Silver Lake
Watershed Management Plan

Prepared By: Palo Alto County Soil and Water Conservation District, and Iowa Department of Natural Resources

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Introduction

Silver Lake is an important natural resource that is currently being underutilized due to poor water quality. The lake suffers from water quality problems associated with high nutrient and sediment loads originating in this predominantly agricultural watershed, especially from its northern portion and land surrounding the lake. High concentrations of nutrients (phosphorus and nitrogen) fuel algae blooms that are dominated by potentially toxic Cyanobacteria (i.e., blue-green algae) during most of the ice-free season. Combined with algae, large loads of soil particles from the watershed during storm events contribute to poor water transparency in the lake. Poor light penetration prevents a healthy, diverse aquatic plant community from being established. Additionally, high concentrations of bacteria during summer and autumn and occasionally high concentrations of Cyanobacteria toxins pose health risks to people and animals (ISU, 2016).

The Iowa Department of Natural Resources Lakes Restoration Program established a water quality target for water transparency (i.e., Secchi depth) to be at least 4.5 ft for 50% of the time from April to September. This general water quality target is difficult to achieve in Silver Lake, even with a maximum 90% reduction in total phosphorus (TP) loads entering the lake. Therefore, a lake-specific goal of 2.0 ft water transparency is a more feasible target for Silver Lake. This would require 60% reduction in TP loads to the lake and can be accomplished through watershed and in-lake management strategies.

Watershed Planning Process

Public outreach is beneficial to any project to gain insight from stakeholders, receive guidance from local experts, and help establish goals to produce a product that is socially acceptable to the public. The community-based planning efforts for included the formation of two committees, conduct coordination meetings with each committee and hold one public meeting.

The two committees formed were the Watershed Advisory Council (WAC) and Technical Advisory Team (TAT). The WAC consists of interested local citizens that will be informed on lake and watershed processes and concepts. They will help develop goals and provide insight on historical and current lake issues and the local perception of different management strategies. The WAC will spread the knowledge they gain to the community and help build consensus and public support. They focused their role on identifying nutrient reduction opportunities and developing public educational tools.

Table 1. Silver Lake Watershed Group Members

Name	Affiliation/Title	Committee
Jeremy Thilges	NRCS	TAT
Craig Merrill	Palo Alto Board of Supervisors	WAC
Jerry Joyce	Palo Alto SWCD	WAC
Kim Kibbie	City of Emmetsburg	WAC
x	Resident	WAC
Anita Fisher	Palo Alto SWCD	TAT
Lucas Straw	DNR - Wildlife	TAT
Mike Kollasch	Palo Alto SWCD	WAC
Mike Hawkins	DNR - Fisheries	TAT
Rob Allen	Palo Alto County Conservation Board	TAT
Kyle Ament	DNR – Water Quality	TAT
x	Farmer	WAC
George Antoniou	DNR – Lake Restoration	TAT
Michelle Balmer	DNR – Lake Restoration	TAT
x	Resident	WAC
Linus Solberg	Palo Alto Board of Supervisors	WAC
Dean Gronemeyer	Natural Resource Conservation Service	TAT
Harley Butler	Watershed Coordinator	TAT

Public Knowledge and Willingness to Participate

Public input and participation are crucial to the success of a watershed project. Watershed residents were surveyed in 2020 to better understand their positions on water quality and gauge interest in participating in water quality improvement projects. Two surveys were distributed, one for urban residents one for rural residents. Of rural residents 9 responded. There were 3 responses from urban residents. The results are summarized below.

Rural residents were first asked to describe themselves.

- Landowner not farming land - 1
- Landowner farming - 4
- Tennant farming rented land – 4

Survey participants were then asked to indicate their level of agreement or disagreement with the following statements.

Table 2. Perceptions of Water Quality in Silver Lake

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Water quality in Silver Lake needs Improvement		1	3	3	2
Ag fertilizers have impacted water quality in Silver Lake	1	1	2	4	1
Eroded soil and sediments have impacted water quality in Silver Lake	1	2	1	4	1
Improperly functioning septic systems have impacted water quality in Silver Lake		2	6	1	
Urban issues have impacted water quality in Silver Lake	4	3	1	1	
Poor water quality effects economic development in the area	1	2	2	4	
I know what steps to take to better conserve soil and water on my land		1	1	4	3
I would be willing to work with others to develop strategies that protect our watershed		1	4	3	1

Survey participants were also asked which sources of information that use or would use to make decisions about their farming operation or land management strategy. Participants could select as many options as applied to them, their answers are as follows:

- Face -to-face contacts - 8
- Information meetings -5
- Field days - 3
- Demonstration projects - 7
- Newsletters - 1
- Newspapers - 3
- Internet - 2
- Farm Magazines - 0
- Other – 1 Farm Manager

Survey participants were then asked their opinions on current use and interest in future use of conservation practices if they were offered at 75% cot share rate. The practices in question were selected based on their effectiveness improving water quality and applicability to the watershed's land scape.

Table 3. BMP Interest

	Would not work on my land	Not at all Interested	Somewhat interested	Very interested	Already adopted
No-till / Strip Till	2	3	1	1	1
Mulch-Till		1	5	1	2
Buffers / Filter Strips / Prairie Strips	2	1	3	1	2
Livestock Exclusion from Streams	6	2	1		
Streambank Stabilization	7		1	1	
Cover Crops	2	3	3		1
Grass Waterways	1		5	1	2
Wetlands	7	2			
Pasture Management	8		1		
Variable Rate Fertilizer Application	1		6	2	
Livestock Waste Systems	8		1		
CRP	1	3	3		2

Urban respondents were first asked to describe where their property was located.

- One the water, lake front - 3
- In the watershed but not directly on the lake - 0
- Unsure – 0

They were then asked about the condition of the lake and describe the water quality they observed over the past 10-15 years.

- Worse – 2
- Unchanged – 1
- Improved – 0
- Unsure - 0

Next, they were asked if they felt the need for continued water quality improvements for Silver Lake.

- Yes – 3
- No – 0
- Unsure – 0

Finally, people were asked which conservation practices they would be interested in adopting or learning more about. Participants were allowed to select as many options as they wished.

- Phosphate free fertilizer voucher - 2
- Information and cost share on rain gardens - 1
- Free or reduced cost rain barrels - 3
- Information and cost share on previous pavers - 0
- Information and cost share on native turf grass - 1
- Information and cost share on native shoreline – 2
- Informational meeting and Q&A with an urban conservationist – 1
- I'm not sure what any of these practices are – 1

At the end of the survey was a section devoted to landowner comments. There were four comments on the rural survey and two on the residential survey pertaining to dredging Silver Lake.

Public Meeting and outreach (as of publication)

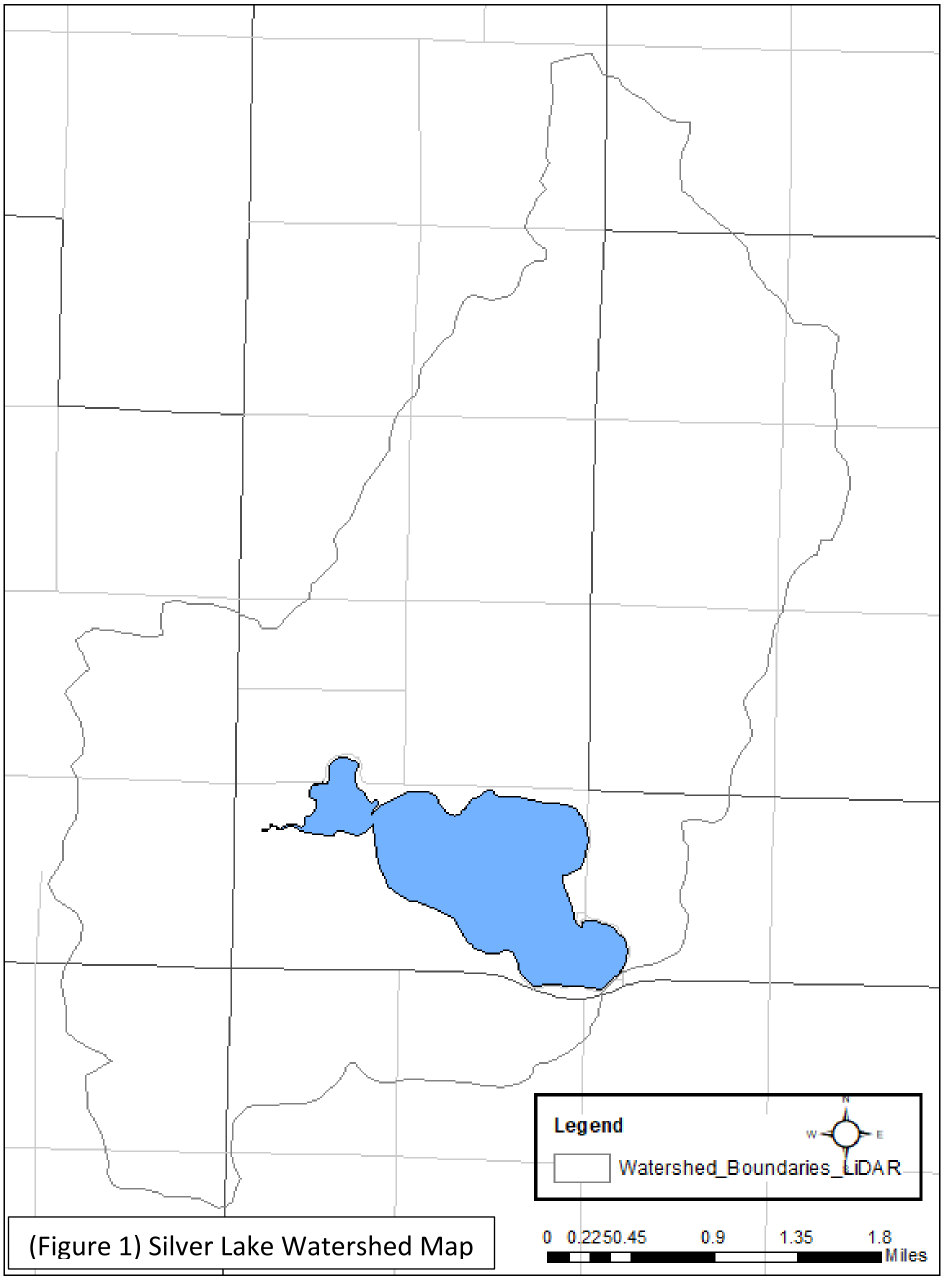
The COVID – 19 pandemic has serious impaired efforts to hold meetings of any sort.

On 12/16/2019 a WAC/TAT meeting was held at the Palo Alto County Nature Center from 6 – 7pm. This meeting was the first time all the partners were assembled. The focus of the meeting was to introduce both the coordinator and the current project and define partner roles in the project.

The Federal Clean Water Act requires the Iowa Department of Natural Resources (IDNR) to develop a total maximum daily load (TMDL) for waters that have been identified on the state's 303(d) list as impaired by a pollutant. Silver Lake has been identified as impaired by algae and turbidity. The purpose of these TMDLs for Silver Lake is to calculate the maximum allowable nutrient loading for the lake associated with algae and turbidity levels that will meet water quality standards. In 2004 a TMDL was completed by Iowa Department of Natural Resources (IDNR) to quantify the excess phosphorus load for the lake and watershed. The TMDL will be the basis for setting our load reduction target in this plan. In 2016, Iowa State University was contracted by IDNR to complete a Diagnostic and Feasibility study for Silver Lake. The findings of the study were presented to the public prior to the finalizing of the document.

Silver Lake Watershed Information

Silver lake is a 642-acre natural lake located two miles west of Ayrshire in Palo Alto County. Silver lake like many other lakes in the area is in a heavily agriculture dominated watershed. Most of the lake's inflows come from the open ditch to the northeast drainage district number 6. Urban development around the lake is low compared to similar lakes in the region with small developments being made on the north and south shores. The DNR operates the Silver Lake Wildlife Management Area on the east shore of the lake. Palo Alto County Consecration owns Salton Park on the north shore of the lake. Both parks offer public access with boat ramps and docks. The Iowa DNR also recently purchased a nearly 180-acre piece of land on the west shore of the lake. This section contains multiple restorable wetland and other opportunities for water quality and habitat improvement.



(Figure 1) Silver Lake Watershed Map

Silver lake has a man-made outlet structure with a stoplog control structure and spillway. The lake's watershed is 8,380 acres which yield a watershed to lake ratio of 13:1. While this is a larger ratio, it is still believed that significant improvements in water quality can be achieved through targeted use of best management practices in the watershed.

Watershed Characteristics (Table 4)

IDNR Waterbody ID	IA 04-UDM-03850-L_0
12- Digit Hydrologic Unit Code (HUC)	07000020301
12- Digit HUC Name	Drainage Ditch 62-Silver Creek
Location	Palo Alto County R-32W-T-96N
Latitude	43.031° N
Longitude	94.884° W
Designated Uses	A1 - Primary Contact Recreation B(LW) - Aquatic Life HH - Human Health
Tributaries	Drainage Ditch 6 and unnamed tributaries
Receiving Waterbody	West Fork of the Des Moines by way of Silver Creek
Lake Surface Area	642 acres
Max. Depth	6.4 feet
Mean Depth	4.3 feet
Lake Volume	2,781.5 acre-feet
Length of Shoreline	14.2 miles
Watershed Area	8,380 acres
Watershed: Lake Ratio	13:1
Lake Retention Time	.6 year

Hydrology

Silver Lake is located within the Upper Des Moines River HUC-8 and Silver Creek HUC-10. The lake is fed primarily by Drainage Dich 6 as well as ground water and tile runoff and a small unnamed tributary from the west. Silver Lake's current outlet structure is a stoplog control mechanism with auxiliary emergency spillway. The spillway serves as the start of Silver Creek. The creek them flows under 430th St. and continues 13.5 miles to the northeast where is empties into the West Fork of the Des Moines River.

Little to no testing has been done to determine average lake level and outflow. However, many residents report that during normal weather conditions the spillway runs most of the year. This is supported by the higher watershed to lake ratio.

Pre-settlement the watershed contained many wetlands as is typical of the region. Today, most of these wetlands have been converted to agriculture, it is estimated that Silver Lake has not experienced pre-settlement flow conditions for over 100 years.

Soils, Climate, Topography

Silver Lake is within the Des Moines Lobe This region of Iowa was formed 12,000 to 14,000 years ago when the last glaciers receded from the state. These massive ice sheets left behind fertile glacial till soil profiles with generally poor drainage. The Des Moines Lobe is also known for being dotted with many small wetlands, and a few larger lakes, scoured out by the glaciers. Today this portion of the state is known as the Prairie Pothole Region. Today many of the historical wetlands have been drained with tiles and converted to row crop production.

Silver Lake Watershed Soils Report (Table 5)

Soil Name	Watershed Area (%)	Description	Typical Slopes (%)
Clarion	41	Loam, moderately well drained	6-10
Webster	13	Clay loam, poorly drained	0-2
Canisteo	12	Clay loam, poorly drained	12
Nicollet	10	Clay loam, somewhat poorly drained	1-3
Okoboji	4	Silty clay loam, very poorly drained	0-1

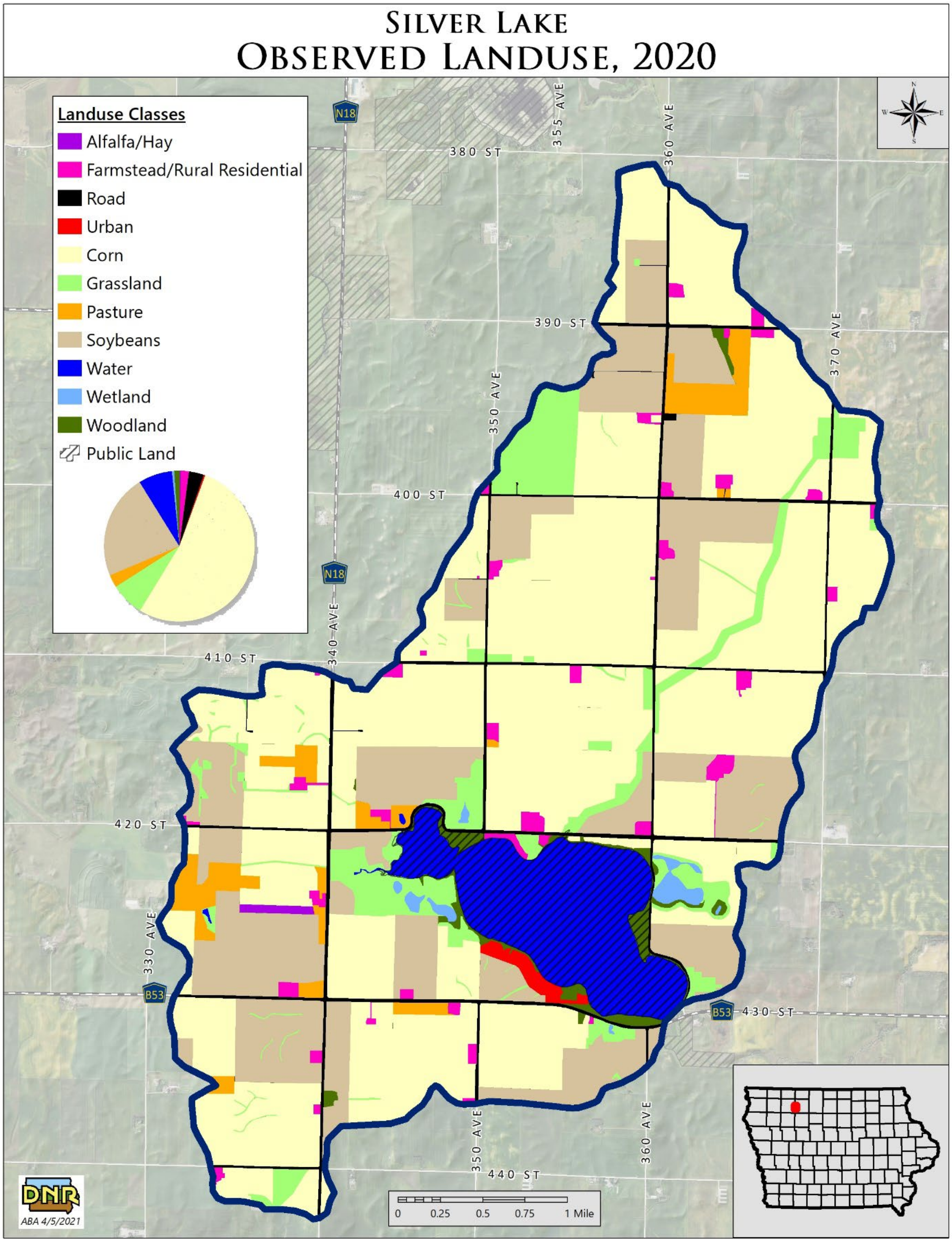
Like most other lakes in the area Silver Lake's watershed consists of prairie derived Wisconsin soils. Most of the watershed is within the Nicollet-Canisteo-Clarion soil (table 5) association which can be well drained to poorly drained. More low-lying areas of the watershed have the Canisteo-Webster-Okoboji association which tends to be poorly drained to very poorly drained.

Topography (Table 6)

Slope (%)		Watershed Area (%)
0-2	Level to nearly level	51
2-5	Gently sloping	39
5-9	Modernly sloping	6.1
>9	Strongly sloping to very steep	3.8

Land Use

A land use assessment was conducted for by SWCD and IDNR staff in the spring of 2020. This windshield survey collected landcover data and tillage type at a field level. As expected, most of the watershed is used for row crop production of corn and soybeans (figure 2). Because of the soil types present and most slopes being below 5% much of the watershed is drained by tile. There are six drainage district associations located in the watershed which are responsible for draining 4357.6 acres or 50.3% of the watershed with numerous private tiles also present.



(Figure 2) Silver Lake Observed Land Use Map

2020 Land use Assessment (Table 7)

COVERCUR	Sum_Acres	Pct
Alfalfa	49.37	0.6%
Corn	4,768.00	53.2%
CRP	681.55	7.6%
Farmstead Active	155.04	1.7%
Grassland	86.34	1.0%
Pasture	170.11	1.9%
Road	280.19	3.1%
Soybeans	1,942.29	21.7%
Timber	75.69	0.8%
Urban/Residential	44.33	0.5%
Water	649.49	7.3%
Wetland	53.55	0.6%
	8,955.95	

Population and Land Ownership

There are no incorporated towns within the Silver Lake watershed. There are two small housing developments, the one on the north shore being old and the one on the south shore being a newer development. The closest town to the lake is Ayrshire which is 2.5 miles straight east of the lake. Ayrshire has a population of 128 according to the 2019 census. No points sources are located in the Silver Lake Watershed.

Water Quality Findings

Silver Lake has had in lake monitoring data going back to the 1990's. Additional monitoring was done during the Diagnostic and Feasibility Study published in 2018. The IDNR has conducted in lake monitoring since 2000. Detailed results for both watershed and in lake monitoring can be found in Figure 4, 5, and 6.

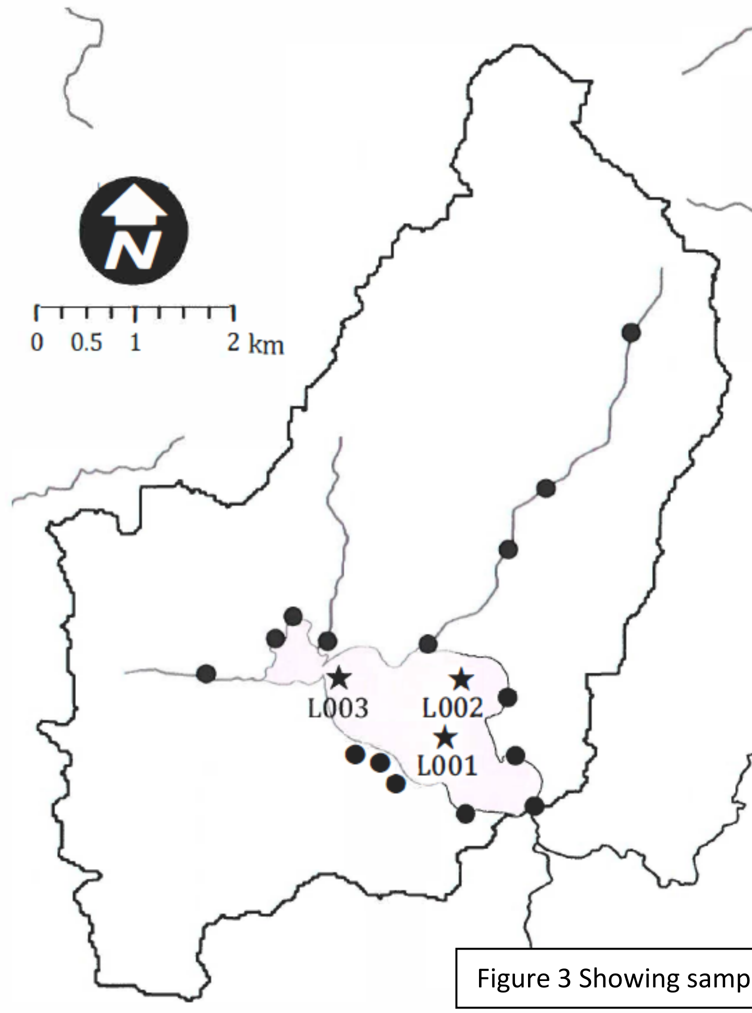


Figure 3 Showing sampling locations.

Watershed monitoring

Watershed monitoring for Silver Lake was conducted as part of the Diagnostic and Feasibility study published in 2016. Monitoring was done at all know inflows to the lake as well as multiple sites along the main tributary, DD 6. (Figure 3)

Since majority of the watershed is row crop it is not surprising that the highest loads come from areas of the watershed with the highest agricultural usage. Most row crop agriculture takes place north of the lake along the DD6 drainage.

In-Lake Monitoring

Silver Lake has ambient lake monitoring date dating back to 2000. The results of this monitoring program led to Silver being added to the Iowa 303(d) Impaired Waterways list since 2002. Silver has been included on the list because the Class A1 designated uses like swimming, boating, and fishing were not being met. This is due to turbidity and algal growth: chlorophyll a. Using Carlson's Trophic State Index which looks at factors such as Secchi depth, chlorophyll a, and total phosphorous, Silver Lake has been identified as a hypereutrophic lake. This means it often experiences algal scums and the has an excessive population of rough fish such as common carp. As of 2016 the lake has also been known to have issues with Cyanobacteria also stemming from excessive algal growth. Figures 4 & 5 show Secchi depth and total phosphorous trends from Silver Lake since 2010.

Figure 4: Secchi Depth since 2000 (DNR – AQUIA)

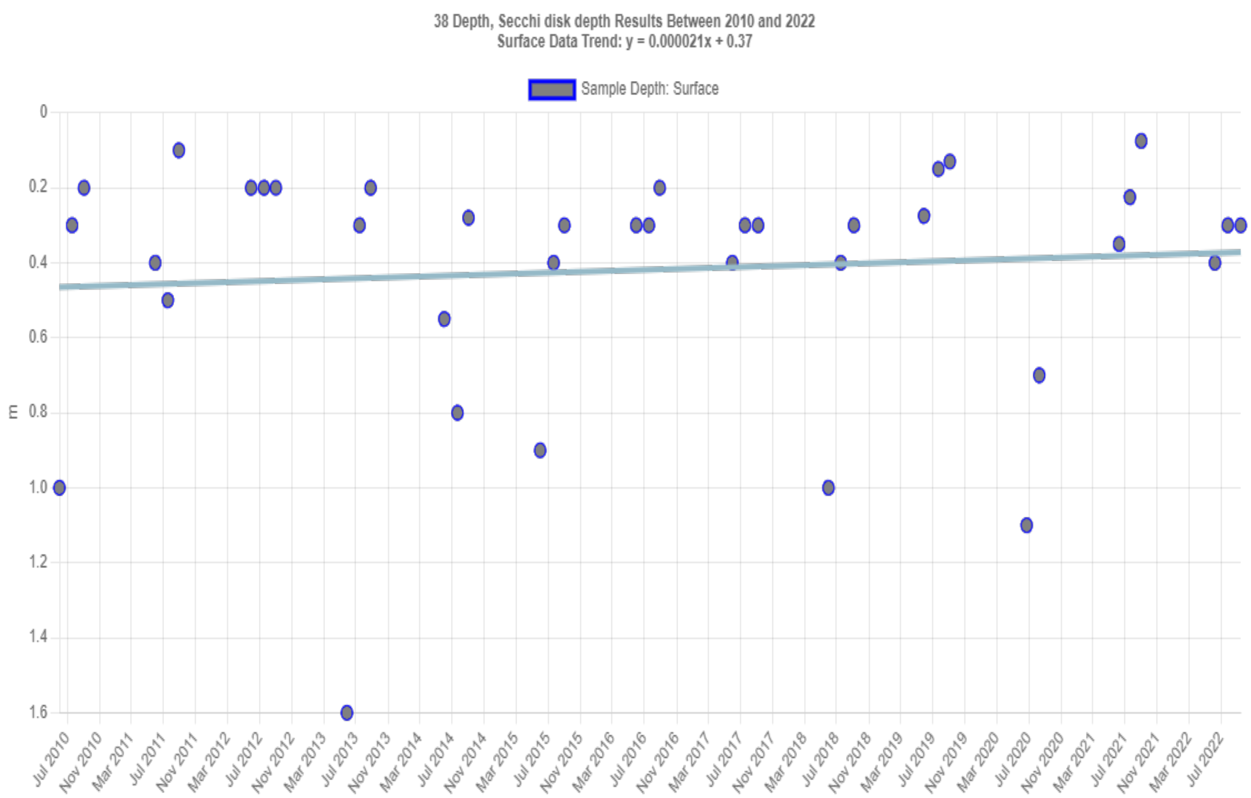
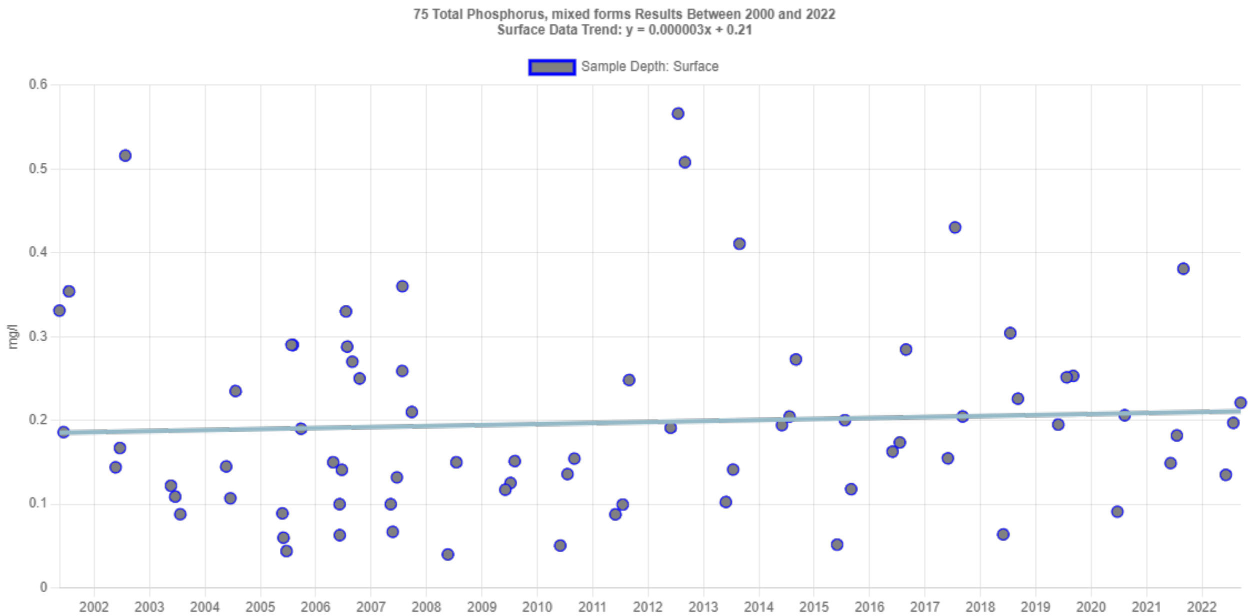


Figure 5: Total Phosphorus since 2000 (IDNR, AQUIA)

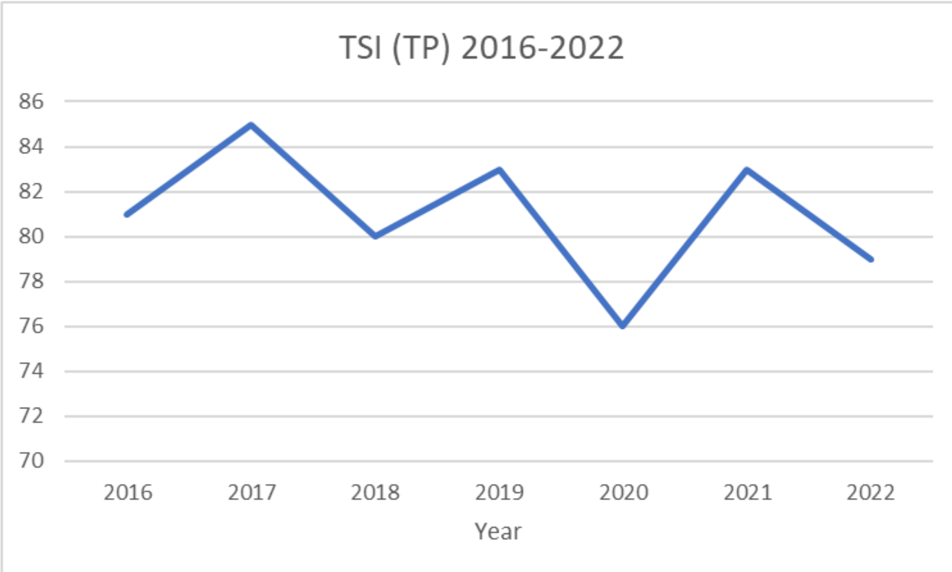


Known Impairments (Silver Lake Diagnostic and Feasibility Study)

Primary Source of Pollutants: Internal resuspension and phosphorous runoff from agricultural landscape.

For the 2020 assessment/listing cycle, which covers 2016-2018, the Class A1 (primary contact recreation) uses of Silver Lake are assessed (monitored) as “not supported” due to pollutant caused impairments. These impairments include algal growth: chlorophyll a, turbidity and pH. Of these impairments turbidity and algal growth mostly lead to aesthetically objectionable conditions like green algae slicks and poor water clarity. The pH impairment was identified in 2018 and can potentially lead to fish kills and other environmental concerns.

(Figure 6) TSI Scores 2016-2022

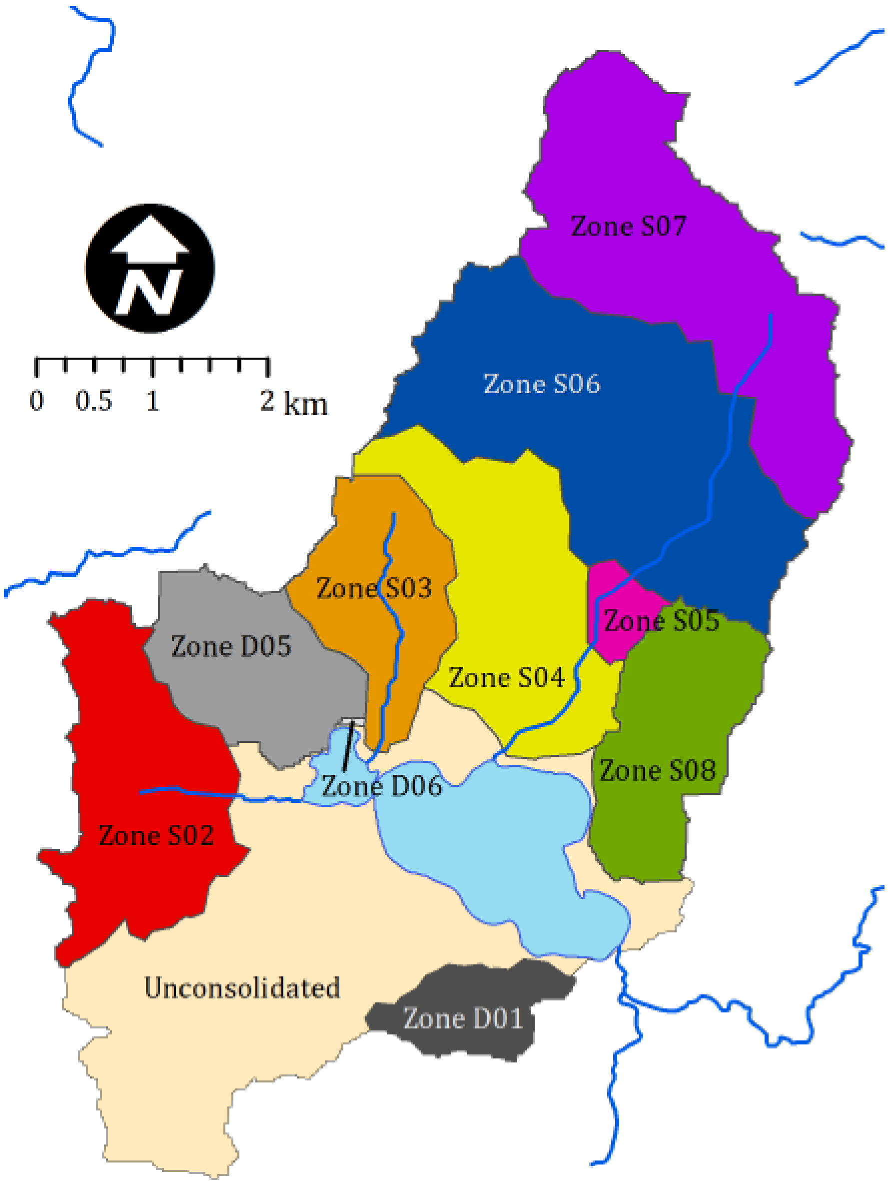


According to Carlson (1977) the Secchi depth, chlorophyll a, and total phosphorous values all place Silver Lake squarely in Hypereutrophic category. These values suggest high levels of chlorophyll a, and suspended algae in the water, very poor water transparency, and high levels of phosphorous in the water column. A TSI Value below 70 is desirable for meeting water quality standards.

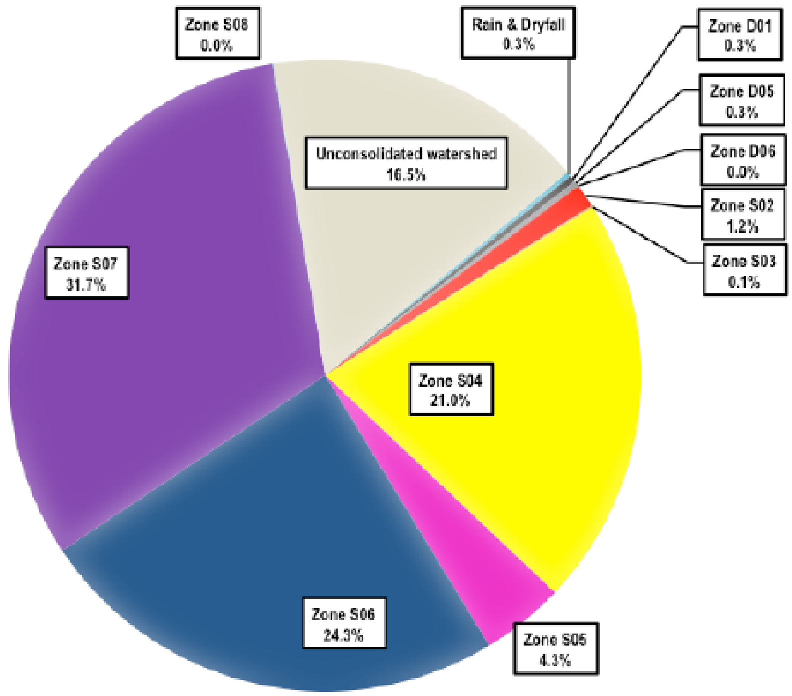
Pollutant Source Assessment

Existing Load

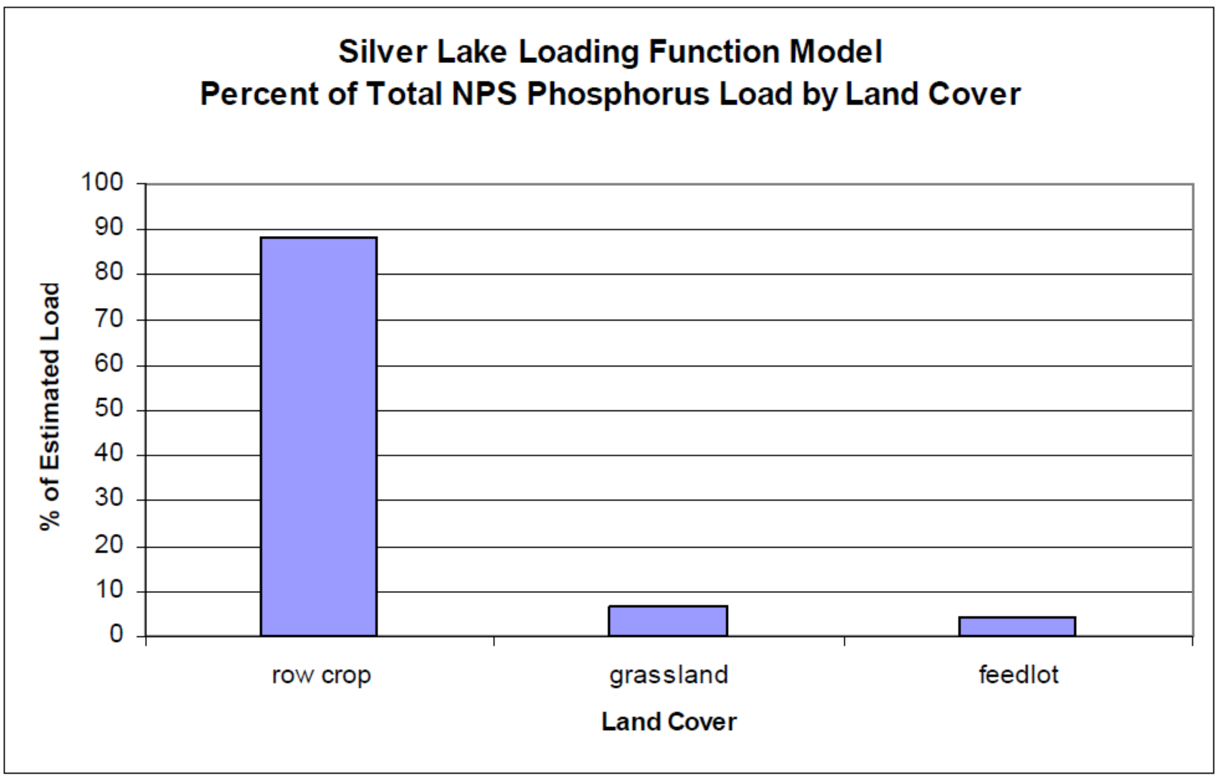
Two sources of information are available for estimating phosphorus loading in the Silver Lake Watershed. For the purpose of setting a load reduction target, the Silver Lake TMDL will be used (60% reduction). In regards to targeting, the Silver Lake DFS will be a useful tool due to the delineation of sub watersheds.



(Figure 7) Locations of sub-watersheds for Silver Lake. Sub-watershed zone colors in this figure correspond to colors presented in source contribution pie chart below (figure 8)



(Figure 8) Total phosphorus contributions to Silver Lake by sub-watershed



(Figure 9) Silver Lake Loading Function Model

Existing vs. Target TSI Values - Silver Lake TMDL (Table 8)

Parameter	2000-2003 Mean TSI	2000-2003 Mean Value	Target TSI	Target Value	In-Lake Increase or Reduction Required
Chlorophyll	75	89 ug/L	<65	<33 ug/L	63% Reduction
Secchi Depth	79	0.3 meters	<65	>0.7 meters	133% Increase in transparency
Total Phosphorus	83	239 ug/L	<70	<96 ug/L	60% Reduction

The State of Iowa does not have numeric water quality criteria for algae or turbidity. The algae and turbidity impairments are due to algal blooms caused by excessive nutrient loading to the lake and resuspension of inorganic suspended solids. The nutrient loading objective is defined by a mean total phosphorus TSI of less than 70, which is related through the Trophic State Index to chlorophyll and Secchi depth. The TSI is not a standard, but is used as a guideline to relate phosphorus loading to the algal impairment for TMDL development purposes and to describe water quality that will meet Iowa's narrative water quality standards.

The critical condition for which the TMDL TSI target values apply is the growing season (May through September). It is during this period that nuisance algal blooms are prevalent. The existing and target total phosphorus loadings to the lake are expressed.

as annual averages. Growing season mean (GSM) in-lake total phosphorus concentrations are used to calculate an annual average total phosphorus loading.

Modeling Approach

A number of different empirical models that predict annual phosphorus load based on measured in-lake phosphorus concentrations were evaluated. In addition, watershed phosphorus delivery using both export coefficients and an annual loading function model as outlined in Reckhow's EUTROMOD User's Manual (10) was calculated. The results from both approaches were compared to select the best-fit empirical model.

Existing Annual Total Load for Phosphors (Table 9)

Model	Predicted Existing Annual Total Phosphorus Load (lbs/yr) for in-lake GSM TP = = ANN TP = 239 ug/L, SPO TP = 157 ug/L	Comments
Loading Function	9,750	Reckhow (10)
EPA Export	10,230	EPA/5-80-011
WILMS Export	6,990	“most likely” export coefficients
Reckhow 1991 EUTROMOD Equation	776,400	GSM model
Canfield-Bachmann 1981 Natural Lake	12,320	GSM model
Canfield-Bachmann 1981 Artificial Lake	33,210	GSM model
Reckhow 1977 Anoxic Lake	3,910	GSM model
Reckhow 1979 Natural Lake	19,710	GSM model. P out of range
Reckhow 1977 Oxic Lake (z/Tw < 50 m/yr)	6,560	GSM model. P out of range
Nurnberg 1984 Oxic Lake	9,750 (internal load = 610)	Annual model. P out of range
Walker 1977 General Lake	3,470	SPO model.
Vollenweider 1982 Combined OECD	11,060	Annual model.
Vollenweider 1982 Shallow Lake	11,710	Annual model.

Existing Load

The annual total phosphorus load to Silver Lake is estimated to be 10,230 pounds per year based on the Loading Function and Nurnberg Oxic Lake models (Table 9). This estimate includes 9,530 pounds per year from external nonpoint sources in the watershed, 610 pounds per year attributable to internal loading, and 220 pounds per year from atmospheric deposition.

In order to reach a 60% reduction in phosphorus concentrations, watershed loading would need to reduced by 5,718 pounds.

Internal Loading

The Nurnberg Model indicates that internal loading makes up approximately 6% of the existing total phosphorus mass loading to the lake. However, the internal load has a much greater effect on in-lake total phosphorus concentrations on a pound for pound basis. The model relationship shows that one pound of internal loading is equivalent to 3.8 pounds of external loading. In terms of lake response, the internal load is estimated to comprise approximately 19% of the existing total load.

Silver Lake Watershed Goals and Objectives

Goals Statement

This Water Quality Management Plan and subsequent projects seek to improve the water quality in Silver Lake to the point where it can be removed from the Iowa Impaired Waterways List by removing the current impairments of algae and turbidity. These goals will be accomplished through a comprehensive plan of Best Management Practices and in-lake improvements. These goals have been created with the help of the Watershed Action Group, watershed residents, and partner organizations. As of this writing these goals are set to be completed within 30 years.

Goal 1: Educate the public on the water quality issues facing Silver Lake

- *Objective 1*: Continue to inform landowners of water quality issues by hosting educational meetings, sending mailers, continuing to publish news articles and develop online resources, and by making personal contacts with key stakeholders.
- *Objective 2*: Educate urban landowners and by holding events like a “Day on the Lake” event to show how their land use affects water quality.
- *Objective 3*: Inform visitors with and online presence, handouts, inclusion in chamber of commerce visitor information, and signage.
- *Objective 4*: Encourage the implementation of BMP’s through demonstration projects, field days, online resources, news articles, and one-on-one contacts.

Goal 2: Use targeted best management practices in Silver Lake and watershed to improve water quality keeping in mind the target TSI scores. Achieve TSI scores under the threshold of impairment for chlorophyll-a, turbidity, and algal growth cyanobacteria

- *Objective 1*: Implement conservation practices on priority agriculture acres. Focus on areas in the north of the watershed along DD 6 that were identified as having a high erosion rate (figure 12 and figure 7) and P load. Also give special attention to areas in close proximity to the lake that could have high P loads during storm events.
- *Objective 2*: Install conservation practices in urban landscapes. Inform and encourage landowners to better understand their role in phosphorous deliver to the lake and the practices they can install to help.
- *Objective 3*: Implement and enhance public land within the watershed. Focus on potholes that are on public land that can be restored.

Water Quality Milestones

Setting water quality goals based on models and TSI scores form the baseline for assessing improvement in water quality projects like this one. The following goals have been established based off the target TSI values.

1. Increase water clarity to delisting from impaired waters criteria (Secchi depth TSI ≤ 63 = Secchi depth ≥ 2.6 ft) = **58% Load Reduction**
2. Increase water clarity to Iowa DNR Lake Restoration Program standards (Secchi depth ≥ 4.5 ft form April to September) = **60% Load Reduction**

Iowa State performed a Diagnostic Feasibility study for Silver Lake in 2016. Their identified water quality goal was to improves secchi depth to 4.5 feet from April through September. This would be sufficient to remove Silver Lake from the Impaired Waterways List.

The annual total phosphorus load to Silver Lake is estimated to be 10,360 pounds per year based on the Loading Function and Nurnberg Oxic Lake models. This estimate includes 9,530 pounds per year from external nonpoint sources in the watershed, 610 pounds per year attributable to internal loading, and 220 pounds per year from atmospheric deposition. Target Watershed Load reduction: 60% - 5,718 lbs to be reduced.

Watershed Phosphorus Load Reduction Goals for each phase of the WMP (Table 10)

Phosphorus Loading						Water Quality Goals	
Scenarios	Watershed TP Load (lbs.)	Internal TP Load (lbs.)	Total TP Load (lbs.)	Reduction (%)	Reduction (lbs.)	Total P (TSI)	Secchi (TSI)
Baseline Conditions	9530	610	12586	-	0	83	79
End of Phase 1	8494	610	9104	10	1039	82	78
End of Phase 2	5617	610	6227	40	2877	75	74
End of Phase 3	3812	TBD		60	1802	68	69
Total Load Reduction	5718						

Water Quality Milestones (Table 11)

% P Load Reduction	TP		Secchi	
	µg/L	TSI	ft	TSI
0%	239	83	0.3	79
20%	210	81	0.5	78
30%	181	79	0.9	76
40%	150	75	1.5	74
50%	120	72	2.1	72
60%	109	68	2.6	69

Estimates are based off load reductions in the watershed and provided by the Silver Lake TMDL.

Best Management Practices

See Appendix B for detailed information.

Ag BMPs

Mulch/No Till

- Phosphorous Reduction Potential: 50-70%
- Goal: 4,480 acres
- Target: Focus on acres north of the lake with high loads and all acres bordering the lake.
- Payment Rate/Incentive: EQIP Payment or Section 319 funding

Cover Crops

- Phosphorous Reduction Potential: 70%
- Goal: 4480 acres
- Target: High load areas in the north end of the watershed
- Payment Rate/Incentive: EQIP Payment of Section 319 funding

CRP/WRP

- Phosphorous Reduction Potential: 45%
- Goal: 850 acres
- Target: Drainage ditches and fields close to the lake
- Payment Rate/Incentive: CRP payment plus $100 per acre one-time sign-up payment

Waterways

- Phosphorous Reduction Potential: Depends on location
- Goal: 21,500 ft
- Target: Areas showing signs of gully erosion
- Payment Rate/Incentive: CRP plus up to 90% of the project cost

Pothole Wetland Restoration

- Phosphorous Reduction Potential: 20%
- Goal: 500 acres
- Target: historical pothole areas north of the lake
- Payment Rate/Incentive: CRP Plus up to 90% of restoration cost plus $100 per acre one-time sign-up payment.

<u>Urban BMPs</u>

See appendix B for more information

Phosphorous Free Fertilizer Program

- Phosphorous Reduction Potential: Medium to High
- Goal: NA
- Target: All residents surrounding the lake
- Payment Rate/Incentive: voucher toward P-free fertilizer purchase

Residential Rain Gardens

- Phosphorous Reduction Potential: Depends on location
- Goal: 5
- Target: Watershed residents, new development
- Payment Rate/Incentive: 50% of total cost

Rain Barrels

- Phosphorous Reduction Potential: Variable
- Goal: 12 rain barrels
- Target: Watershed residents
- Payment Rate/Incentive: $50 toward purchase of rain barrel

Bioswales

- Phosphorous Reduction Potential: Depends on location
- Goal: 4
- Target: All residential ditches near the lake
- Payment Rate/Incentive: 75% of project cost

Water Quality Monitoring

Water monitoring is an important tool in all watershed improvement projects. Monitoring tracks the progress of the project and allows for future changes and improvements. This water monitoring plan will collect data from both from within the watershed and Silver Lake. A detailed water monitoring plan will be implemented with the State Hygienic Lab once the Watershed Plan is approved. The results of the water quality will be utilized to establish long term results for the progress of the watershed project as well as to identify high P delivery zones for targeted BMP implementation. DNR staff will meet on an annual basis to share and evaluate the data collected with the project coordinator to determine if efficient implementation of BMP's is occurring.

Site Locations

In-Lake: The ambient lake location will continue to be monitored by Iowa State through the IDNR's ambient lake monitoring program. This should suffice for the purposes of this plan.

Watershed Tributaries: Multiple sites along DD 6 as well as the western inflow now owned by the DNR. It could also be beneficial to obtain the sampling done by ISU on the CREP site just north of the lake as well as any CREP sites build in the future.

Use some of the same sites that were tested for the DFS study. Test seven key locations, the north end of DD6, the middle of DD6 where another ditch enters it, the outflow of DD6 into the lake, the outlet of the CREP site, the western in flow through the DNR property, A tile inflow on the south shore, and the wetland inflow on the eastern shore.

Frequency

In-Lake: Monthly (April through October)

Tributary: Twice per month (April through October) and try to include some samples taken during heavy rain events to better understand high load conditions.

Parameters

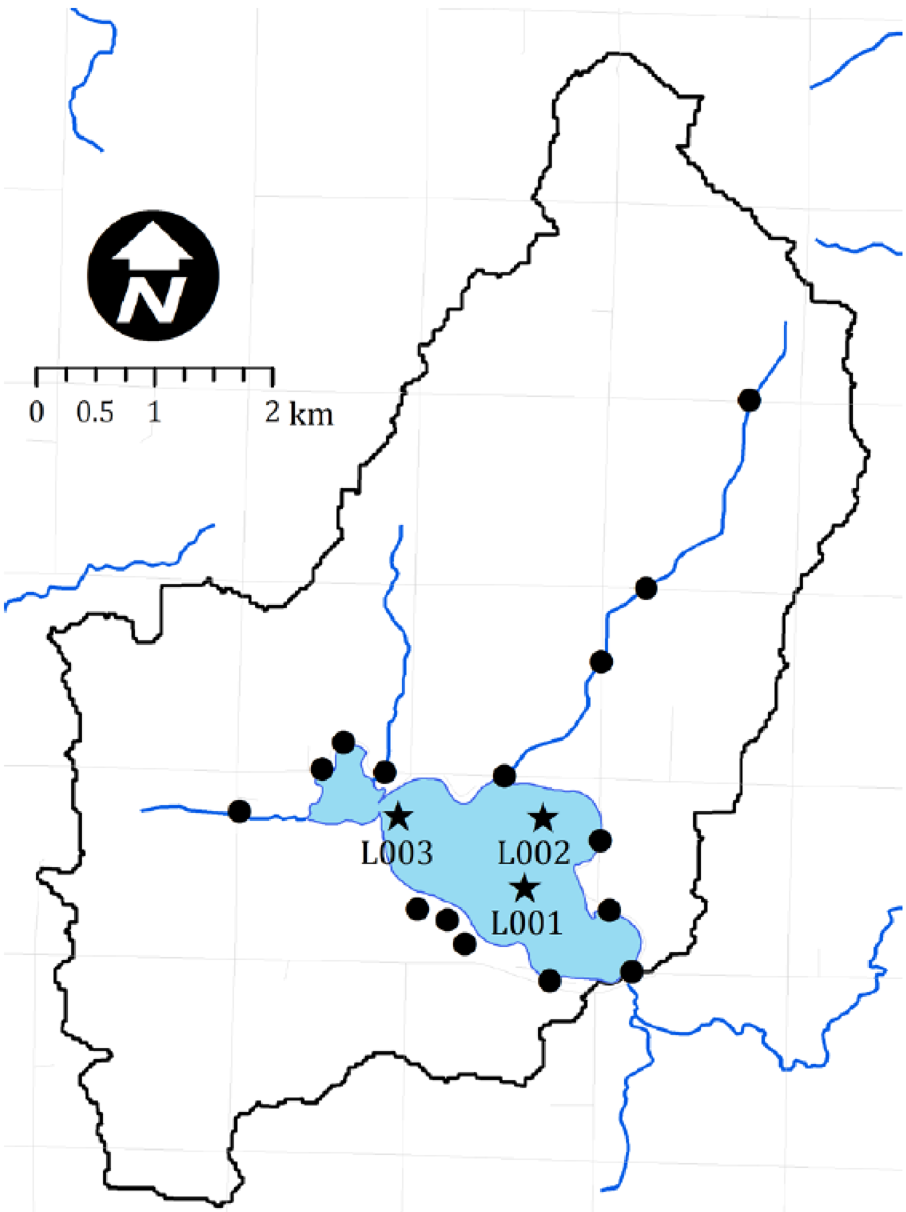
In-Lake: chlorophyll-a, total suspended solids, total fixed suspended solids, nitrate and nitrite, total phosphate, orthophosphate, Secchi depth, dissolved oxygen, temperature, pH, turbidity.

Tributary: total suspended solids, nitrite and nitrate, total phosphate, orthophosphate, dissolved oxygen, temperature, pH, turbidity, and flow.

Water Sampling Budget

Tributary (Table 12)

Parameter	Cost per Sample	# of Sites	# of samples	Total Cost
Total suspended solids	$13	7	7	$637
Total fixed suspended solids	$26	7	7	$1274
Nitrite and nitrate	$13	7	7	$637
Total phosphate and orthophosphate	$26	7	7	$1274
			Shipping	$300
			Total	$3922



(Figure 10) Silver Lake Water Quality Monitoring Sites from DFS

Public Outreach Plan

Public input and involvement are crucial to the success of watershed projects like this one. Landowners who live in and own land in the watershed have directly influence the water quality in Silver Lake through their land management decisions. It is crucial to maintain their involvement in the planning process, even with the additional challenges of COVID-19.

Goals

- Education: There is a big need to increase the public knowledge of the specific factors impacting water quality in Silver Lake
- Utilize public input to shape the Best Management Practices Targeting plan

Target Audiences

People directly responsible for implementing practices to improve the land and water

- Ag landowners
- Ag tenants
- Residents of Emmetsburg and surrounding developments
- Year-round residents around Silver Lake
- Seasonal residents around Silver lake
- Rural residents
- Public land managers (Palo Alto County Conservation and IDNR)
- Local business that benefit from the lake

Agencies needed to advance the project

- Palo Alto SWCD
- Palo Alto County Conservation Board
- Iowa DNR
- NRCS
- Silver Lake Homeowners Association

Target Audience Outreach Strategy and Tactics

All audiences are different and come with their own preconceptions and challenges. This section will explore ways to contact and work with the many unique audiences that will be involved with this project. It will address key messaging and contact strategies as well as each groups barriers to participation and ways to overcome them.

Potential Barriers to Participation by Group

Ag Landowners

- Loss of land in production and therefore income from implementing conservation practices
- Cost share rates on conservation practices
- Perception of yield loss when transitioning a new system such as no-till or implementing cover crops
- Absentee landowner contact and education

Ag tenants

- Loss of acres in production and therefore income
- Perception of yield loss when implementing a new practice such as no-till or cover crops
- Convincing absentee landowners to participate in conservation practices
- Cost share rates for conservation practices
- Uncertainty about continuing to farm the land in the future

Urban Property Owners

- Loss of property to install conservation practices
- Cost share to install practices
- Maintenance of conservation practices
- HOA codes
- Neighbors
- Seasonal resident availability
- Visual appeal of conservation practices

Potential Solutions, Motivators, Incentives and Benefits to Participate

- Provide or increase cost share rates for conservation practices
- Utilized multi-program funds / stack benefits where possible
- Participation recognition/ awards
- Educational projects and demonstrations

Keeping in mind the potential barriers to participation as well as ways to mitigate them, outreach tactics are being developed to specific audiences preferred methods of communication. These include one-on-one contacts, smaller group meetings (e.g. attending an HOA meeting), direct mail, email, and press (e.g. local papers). Also included are general communication elements that will assist the advancement of all public outreach efforts in the future.

General Communication Elements

- Project Identity: developing an identity for the project that will provide consistency to all public outreach so it can be tied back to the project
- Online presence: Maintain and enhance a web presence to provide basic information about the watershed and project activities. Utilize online platforms that appeal to a wide range of people. (e.g. Facebook, Town website, YouTube, Zoom etc.) Theses communication methods are becoming increasingly popular and important in the age of COVID-19
- Photography: Take photos of watershed projects that can show progress and be used to educate other interested groups.
- Communication schedule: Create an annual outreach plan that focuses on key seasons / events to reach target audiences and ensure that the project remains relevant (e.g. summer events that target seasonal residents)

One-on-One Personal Contact

- Personal meeting/phone calls: Schedule private meeting or phone calls with individuals to educate them about the project and explain methods and cost share options in detail. Focus on influential landowners and community members.
- Field Days: arrange at lease one annual field day to increase awareness of watershed projects and show off project progress. Tours should include representatives from as many partner groups as possible to demonstrate cooperation on the project. Schedule additional field days that showcase specific projects or groups (e.g. spring ag tour by SWCD or Master Gardeners open house)
- Other educational events: Take advantage of any opportunity to expose the technical advisory team or watershed advisory group to the public. Encourage member to build relationships with other agencies and have one-on-one conversations with public (e.g. Summer Water Quality Festival modeled after the Okoboji one)

Direct Mail/Email

- Annual letter: Draft and annual letter or brochure to raise awareness and education. The Five Island Lake Association has already started this process.
- Email newsletter: Create an E-newsletter that can be used for project updates, watershed news, and educational pieces.

Press/Publicity

- News articles: Send quarterly press releases to media outlets (Local newspapers/websites) with project news and updates. Focus on including pictures or other visuals when possible. Additional write a few columns for the Five Island Lake Association's bimonthly spot.
- Public recognition/awards: Create and present urban and rural watershed awards to publicly recognize participating landowners and partners.
- Publicity Events: Hold events and educational activities that have a "feel good" spin, like field days or watershed tours mentioned previously. Also plan events that include other key audiences (e.g. youth events with local 4-H and FFA, county conservation programs, local high school or college environmental science classes)

Other

- Partnerships: Develop good relationships with local groups and organizations that have platforms that can be utilized to communicate watershed information to the public. (e.g. City of Emmetsburg website, Five Island Lake Association)
- Committee and Public Meetings
    - Hold quarterly watershed advisory committee meetings
    - Hold annual project review meeting
    - Hold annual public meeting

Evaluation/measurement

- Keep track of meeting attendance and participation
- Follow-up surveys (e.g. hand out a survey at the annual meeting and public meeting, post online surveys periodically do gauge public opinion)
- Follow-up phone calls with key partners and landowners
- Follow-up one-on-one interviews
- Conservation practice participation reports
- Press hits/media coverage

Implementation Schedule

Achieving the water quality targets set forth in this plan will be no easy task. Implementation and adoption of these practices must happen across the board to meaningfully impact water quality. Tables 13 and 14 are divided the areas where these practices will be implemented, watershed, urban, and in lake.

Implementation Schedule Phases and Goals (Table 13)

Component	Units	Phase One (Years 1-5)	Phase Two (Years 6-15)	Phase 3 (Years 15-30)	Total
Waterways	FT	3500	9000	9000	21,500

Pothole Wetland Restoration	AC	50	250	200	500
No-till/Strip till	AC	800	2500	1180	4480
Cover Crops	AC	800	2500	1180	4480
P Removal Bioreactor	No	1	2	1	4
CRP/WRP	AC	250	300	300	850

<u>Residential practices (Table 14)</u>

Residential Rain Gardens	NO	2	2	1	5
Rain Barrels	NO	5	5	2	12
Bioswales	FT	3,000	3,000	2,310	8310
Bio cell	NO		1		1

Resource Needs (Table 15)

BMP	Unit Cost	Unit	Planned Amount	Total Cost	P Reduction (lbs)
No Till	$ 25.00	acre	4480	$ 134,400	1747.2
Cover Crops	$ 45.00	Acre	4480	$ 179,200	1747.2
CRP/WRP	$ 800.00	Acre	850	$ 680,000	535.5
Grassed Waterways	$ 7.00	Feet	21500	$ 150,500	1290
Pothole Wetland Restoration	$ 1,000.00	Acre	500	$ 500,000	356.5
No Phosphorus Fertilizer	$ 15.00	Each	0	$ -	0
Bioswale	$ 2,200.00	each	4	$ 8,800	3
Rain Gardens	$ 800.00	Each	5	$ 4,000	3
Rain Barrels	$ 120.00	Each	12	$ 1,440	1
Phosphorus Removing Bioreactor	$ 15,000.00	Each	4	$ 60,000	34.8
Water Quality Monitoring	$ 7,392.00	Year	30	$ 221,760	
Public Outreach	$ 1,500.00	Year	30	$ 45,000	
Project Coordinator (1/3 time)	$30,000	Year	30	$ 900,000	
				$ 2,885,100	5718.2

Cost Estimates

BMP practice information and cost-share amounts were determined by local NRCS staff and contractors with input from the SWCD Commissioners.

In Lake Practices – TBD

Once sufficient progress has been made treating the watershed IDNR- Lake Restoration will work with local stakeholders to determine feasibility and cost of in lake BMPs.

Implementation Schedule (Years 1-5)

Goal 1: Educate the public on the water quality issues facing Silver Lake

- *Objective 1*: Continue to inform landowners of water quality issues by hosting educational meetings, sending mailers, continuing to publish news articles and develop online resources, and by making personal contacts with key stakeholders.
- *Objective 2*: Educate urban landowners and by holding events like a "Day on the Lake" event to show how their land use affects water quality.
- *Objective 3*: Inform visitors with and online presence, handouts, inclusion in chamber of commerce visitor information, and signage.
- *Objective 4*: Encourage the implementation of BMP's through demonstration projects, field days, online resources, news articles, and one-on-one contacts.

Goal 2: Use targeted best management practices in Silver Lake and watershed to improve water quality keeping in mind the target TSI scores. Achieve TSI scores under the threshold of impairment for chlorophyll-a, turbidity, and algal growth cyanobacteria

- *Objective 1*: Implement conservation practices on priority agriculture acres. Focus on areas in the north of the watershed along DD 6 that were identified as having a high erosion rate and P load. Also give special attention to areas in close proximity to the lake that could have high P loads during storm events.
- *Objective 2*: Install conservation practices in urban landscapes. Inform and encourage landowners to better understand their role in phosphorous deliver to the lake and the practices they can install to help.
- *Objective 3*: Implement and enhance public land within the watershed. Focus on potholes that are on public land that can be restored.

Goal 1: Educate the public on the water quality issues facing Silver Lake (Table 16)

		Metric	Total	FY24	FY25	FY26	FY27	FY28
Objective 1	Inform Landowners of WQ Issues							
Task1	Utilize Social Media	Online Postings	15	3	3	3	3	3
Task 2	Draft Annual Letter to Landowners	Mailings	5	1	1	1	1	1
Task 3	Meet one on one with Landowners	Contact	45	0	10	15	20	
Task 4	Kickoff Open House Event	Event	1	1				
Objective 2	Education Landowners by “Day on the Lake” Event							
Task 1	Host event by year 2	Events	4		1	1	1	1
Objective 3	Inform Visitors with Educational information							
Task 1	Create Handout about watershed and cost share	Handout	5	1	1	1	1	1
Task 2	Signage at stream crossings and watershed boundaries	Signs	20	20				

Goal 2: Use targeted best management practices in the watershed and the lake to improve water quality while targeting TSI scores. Achieve TSI scores under the threshold of impairment for chlorophyll-a, turbidity, and algal growth and cyanobacteria (Table 17**)**

		Metric	Total	FY24	FY25	FY26	FY27	FY28
Objective 1	Implement conservation on Agriculture Lan							
Task 1	Grassed Waterways	Feet	3500	500	900	700	700	700
Task 2	No-Till/Strip Till	Acres	800	100	120	180	200	200
Task 3	Pothole Wetland Restoration	Acres	50	0	5	5	20	20
Task 4	Cover Crops	Acres	800	40	100	200	200	260
Task 5	Phosphorus Reducing Bioreactor	No.	1	0	0	0	1	0
Task 5	CRP/WRP	Acres	250	0	50	50	50	100
Objective 2	Urban Practices							
Task 1	Bioswale	Each	1	0	0	1	0	0
Task 2	Rain Barrels	No.	10	3	3	3	1	0
Task 3	Rain Gardens	No.	5	0	1	1	2	0

Funding Sources

In order to obtain the goals/objective of this plan, multiple funding sources will need to be utilized. Below is a list of funding possibilities.

EPA Section 319 Funding, managed by Iowa DNR: The 1987 amendments to the Clean Water Act (CWA) established the Section 319 Nonpoint Source Management Program Section 319 addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects.

Iowa DNR – Lake Restoration Funding: The goal is to invest money on projects with multiple benefits such as improved water quality and increased public use, while taking into account feasibility of restoration. Science based prioritization has been our most effective tool in targeting projects of value to the state. Funding for the Lake Restoration Program (LRP) is currently appropriated on an annual basis. We anticipate that at the current annual level of $9.6 million per year the DNR can stay on schedule with implementing restoration efforts at the significant publicly-owned lakes and publicly-owned shallow lakes/wetlands currently prioritized in the five-year plan.

Iowa Department of Agriculture and Land Stewardship:

Conservation Reserve Enhancement Program (CREP) - The Iowa Conservation Reserve Enhancement Program is a state, federal, local, and private partnership that provides incentives to landowners who voluntarily establish wetlands for water quality improvement in the tile-drained regions of Iowa. The goal of the program is to reduce nitrogen loads and movement of other agricultural chemicals from croplands to streams and rivers. In addition to improving water quality, these wetlands will provide wildlife habitat and increase recreational opportunities.

Water Quality Initiative (WQI) -The Iowa Water Quality Initiative (WQI) is the action plan for the Iowa Nutrient Reduction Strategy (NRS) established in 2013. The WQI improves water quality through a collaborative, research-based approach that is evaluated and reported by a team of independent researchers from multiple institutions, led by Iowa State University. This comprehensive approach allows farmers and cities alike to adopt conservation practices that fit their unique needs, lands, and budgets.

Natural Resource Conservation Service (NRCS):

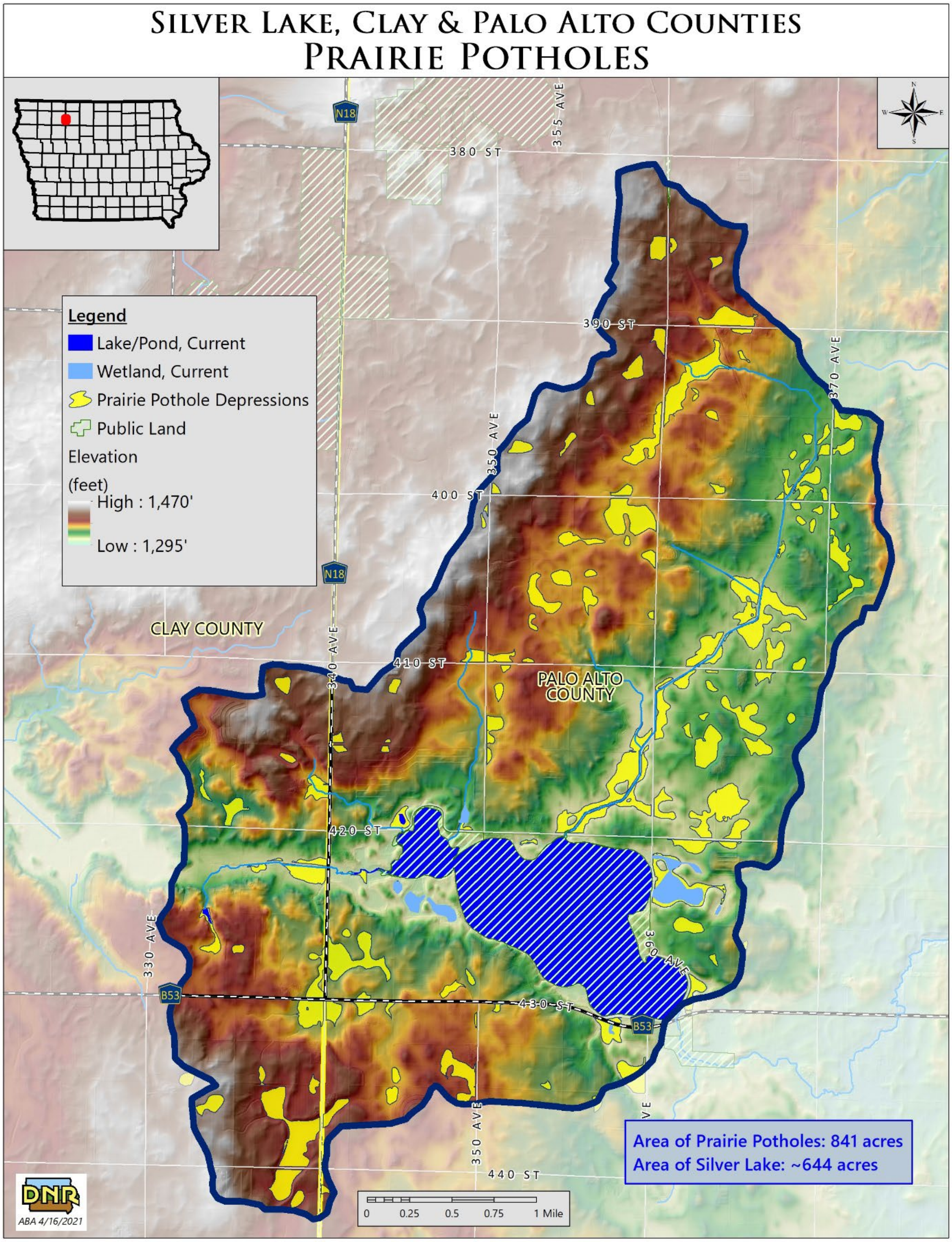
Environmental Quality Incentive Program (EQIP)- The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, increased soil health and reduced soil erosion and sedimentation, and improved or created wildlife habitat.

Conservation Stewardship Program (CSP) helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment.

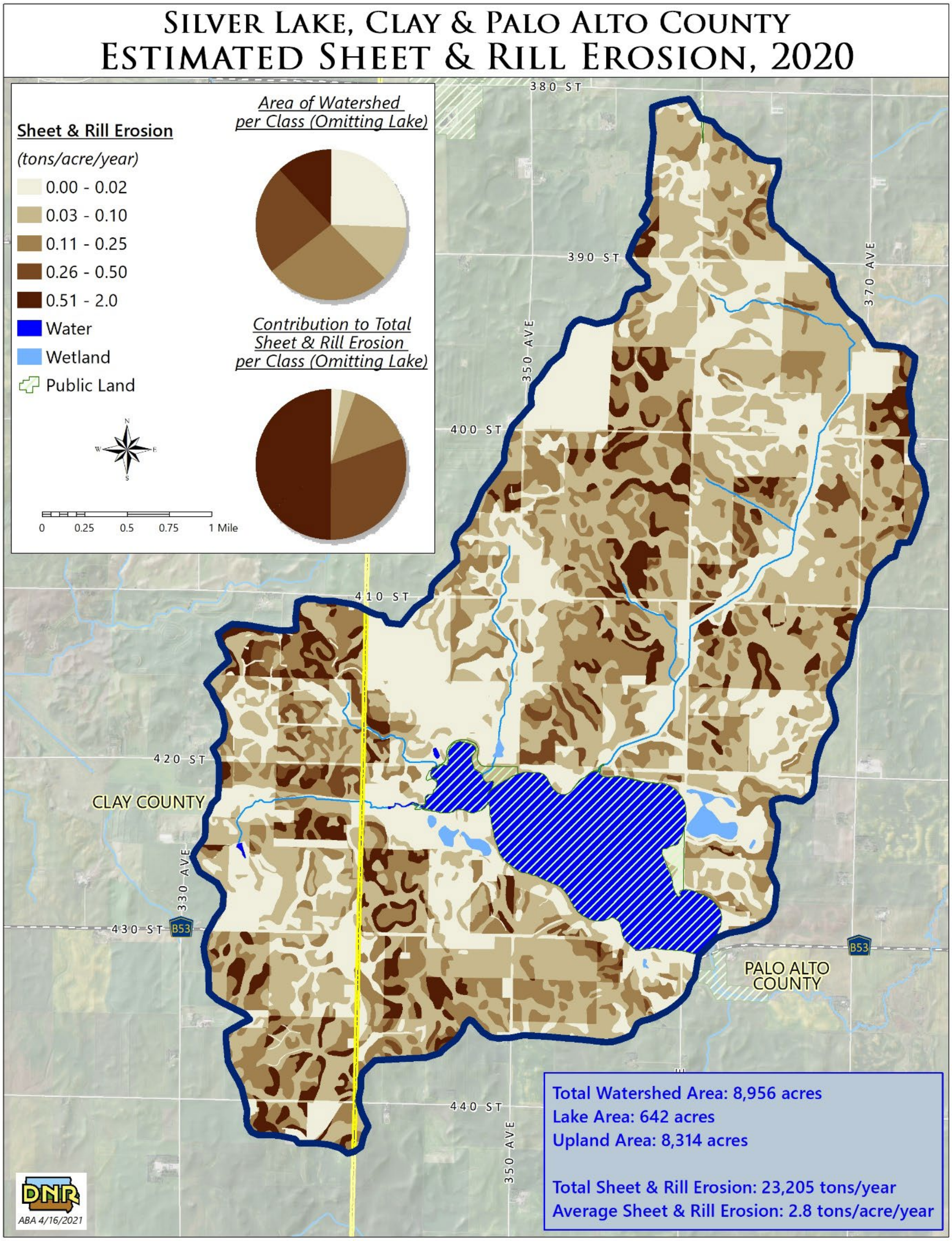
Farm Service Agency (FSA):

Conservation Reserve Program (CRP) - CRP is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are from 10 to15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

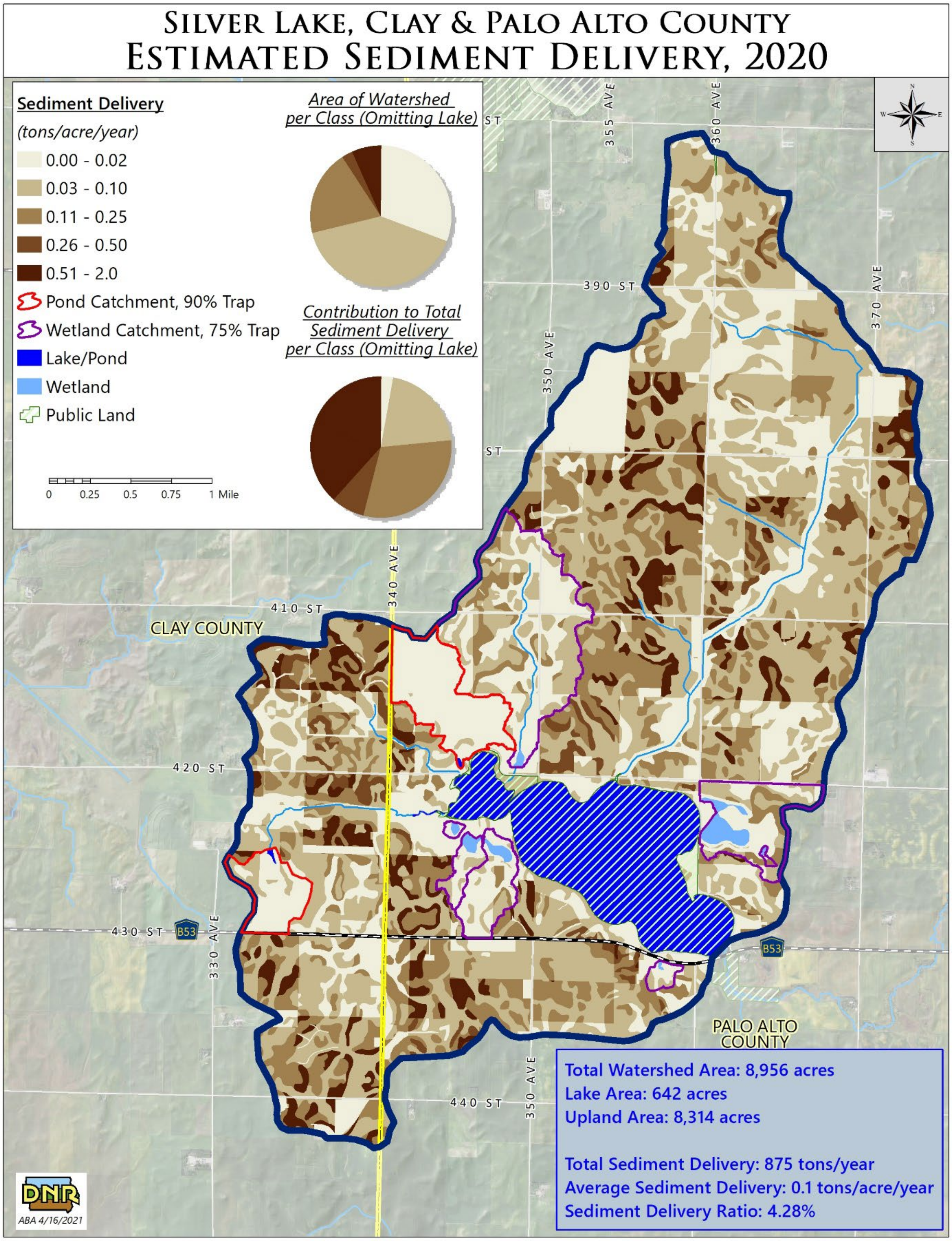
Local Partners and Funding Sources: As opportunities present themselves, local partners will contribute funds to the projects.



(Figure 11) Silver Lake LIDAR Elevation Height



(Figure 12) Silver Lake Estimated Rill Erosion Map



(Figure 13) Silver Lake Estimated Sediment Delivery. Areas with sediment deliver values higher than 0.26 will be targeted for BMP implementation.

Appendices

Appendix A

Lake Assessment

Physical features: bathymetry and sediment deposition

Using sediment probing techniques, field crews determined soft sediment depths at pre-determined sampling locations along an evenly-spaced grid (100 m × 100 m) with calibrated sampling poles. At each sampling location, the depth of the sediment surface and the depth of compacted sediment were recorded; the difference between these two depths was calculated as the thickness of soft sediment accumulation. Depths were measured to the nearest ¼ of a foot. Real-time GPS locations of sampling station coordinates were collected for mapping analysis. In total, 255 soft sediment depth measurements were taken for Silver Lake. Using ArcGIS 10.2, geospatially-referenced sediment depths were mapped. Point soft sediment data were combined with the lake edge, where sediment depth was set to zero. These data were interpolated at a 5 x 5-meter grid for each lake using the Empirical Bayesian Kriging tool within the Geospatial Analysis Wizard.

Water quality monitoring

To account for spatial variability in water quality, three sampling stations were established in Silver Lake. One primary lake sampling station (S001) was located at the historic deepest sampling point in the lake, one secondary lake sampling station was located close to the inflow of the northeastern inflow (S002), and one secondary lake sampling station was located close to the western inflow (S003) (Figure 9). Mixed zone water samples were collected at all lake sampling stations using a 0-2 m integrated water column sampler. At the primary sampling station in each lake, discrete depth samples were collected from the surface (0.5 m depth) to the lake bottom at regular intervals.

Water samples were collected monthly to semi-monthly from April 2014 through January 2016 from all lake sampling stations. Sampling frequency varied by season, with samples being collected less frequently during winter and more frequently during the summer. The lake was sampled during winter to characterize how water quality conditions reset after the summer growing season and how variability in under-ice conditions influences water quality conditions during the summer. The sampling event in February 2015 characterized baseline conditions for sampling during summer 2015, while the sampling event in January 2016 characterized baseline conditions after that season. Overall, the lake and its watershed were sampled 24 times during this project. Water samples were analyzed for physical, chemical, and biological variables important in determining water quality (Table 7). Detailed descriptions of measured variables and their importance in water quality monitoring can be found in Appendix B.

Additionally, two hourly series of samples (i.e., extra sample sets collected on each of two sampling events) were collected from the primary sampling location of each lake (S001) during days in which wind patterns changed from calm winds in the morning to gusty winds in the afternoon. The purpose of these diurnal sampling events was to determine if wind-generated wave mixing contributed to increased nutrient and sediment concentrations in the water column (i.e., internal nutrient and sediment loading). Internal loading rates were calculated using estimates of inputs, outputs, and changes in storage within the lakes.

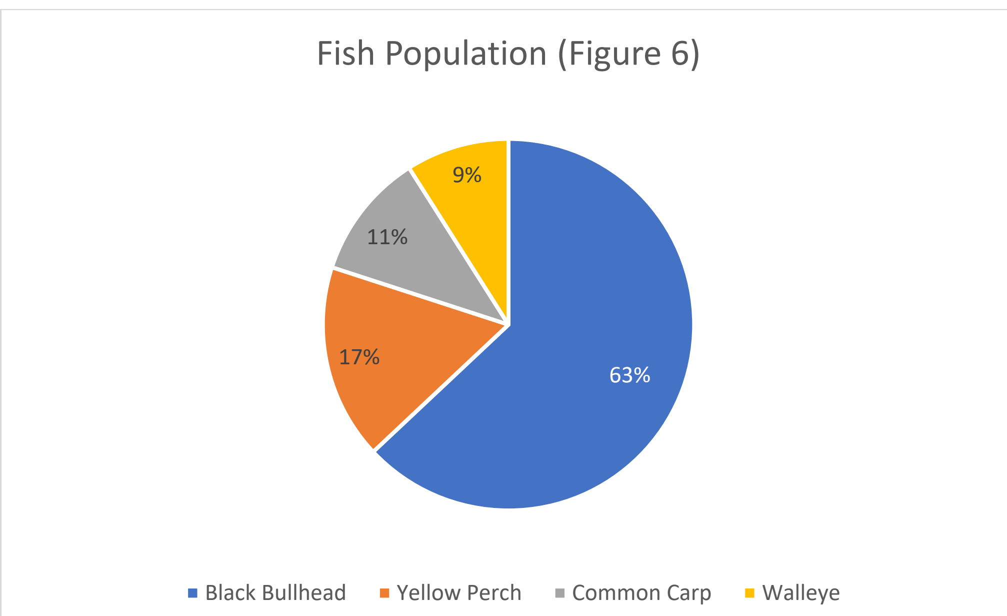
Watershed Assessment

Stream water quality monitoring

A network of stream monitoring stations was established in the watershed to calculate nutrient budgets for the lakes and to localize nutrient and sediment sources within the watersheds (Figure 9). Water samples were collected at 7 tributary monitoring stations and the outflow of Silver Lake. Water samples were collected monthly to semi-monthly from April 2014 through January 2016, with samples being collected less frequently during winter and more frequently during the summer. Water samples were analyzed for physical, chemical, and biological variables important in determining water quality.

Fisheries Overview

Silver Lake has had a decent sport fishery since 1916, although fishing had been poor for several years preceding the 1916 State Highway Commission Report on Iowa lakes and lake Beds (State Highway Commission 1916). The report indicated that" ... no reason appears why it should not once more become as good as in any of the smaller lakes." Today, popular sport fish in the lake include walleye, northern pike, yellow perch, and black bullhead. The fishery is not very diverse, with black bullhead dominating the fishery at 63%, followed by yellow perch (17%), common carp (11 %), and walleye (9%) (Figure 6)



To reduce the common carp population, Silver Lake has had a commercial harvest program for common carp since 1990, with buffalo being added to the program in 2001. The commercial harvest of common carp peaked in 1994 with approximately 85,000 pounds of carp being removed from the lake. The commercial harvest of common carp has varied widely through time, and< 20,000 lbs. of carp have been harvested each year from 2013 - 2015.

Because of poor water quality, fish stocking efforts at the lake have also been less robust than other lakes in the area like Five Island and Lost Island.

Appendix B

BMP Descriptions and Definitions

Row Crop

Description – Incorporation of additional conservation practices in lands supporting row crop production will improve soil health and water quality. Many nonstructural management practices reduce soil erosion and increase infiltration, which reduces sediment and phosphorus transported to the lake. Structural conservation practices provide the next level of protection that intercept and trap/ treat pollutant loads during transport. In the poorly drained landscape surrounding Five Island Lake, subsurface tile drainage has been used extensively to improve row crop production. This feature alters water and nutrient transport and must be considered when selecting and locating conservation practices.

Ability to Assist in Achieving Goals – Because cropland comprises most of the drainage area to the lake, and hence the largest source of phosphorus from the watershed, implementation of agricultural conservation practices provides significant opportunities to reduce phosphorus losses to Silver lake. Non-structural management practices that are most applicable to the Five Island Lake watershed include (but are not limited to):

- Conservation tillage and no-till farming
- Cover crops
- Extended crop rotations (to include small grains and/or hay)
- Fertilizer and manure management
- Increased perennial vegetation using the Conservation Reserve Program (CRP) or Wetland Reserve Program (WRP)

Structural conservation practices can be implemented by private landowners on fields and waterways on their property. The watershed for Five Island Lake is dominated by gentle sloped terrain with many low-lying depressions and a subsurface tile drainage. Consequently, commonly-used structures such as terraces and farm ponds are not suitable in much of the watershed. Practices that focus on filtration and nutrient uptake are more appropriate for this watershed include:

- Grassed waterways
- Riparian buffer strips (traditional and saturated buffers)
- Restoration of pothole wetlands
- Iron-enhanced sand filters

Qualitative Description of Cost – The cost of implementing non-structural conservation practices varies widely depending by practice type and position in the landscape. There are a wide range of Federal programs available largely through USDA-NRCS that provide cost-share for conservation practices, but the implementation is voluntary through landowner participation. Applications to the NRCS Environmental Quality Incentives Program (EQIP) that are located within the drainage area to Five Island Lake will be given priority points when applications are evaluated. The iron-enhanced sand filter is not an approved practice for cost sharing and is not a traditional practice commonly applied in the watershed. Implementation of this alternative would require additional education and design assistance, which could be a task for a watershed coordinator. A watershed coordinator would also assist USDA-NRCS employees with landowner/operator outreach and education. This focused attention on the drainage area to Five Island Lake should increase the rate of adoption and implementation of voluntary conservation practices.

Livestock Management Practices

Description – While all registered concentrated animal feeding operations (CAFOs) are required to have proper storage facilities, smaller animal feeding operations and grazing operations are unregulated. Smaller operations should develop a Comprehensive Nutrient Management Plan (CNMP) with the NRCS to ensure efficient manure management and prevention of nutrient losses to waterways. Common practices include Waste Storage Facilities (WSF), grazing management (i.e., rotational grazing), and exclusion of livestock from streams (via alternate water sources and fencing).

Ability to Assist in Achieving Goals – Permitted feeding operations in the watershed were mapped, all of which should have the proper runoff controls in place. Based on investigation of aerial photographs, there does not appear to be many unregulated AFOs in the watershed; however, outreach and education may still be helpful to minimize or eliminate any instance where flow is discharged from a feeding operation without treatment. This effort would be significantly aided by the availability of a watershed coordinator.

Qualitative Description of Cost – Similar to the land management practices, the cost varies widely depending on what practice measures are made. Implementation is voluntary by individual landowners in the watershed but is encouraged and assisted (technically and financially) by USDA-NRCS. A designated watershed coordinator would help identify opportunities and coordinate these practices.

Urban Land Practices

Description – There are a different set of practices that are suitable for urban area, but like cropland practices, there are non-structural and structural opportunities. Non-structural practices or ordinances can be implemented to reduce the amount of nutrients introduced into the runoff. Structural practices provide the next level of protection that trap and/or treat pollutant loads that are generated from urban land uses and transported with overland runoff.

Ability to Assist in Achieving Goals – Since urban area is a small portion of the land use in the watershed, it is not a major contributor of phosphorus to the lake. However, the phosphorus loading rate (pounds per acre) is high, so efforts to reduce the amount of nutrients generated from urban land have some water quality benefit. Further, cooperation and adoption by urban landowners often increases participation by rural residents and farmers. Non-structural management practices that are most applicable to urban areas in the Silver Lake watershed include (but are not limited to):

- Use of no-phosphorus fertilizer
- Pet waste management
- Soil quality restoration

Structural conservation practices can be implemented by private landowners to treat runoff from individual properties. Structural practices that focus on filtration and nutrient uptake that would be highly suitable for this watershed include:

- Rain Gardens
- Bioswales

Qualitative Description of Cost – Costs will vary dependent upon the practice. Stormwater ordinances may cost little to implement, with only minor costs required for public outreach and education. Iowa's Resource Enhancement and Protection (REAP) will provide cost-share for some urban practices. A watershed coordinator would help identify opportunities, coordinate activities, and educate the public on the benefits of urban practices.

Septic System Repairs

Description – Faulty onsite wastewater treatment systems (septic tank and leaching systems) can develop leaks or untreated discharges that contribute pollutants to surface and groundwater. Not only nutrients, but also bacteria that can lead to health concerns. Failing septic systems should be identified and repaired.

Ability to Assist in Achieving Goals – There is limited information on the number of septic systems that are failing, but any system should have routine inspections to ensure proper function. Since the current level of function/failure is unknown, it is difficult to estimate the pollutant load from septic, as well and the load reductions that would be achieved. The relatively small number of systems would not generate a large flux of phosphorus compared to other sources but would provide overall lake/health benefits. Any site located directly on the lake with an older system is likely to have the biggest impact on the lake from any leaks; these systems should be inspected and repaired as needed.

Qualitative Description of Cost – Dependent upon the problem, repairs to or complete replacement of septic systems can be high for individual property owners. A specific grant opportunity through the Palo Alto Gaming Development Corporation Grant (Casino Grant) that should undoubted be taken advantage of by landowners in the watershed.

Construction Ordinances

Description – Controlling sediment and erosion on construction sites is important to prevent transport of the sediment and associated pollutants to local waterbodies. Common methods for sediment control includes silt fence, erosion control blankets, detention ponds, rock entrances at access points, and haybales or coir rolls as checks along drainage paths within a construction site.

Ability to Assist in Achieving Goals – Any construction directly along the lakefront should have very strict controls to prevent immediate delivery of sediment to the lake. Any development or construction activity should abide by a set of established rules to help protect Silver Lake. Potential methods to implement and enforce runoff from construction sites should be investigated in more detail, which may be another potential activity for a watershed coordinator.

Qualitative Description of Cost – Costs associated with this alternative include implementation and enforcement by the responsible entity and relatively minor increased costs to the party responsible for the construction activity.

Near-Lake Management Practices

Near-lake alternatives, which are capable of treating large drainage areas, provide good opportunities for significant load reductions at improved economies of scale. These features are sometimes installed on private land with potential cost-share dollars but could be implemented several alternatives upon acquiring the necessary land rights. Examples of some near-lake strategies include:

- Constructed/CREP wetlands
- Detention basins or
- Sediment forebays

Constructed/CREP Wetlands

Description – Wetlands can provide uptake of dissolved phosphorus via the growth of aquatic vegetation and adsorption to wetland soils. Secondary benefits include aquatic habitat and a more diverse ecosystem around the lake. Wetlands initially have relatively high phosphorus removal rates; however, over time phosphorus-binding decreases as the wetland soils “fill up” with phosphorus. Additionally, phosphorus taken up by plants is released when the plants die and decay. Research suggests the phosphorus removal efficiency in unmanaged wetlands begins to decrease after 5-10 years. During periods of vegetation die-off, nutrients can be released, making the wetland a temporary source of phosphorus to the lake. Ideally, this die-off would occur only after the recreation season has ended, therefore impacts to algal growth and recreational uses should be minimal. With proper management, which may require occasional harvest and removal of wetland vegetation, nutrient uptake can be enhanced and sustained over time.

Ability to Assist in Achieving Goals – Constructing large wetlands at major inlets to the lake could provide substantial phosphorus load reduction. A wetland design that provided treatment of tile drain outlets would have the greatest potential water quality benefits.

Qualitative Description of Cost – Costs associated with constructing wetlands are primarily earthwork and water level control structures. If this is pursued and land rights need to be acquired, that would also be a factor in the cost. If implemented through the Iowa Conservation Reserve Enhancement Program (CREP) and IDALs or the local conservation district, financial incentives are provided to private landowners. Constructed wetlands are also eligible for EQIP funding through USDA-NRCS. Grant opportunities through REAP, IDALs and/or the Casino Grant should be investigated.

Detention Basins or Sediment Forebays

Description – Detention basins are earth embankment structures installed on tributaries to impound water and help improve water quality by trapping sediment and sediment-attached phosphorus. A sediment forebay is a similar alternative to the detention basin that traps/treats the watershed load, however if there are space/land rights limitations in the uplands, a sediment forebay can be implemented in the lake at a concentrated location of stormwater discharge.

Ability to Assist in Achieving Goals – The design of a detention structure includes impounding a tributary and artificially raising the water level. This is not conducive to intercepting tiling drain outlets that discharge immediately at the lake., however any tile drains that are outlet into overland drainage paths throughout the watershed would be treated. The feasibility of a detention basin at each near-lake outlet should be investigated to ensure that available space and topography allow for proper design, and care would have to be taken to place detention basins at locations where elevated water levels do not inundate tile drainage outlets and prevent proper drainage from the fields they are draining

Qualitative Description of Cost – The primary cost of detention basins is for earthwork, outlet control structures, and land rights. Sediment forebays are generally constructed with rock, which can be expensive and often limits the size (and trapping efficiency) of the structure. EQIP funds will provide cost-share for private land owners that install detention basin/farm ponds. If a constructed wetland is pursued, grant opportunities through REAP, IDALs and/or the Casino Grant should be investigated.

In-Lake Management Practices

- Rough Fish Management
- Wetland Creation
- Shallow Vegetation/Lake Level Management
- Phosphorus Inactivation
- Boating Restrictions
- Dredging

Rough Fish Management

Description – Fish that have bottom feeding habits that disturb lakebed sediments and create turbid conditions are often referred to as 'rough fish'. The most commons species encountered in the Midwest are common carp and bigmouth buffalo. Controlling the rough fish species reduces the amount of sediment resuspension and release of phosphorus that contributes to internal loading. Reduction of the rough fish population would also facilitate establishment of desirable, shallow aquatic vegetation.

Ability to Assist in Achieving Goals – If the biomass density at Silver Lake Lake could be reduced to 50-100 lbs/acres, significant water quality benefits would be achieved though reduced lakebed resuspension/internal loading, and improvements to the aquatic habitat and fishery would be experienced. There are several approaches to managing the rough fish described below that together could bring down the population. These include fish removal, reducing access to spawning habitat (via hard barriers or lake level drawdown), fish passage barriers, and public education.

Fish Removal

Commercial harvests of rough fish at Silver Lake are reported to DNR, but available data has limited utility for estimating the population and understanding recruitment trends. The results of the study by Iowa State will be available in the fall and will be used to evaluate the feasibility of options to meet rough fish population goals.

If commercial harvesting cannot meet goals, chemical applications such as Rotenone or physical removal of the fish may be necessary. Both options would be made easier and more affordable by concentrating fish within smaller areas of the lake. This would be facilitated by the implementation of a fish passage barrier in the northern portion of the lake and/or a lake level management (i.e., drawdown) system.

Reduce Spawning Habitat

Rough fish typically spawn in shallow waters, and removing access of undesirable species to shallow areas of Five Island Lake will help reduce recruitment. A permanent or temporary fish barrier can be placed in the lake to prevent access to the shallow waters on the north end from the remainder of the lake. Installing this barrier would be facilitated by a lower lake level during construction. Additionally, lowering the lake level may limit rough fish access to some spawning areas without the need for additional barriers.

Rough Fish Public Education

Because there are no upstream impoundments in the watershed, rough fish are likely entering the system through one of two avenues; they are passing through the downstream channel and jumping over the outlet weir or they are being brought in by fishermen through live bait or in fishing wells in boats and get released into the lake.

Fish passage through the outlet structure is identified within this Plan and a renewed effort with the public on education related to keeping invasive and undesired species of fish, aquatic vegetation and other organisms such as mussels, etc. should accompany the implementable portions of the Plan. Iowa DNR has a wealth of available information and education tools to assist the community in getting the word out.

Qualitative Description of Cost – The rough fish management approach will depend upon the results of the results of the Iowa State study, which will dictate the costs. The fish passage barrier screen costs are estimated at only $4,000, and the major costs associated with this alternative will be function of the fish removal method selected.

Shallow Vegetation/Lake Level Management

Description – Like wetlands discussed above, increasing aquatic vegetation in a lake provides numerous benefits to a waterbody. The management of shallow vegetation in the lake would be enhanced by the ability to vary the water level in the lake during a growing season approximately 2-4 ft to help establish vegetation in the shallow areas primarily around the perimeter of the lake. This is most commonly achieved by making modifications to the outlet control structures to allow for water level control.

Ability to Assist in Achieving Goals – At Silver Lake, the ability to temporarily lower lake levels would not only help establish shallow vegetation around the perimeter of the lake, but it would also greatly assist in establishing aquatic vegetation in the western bay.

Whole-Lake Phosphorus Inactivation

Description – Phosphorus inactivation across the entire lake involves use of a chemical agent to bind with phosphorus in the water column and the lake bed sediments. The most common compound that is used for this treatment is aluminum sulfate (alum). Alum is applied just below the water surface of a waterbody with a barge. As it sinks, it will bind to phosphorus, form a floc, and strip it from the water column as the floc settles to the lake bottom creates a thin, unnoticeable layer. To control internal loading, dose of alum should allow for available binding sites in the floc after stripping phosphorus from the water column and settling to the bottom. The floc will provide reductions in the internal load by binding with any phosphorus released from sediments during anoxic conditions.

Ability to Assist in Achieving Goals – Whole lake treatments provide immediate stripping of water column phosphorus (and other constituents) and can be very effective in reducing lake phosphorus concentrations and increasing clarity to meet water quality goals. The longevity of water quality improvement is a function of proper dosing rate, timing of application, and other factors that increase phosphorus levels to pre-treatment levels (watershed load, organic matter decay, etc).

Qualitative Description of Cost – The cost of whole lake phosphorus inactivation is dependent upon type and amount of the chemical agent used. Typically, it is most efficient and effective to apply an amount that can strip the quantity of phosphorus in the water column while also addressing the potential release of phosphorus from the sediment layer. The required dose it typically based on the amount of potentially available phosphorus in the sediment or estimated phosphorus release rates over some designated time frame. For planning purposes, dosing costs in this study assumed that alum would be dosed in a quantity sufficient to capture potentially available phosphorus, which is equivalent to a 4-year release rate (estimated from sediment core analysis and mass balance modeling). The proposed dosing rate (and cost) should be refined based on more detailed investigation/study before implementation of this alternative.

Dredging

Description – Removal of lakebed material by dredging is often performed to increase lake depths and volume. Increasing lake depths in shallow areas can help reduce the amount of wave-induced resuspension. Increases in volume can help dilute pollutants and change the lake's response to loading, however this requires very large removal volumes to achieve noticeable water quality improvement.

Ability to Assist in Achieving Goals – Dredging has long been a hot topic around Silver Lake. Dredging could increase volume and reduced the area of lakebed susceptible to resuspension. This alternative was assessed during the 2016 DFS study and was found to be of minimal water quality benefit. Another approach to consider is localized dredging to target shallow areas in the high-use boating areas on the south and north shores of the lake.

Qualitative Description of Cost – The unit cost of dredging is dependent on method (mechanical vs. hydraulic) and directly related to the volume of material dredged and the proximity of the location to spoil the material. Mechanical dredging could be an option and has been done on other area lake such as Virgin and Trumbull and a new DNR project is starting at Elk Lake. This would probably be met with public pushback because of the houses present on the lake. Hydraulic dredging is also an option. Standard hydraulic dredging rates often range from $6-$20 per cubic yard making an expensive option with minimal water quality benefits.

Appendix C

Total Maximum Daily Load for Alge and Turbidity

Silver Lake Palo Alto County, Iowa