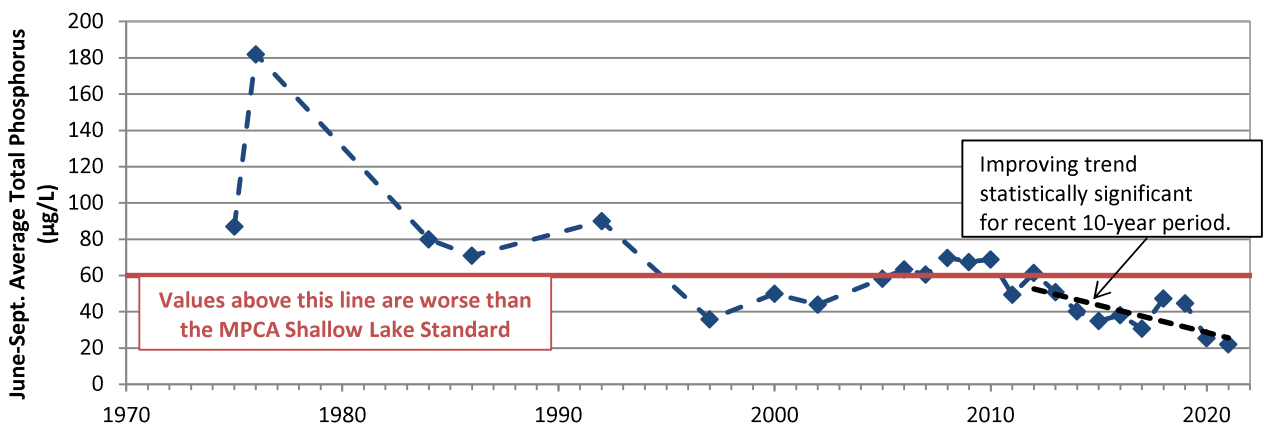
Sunfish Lake June-Sept. Secchi Disc Transparency



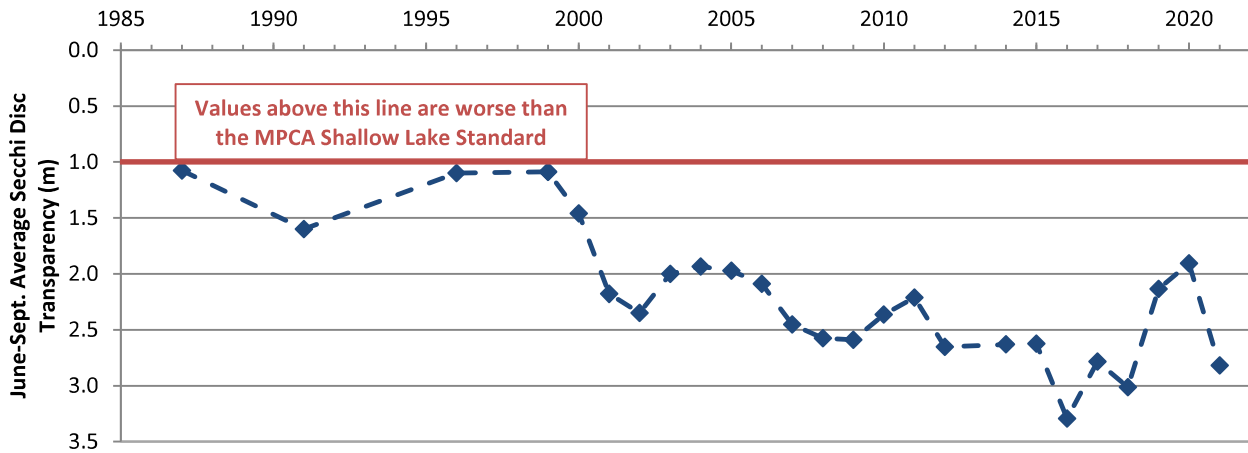
Sunfish Lake June-Sept. Average Chlorophyll *a*



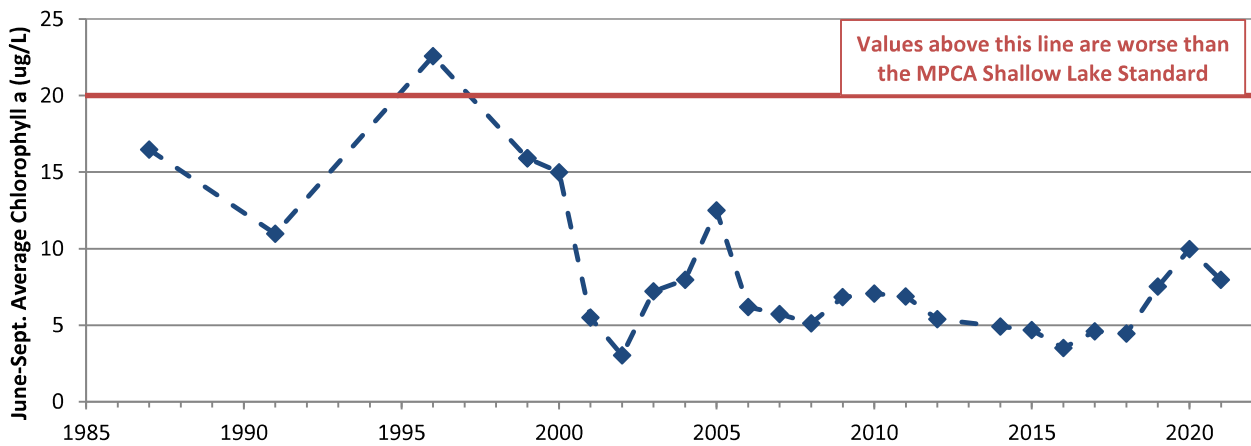
Sunfish Lake June-Sept. Average Total Phosphorus



Sunnybrook Lake June-Sept. Secchi Disc Transparency



Sunnybrook Lake June-Sept. Average Chlorophyll *a*



Sunnybrook Lake June-Sept. Average Total Phosphorus

