2018

Spectacle Lake
Stormwater Retrofit Analysis

Prepared by:

Isanti Soil and Water Conservation District

Executive Summary

Spectacle is located within Wyanett Township of Isanti County, Minnesota. This study provides recommendations for cost effectively improving treatment of storm water from areas draining directly to Spectacle Lake and areas in the surrounding rural area. This report provides sufficient detail to identify projects, rank projects by cost effectiveness at removing phosphorus and begin project planning. It includes project concepts and relative cost estimates for project selection. Site specific planning, designs and refined cost estimates should be done after committed partnerships for project installation are in place.

Spectacle Lake, although only 246 acres, is one of Isanti County's most sought-after lakes for recreation such as boating, swimming and fishing. The land area draining to the lake (watershed) is very small, only 790 acres. The majority of the shore around Spectacle Lake is developed with residential homes both seasonal and year-round. Just under one-third of the 790 acre watershed consists of cultivated cropland; however, the majority is situated upland and does not drain directly to the lake.

To better understand lake water quality trends, volunteers from the lake association annually monitor total phosphorus, chlorophyll and water clarity. Water quality of Spectacle Lake is exceptional, meeting state water quality goals for transparency, total suspended solids and total phosphorus. To continue the trend of being one of the healthiest lakes in Isanti County, the lake association has taken a proactive role in partnering with Isanti SWCD to plan and implement water quality improvement projects.

This storm water analysis focuses on "storm water retrofitting" and ranking projects based on cost effectiveness for reducing nutrients flowing into the lake. Storm water retrofitting refers to adding storm water treatment to an already built-up area, where little open land exists. This process is investigative and creative. Storm water retrofitting success is sometimes improperly judged by the number of projects installed or by comparing costs alone. Those approaches neglect to consider how much pollution is removed per dollar spent. In this storm water analysis we estimated both costs and pollutant reductions and used them to calculate cost effectiveness of each possible project.

The watershed area was delineated using available digital mapping information. The watershed area was divided into small catchments to help with prioritizing areas and modeling. For each catchment, modeling of storm water runoff volume and pollutants was completed using the software WinSLAMM. Current and existing conditions were modeled, including existing storm water treatment practices.

Potential storm water retrofits identified during this analysis were then modeled to estimate reductions in total phosphorus, and total suspended solids. Finally, cost estimates were developed for each retrofit project, including 30 years of operations and maintenance. Projects were ranked by cost effectiveness with respect to their reduction of total phosphorus.

A variety of storm water retrofit approaches were identified. They included:

- Residential curb-cut rain gardens,
- Trench grate filtration,
- Purchasing property for protection,
- Vegetative swales
- Shoreline buffers
- Cover Crops
- No-till farming

If all these practices were installed, significant pollution reduction could be accomplished. However, funding limitations and landowner interest makes this goal unlikely. Instead, it is recommended that projects be installed in order of cost effectiveness (pounds of pollution reduced per dollar spent). Other factors, including a project's educational value/visibility, construction timing, total cost, or non-target pollutant reduction also affect project installation decisions and will need to be weighed by resource managers when selecting projects to pursue.

The intent is to provide an understanding of the approach. If a project is selected, site-specific designs must be prepared. This typically occurs after committed partnerships are formed to install the project. Committed partnerships must include willing landowners when installed on private property.

About this Document:

This Stormwater Retrofit Analysis is a watershed management tool to help prioritize stormwater retrofit projects by performance and cost effectiveness. This process helps maximize the value of each dollar spent.

This document presents the findings of Spectacle Lake's watershed study.

Urban/Residential Catchments:
This section covers land adjacent to and directly draining to the lake. These areas are largely medium density residential. Field investigation along with computer analysis were completed to identify areas near the lake that had the highest potential of contributing sediment and nutrients to Spectacle Lake. Project areas were identified, and computer modeling was completed to understand the effectiveness of specific water quality projects.

Shoreline Analysis:
This section covers the entire shoreline surrounding Spectacle Lake. A boat survey along with computer analysis were completed to identify areas of the shoreline that had the highest potential of contributing sediment and nutrients. Project areas were identified, and computer modeling was completed to understand the effectiveness of specific water quality projects.

Rural Catchments:
This section covers the land not adjacent to or directly draining to the lake. The Natural Resources Conservation Service (NRCS) Engineering Tool was used to highlight the areas with the highest potential for contributing sediment and nutrients to Spectacle lake. Project areas were identified, and computer modeling was completed to understand the effectiveness of specific water quality projects.

Retrofit Ranking:

This section ranks stormwater retrofit projects across all selected catchments to create a prioritized project list. The list is sorted by cost per pound of total phosphorus removed for each project. The final cost per pound treatment value includes installation and maintenance costs.

There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point. Other considerations for prioritizing installation may include:

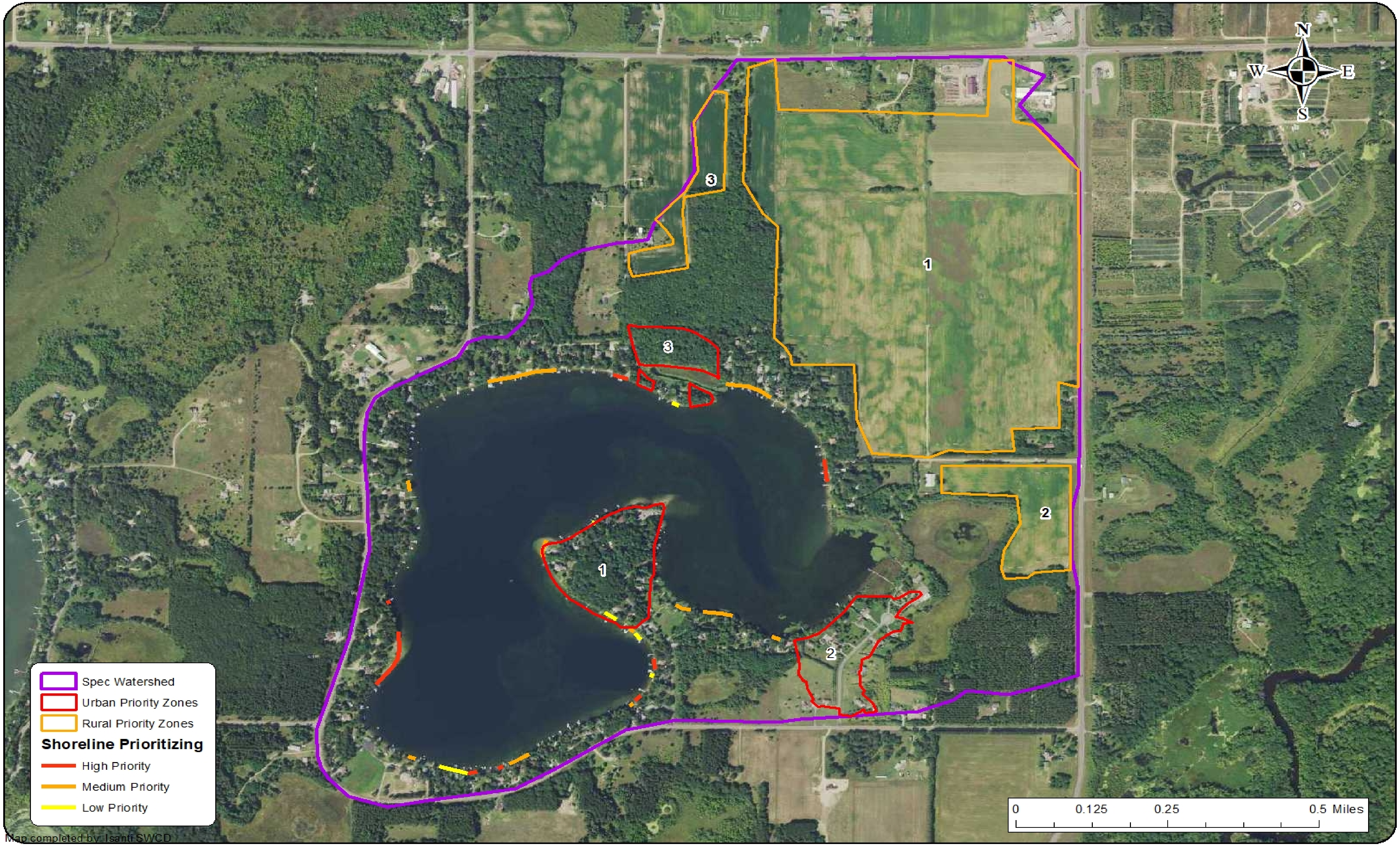
- Non-target pollutant reductions
- Timing projects to occur with other road or utility work
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Landowner willingness

Evaluation and Ranking

The cost per pound of phosphorus treated was calculated for potential retrofit projects, and projects were ranked by this cost effectiveness measure. Local officials may wish to revise the recommended project list based on water quality goals, finances, public opinion and feasibility.

Summary of all stormwater retrofit opportunities ranked by cost-effectiveness with respect to total phosphorus (TP) reduction. (All Projects Possibilities)

Project Rank	Subwatershed ID	Retrofit Type (refer to catchment profile pages for additional detail)	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2014 Dollars)	Estimated cost/ 1,000lb-TSS (30-year)	Estimated cost/ lb-TP (30-year)	Notes/Description
1	Zone 1 - rural	Cover Crop - zone 1	2.6	2,960	$9,474	NA	$107	$121	
2	Zone 1 - rural	No-Till and Cover Crop - zone 1	15.1	16,280	$159,474	NA	$327	$353	
3	Zone 1 - rural	No-Till Farming zone 1	12.5	13,660	$150,560	$151,752	$370	$405	
4	Lakeshore	High Priority 400 ft	3.6	1,976	$27,360	$900	$917	$498	
5	Lakeshore	High Priority 1,000 ft	8.5	4,940	$62,560	$2,250	$887	$513	
6	Lakeshore	High Priority 600 ft	5.1	2,964	$38,850	$1,350	$892	$552	
7	1	Rain Garden 3 - 600 sqft	1.5	555	$17,764	$225	$1,471	$556	Overflow is expected with rains events greater than 2.0"
8	1	Rain Garden 3 - 450 sqft	1.3	515	$15,664	$225	$1,451	$558	Overflow is expected with rains events greater than 1.5"
9	1	Rain Garden 3 - 750 sqft	1.5	565	$19,864	$225	$1,569	$594	
10	Lakeshore	High Priority 100 ft	0.9	494	$8,665	$225	$1,040	$597	
11	Lakeshore	High Priority 1,400 ft	9.1	5,460	$86,270	$3,150	$1,104	$662	
12	1	Trench Grate - Boat Landing	1.7	628	$21,480	$500	$1,936	$720	The current lakeshore buffer will need to be utilized for this project to be successful
13	2	Residential Rain Garden Series - 300 sq ft	3.8	1,609	$66,452	$700	$1,811	$769	Less raingardens can be installed if sq ft is increased
14	Zone 2 - rural	Cover Crop - zone 2	0.03	320	$6,912	NA	$720	$853	
15	2	Residential Rain Garden Series - 450 sq ft	3.8	1,614	$81,152	$700	$2,110	$896	
16	2	Residential Rain Garden Series - 650 sq ft	3.8	1,614	$100,757	$700	$2,251	$1,068	
17	Zone 3 - rural	Cover Crop - zone 3	0.1	140	$4,749	NA	$1,131	$1,319	
18	1	Rain Garden 2 - 300 sqft	0.4	159	$11,120	$225	$3,744	$1,435	
19	1	Rain Garden 2 - 400 sqft	0.4	168	$12,520	$225	$3,818	$1,450	
20	1	Rain Garden 2 - 200 sqft	0.4	142	$9,720	$225	$3,875	$1,484	
21	3	Land Protection - 8.2 acres	7.2	2582	$642,920	na	$8,300	$2,976	
22	Zone 2 - rural	No-Till and Cover Crop - zone 2	1.6	1,820	$156,912	NA	$2,874	$3,331	
23	Zone 2 - rural	No-Till Farming zone 2	1.3	1,500	$151,752	NA	$3,372	$3,952	
24	1	Rain Garden 1 - 100 sqft	0.1	36	$5,186	$225	$11,132	$4,144	
25	1	Swale and Grate - Beach Area	0.1	51	$8,809	$225	$10,155	$4,987	This project will only be successful if projects are installed up in the watershed
26	1	Rain Garden 1 - 150 sqft	0.1	37	$9,020	$225	$14,292	$5,310	
27	Zone 3 - rural	No-Till and Cover Crop - zone 3	0.7	780	$154,749	NA	$6,613	$7,066	
28	Zone 3 - rural	No-Till Farming zone 3	0.6	640	$151,752	NA	$7,904	$8,574	


N
W
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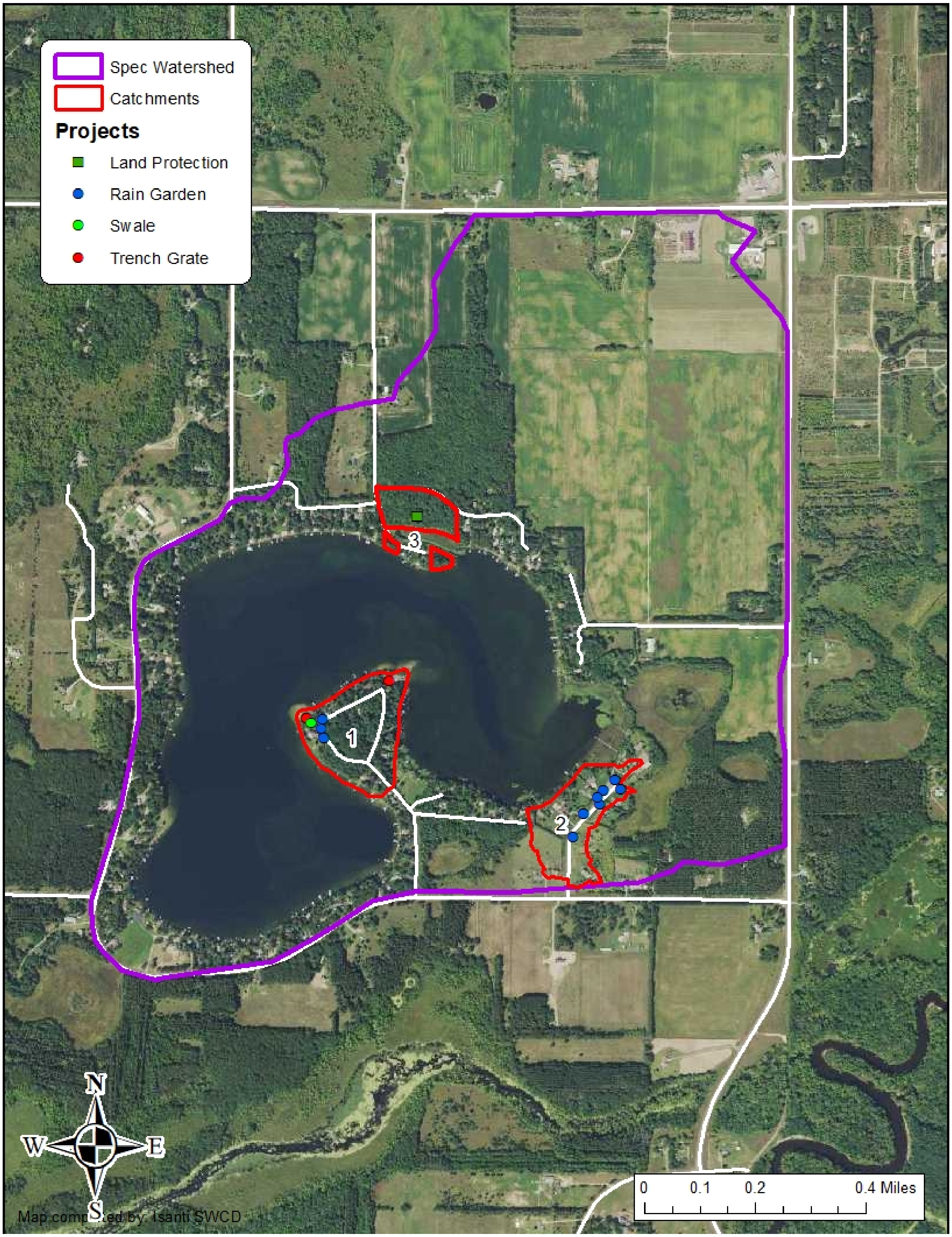
3
3
1
1
2
2
Spec Watershed
Urban Priority Zones
Rural Priority Zones
Shoreline Prioritizing
High Priority
Medium Priority
Low Priority
0
0.125
0.25
0.5 Miles
Map completed by: Isanti SWCD

Priority Catchments - Nearshore



Priority Catchment 1

Existing Catchment Summary	
Acres	19
Dominant Land Cover	Medium Density Residential

Catchment Description

Catchment 1 consists of medium density residential and forested land use type within the 50 parcel, 19 acre area. The priority areas where water quality projects are assumed most beneficial are located at the boat access, swimming beach, and the east corner of Cobalt Cir NW. Based on computer analysis and field data, an estimated 2.1 acres of stormwater discharges into the lake from the public beach area and 1.8 acres of stormwater discharges into the lake from the boat access.

Currently, there is a small vegetative area located at the outlet of the beach. The vegetation is not successful in treating the 2.1 acre subwatershed draining to the area. (table 1).

The boat access also has a large vegetative buffer along the north shoreline. This area can be utilized if stormwater can be directed to the area.

	Beach Shore Vegetation		
	Existing Conditions	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMPs*	35	ft
	TP (lb/yr)	0.050	3.0%
	TSS (lb/yr)	59	9.6%

Table 1

Existing Catchment Summary	
Acres	0.1
Dominant Land Cover	Residential
Parcels	2
TP (lb/yr)	0.1
TSS (lb/yr)	37

Location- 33551 Cobalt Cir NW

Property Ownership - Private. Landowner cooperation needed for project to proceed.

Description - This project ranked 25 for cost effectiveness at removing phosphorus among all projects identified in this assessment. The proposed project is a raingarden installed in a residential yard. The raingarden would collect and infiltrate stormwater runoff from the Cobalt Cr. NW and surrounding landscape. The garden is designed to hold water for no more than 48 hours after a storm event, but the ponding time is often much shorter in areas with sandy soils.

We've analyzed scenarios where one or two raingardens are installed: 100 sqft and 150 sqft. The results indicate that it would be most cost effective to install a 100 sqft raingarden.

Cost Analysis:

Rain Gardens					
	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	1		1	
	Total Size of BMPs	100	sq-ft	150	sq-ft
	TP (lb/yr)	0.1	95.9%	0.1	98.9%
	TSS (lb/yr)	36	96.3%	37	99.1%
Cost	Administration & Promotion Costs*	$2,920		$2,920	
	Design & Construction Costs**	2,266		6,100	
	Total Estimated Project Cost	**$5,186**		**$9,020**	
	Annual O&M***	$225		$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$4,144**		**$5,310**	
	30-yr Average Cost/1,000lb-TSS	**$11,132**		**$14,292**	

Existing Catchment Summary	
Acres	0.4
Dominant Land Cover	Residential
Parcels	4
TP (lb/yr)	0.5
TSS (lb/yr)	180

Location- 33510 Cobalt Cir NW

Property Ownership - Private. Landowner cooperation needed for project to proceed.

Description - This project ranked 18 for cost effectiveness at removing phosphorus among all projects identified in this assessment. The proposed project is a raingarden installed in a residential yard. The raingarden would collect and infiltrate stormwater runoff from the Cobalt Cr. NW and surrounding landscape. The garden is designed to hold water for no more than 48 hours after a storm, but the ponding time is often much shorter in areas with sandy soils.

We've analyzed scenarios where one to three raingardens are installed: 200 sqft , 300 sqft and 400sqft. The results indicate that it would be most cost effective to install a 300 sqft raingarden.

Cost Analysis:

Rain Gardens							
	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	1		1		1	
	Total Size of BMPs	200	sq-ft	300	sq-ft	400	sq-ft
	TP (lb/yr)	0.4	77.1%	0.4	86.5%	0.4	92.3%
	TSS (lb/yr)	142	78.9%	159	88.6%	168	93.7%
Cost	Administration & Promotion Costs*	$2,920		$2,920		$2,920	
	Design & Construction Costs**	6,800		8,200		9,600	
	Total Estimated Project Cost	**$9,720**		**$11,120**		**$12,520**	
	Annual O&M***	$225		$225		$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$1,484**		**$1,435**		**$1,450**	
	30-yr Average Cost/1,000lb-TSS	**$3,875**		**$3,744**		**$3,818**	

Existing Catchment Summary	
Acres	2.0
Dominant Land Cover	Residential, Open Space
Parcels	9
TP (lb/yr)	1.5
TSS (lb/yr)	576

Location- 33505 Cobalt Cir NW

Property Ownership - Private. Landowner cooperation needed for project to proceed.

Description - This project ranked 7 for cost effectiveness at removing phosphorus among all projects identified in this assessment. The proposed project is a raingarden installed in a residential yard. The raingarden would collect and infiltrate stormwater from the Cobalt Cr. NW and surrounding landscape. The garden is designed to hold water for no more than 48 hours after a storm, but the ponding time is often much shorter in areas with sandy soils.

We've analyzed scenarios where one to three raingardens are installed; 450 sqft , 600 sqft and 750sqft. The results indicate that it would be most cost effective to install a 600 sqft raingarden. Note that computer modeling results indicated water overflow would occur during heavy rain events of 1.45 inches for both the 450 and 600 sq-ft raingarden. Adding a grass swale to the outlet of the rain gardens could improve the treatment during water overflow events.

Cost Analysis:

	Rain Gardens						
	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	1		1		1	
	Total Size of BMPs	450	sq-ft	600	sq-ft	750	sq-ft
	TP (lb/yr)	1.3	87.6%	1.5	96.0%	1.5	97.6%
	TSS (lb/yr)	515	89.3%	555	96.3%	565	98.0%
Cost	Administration & Promotion Costs*	$3,364		$3,364		$3,364	
	Design & Construction Costs**	12,300		14,400		16,500	
	Total Estimated Project Cost	**$15,664**		**$17,764**		**$19,864**	
	Annual O&M***	$225		$225		$225	
Efficiency	**30-yr Average Cost/lb-TP**	**$558**		**$556**		**$594**	
	30-yr Average Cost/1,000lb-TSS	**$1,451**		**$1,471**		**$1,569**	

Existing Catchment Summary	
Acres	0.2
Dominant Land Cover	Residential, Open Space
Parcels	1
TP (lb/yr)	0.1
TSS (lb/yr)	54

Location- North West corner of Colbalt St NW

Property Ownership – Township of Wyanett.

Description - This project ranked 24 for cost effectiveness at removing phosphorus among all projects identified in this assessment. The proposed project would collect runoff from the public beach access on Cobalt Circle NW and the parking area. Stormwater projects would also need to be installed farther up in the watershed for this project to be effective (Raingardens 1, 2 or 3 described above). This practice would not be successful in treating the 2.1 acre watershed draining to the area.

Limited space at the beach area as well as the distance to ground water makes installing water quality projects difficult in this area. Currently, an 875 sq-ft vegetated buffer near the shore filters nearly 2.1 acres of storm water. The current buffer is not effective; however, if water quality projects are installed farther up in the watershed, the buffer along with the proposed swale and trench grate could be an effective option in treating stormwater runoff.

Cost Analysis:

	Swale and Trench Grate		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Number of BMPs	1	
	Total Size of BMPs*	1,700	Sqft
	TP (lb/yr)	0.1	94.5%
	TSS (lb/yr)	51	94.9%
Cost	Administration, Promotion & Design Costs	$2,409	
	Construction Costs**	$6,400	
	Total Estimated Project Cost	**$8,809**	
	Annual O&M***	$225	
Efficien	**30-yr Average Cost/lb-TP**	**$4,987**	
	30-yr Average Cost/1,000lb-TSS	**$10,155**	

Existing Catchment Summary	
Acres	1.8
Dominant Land Cover	Residential
Parcels	18
TP (lb/yr)	1.8
TSS (lb/yr)	642

Location- North East corner of Colbalt St NW

Property Ownership – State of Minnesota.

Description - This project ranked 12 for cost effectiveness at removing phosphorus among all projects identified in this assessment. The proposed project would collect stormwater runoff into a trench grate then divert the water into the existing vegetated shoreline. The 15,000 sq-ft buffer is primary composed of woody vegetation and grasses. Some grading may be needed in the buffer area to manipulate the direction of the stormwater to accomplish maximum treatment.

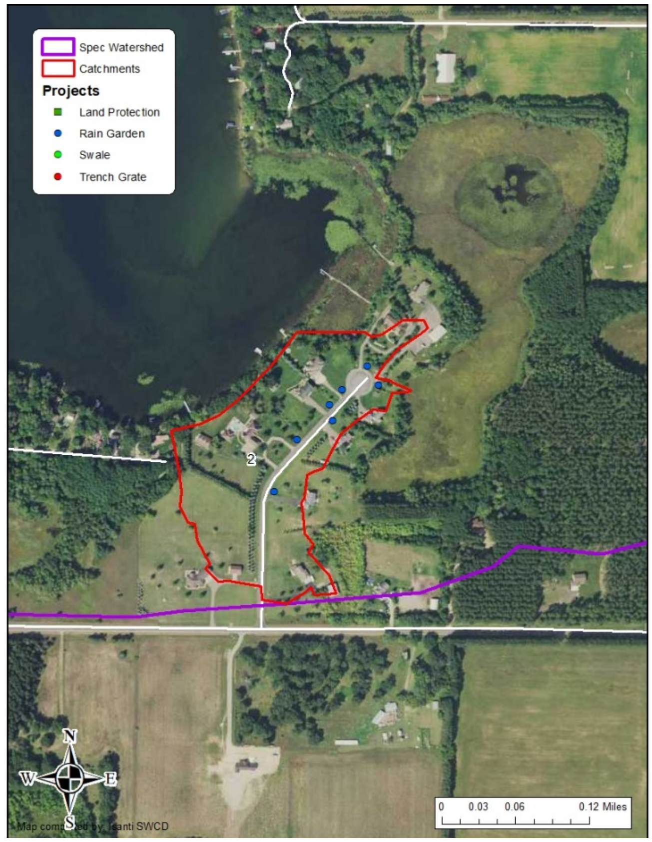
Similar to the beach area site, installing water quality projects is difficult because of the proximity to ground water and available space. This project was modeled assuming the current buffer will treat stormwater. The trench grate is a water diversion tool only, it does not treat stormwater. This project will be successful only if the current buffer can be used to treat the diverted stormwater.

Cost Analysis:

	Trench		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	Number of BMPs	1	
	Total Size of BMPs*	114	ft
	TP (lb/yr)	1.7	94.4%
	TSS (lb/yr)	628	97.4%
Cost	Administration, Promotion & Design Costs	$4,380	
	Construction Costs**	$17,100	
	Total Estimated Project Cost	**$21,480**	
	Annual O&M***	$500	
Efficiency	**30-yr Average Cost/lb-TP**	**$720**	
	30-yr Average Cost/1,000lb-TSS	**$1,936**	

Priority Catchment 2

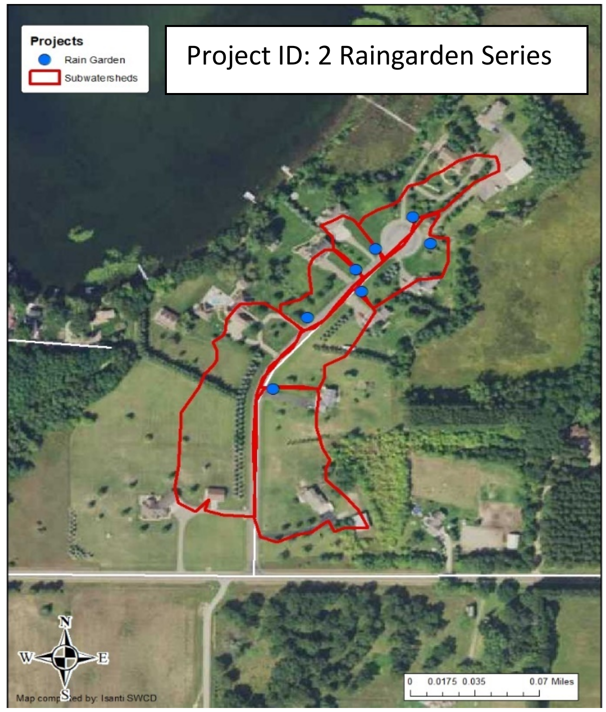
Existing Catchment Summary	
Acres	14.48
Dominant Land Cover	Medium Density Residential



Catchment Description

This catchment consists of medium density residential land use type. The total area is 14.48 acres that include 9 parcels. The priority areas where water quality projects are assumed most beneficial are located along Xkimo Train NW. The layout of the landscape allows for projects to work in series. Series projects are multiple smaller stormwater projects that can treat larger amounts of stormwater. This option can be used when installing one large water quality project is not feasible. Using NRCS Engineering Tools, it was determined a total of 9.1 acres of watershed is draining directly into the wetland connected to Spectacle Lake. Currently, there are no water quality projects in this area.

Existing Catchment Summary	
Acres	9.1
Dominant Land Cover	Residential, Open Space
Parcels	9
TP (lb/yr)	3.8
TSS (lb/yr)	1,614



Location- Xkimo Trail NW

Property Ownership – Private. Landowner cooperation needed for project to proceed.

Description - This project ranked 13 for cost effectiveness at removing phosphorus among all projects identified in this assessment. The purpose of this project is to collect stormwater from the surrounding development using raingardens. The proposed project is designed as a series to allow multiple smaller projects to be constructed but still allow for maximum treatment of stormwater.

We've analyzed scenarios where one to three raingarden sizes are installed: 300 sqft , 450 sqft and 650 sq-ft. The results indicate that it would be most cost effective to install 300 sqft raingardens, the series having the lowest cost per pound of phosphorus removed. The number of raingardens can be reduced if the total sq-ft of the raingardens are increased.

Cost Analysis:

	Rain Garden Series						
	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	7		7		7	
	Total Size of BMPs	300	sq-ft	450	sq-ft	650	sq-ft
	TP (lb/yr)	3.8	99.7%	3.8	100.0%	3.8	100.0%
	TSS (lb/yr)	1,609	99.7%	1,614	100.0%	1,614	100.0%
Cost	Administration & Promotion Costs*	$9,052		$9,052		$9,052	
	Design & Construction Costs**	57,400		72,100		91,700	
	Total Estimated Project Cost	**$66,452**		**$81,152**		**$100,752**	
	Annual O&M***	$700		$700		$700	
Efficiency	**30-yr Average Cost/lb-TP**	**$769**		**$896**		**$1,068**	
	30-yr Average Cost/1,000lb-TSS	**$1,811**		**$2,110**		**$2,514**	

Priority Catchment 3

Existing Catchment Summary	
Acres	8.2
Dominant Land Cover	Undeveloped, Forested

Catchment Description

This catchment is the only area near shore Spectacle Lake that is undeveloped. The naturally forested area is currently contributing 1.0 pound of phosphorus and 470 pounds of sediment per year to the Lake. Converting this area to medium density residential would greatly increase the amount of impervious surface thus greatly increasing the amount of untreated stormwater entering the lake. Total pounds of phosphorus would increase from 1 pound per year to 8.2 pounds per year and sediment loading would increase from 470 pounds per year to 3,052 pounds per year.

Land Protection					
Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading	
Future Development	Number of BMPs	1			
	Total Size of BMPs	8.2 acres			
	TP (lb/yr)	1.0		0%	**1.0**
	TSS (lb/yr)	470		0%	**470**

Existing Catchment Summary	
Acres	8.2
Dominant Land Cover	Forested, Undeveloped
Parcels	16
TP (lb/yr)	1.0
TSS (lb/yr)	470

Location- 337th Ave NW

Property Ownership – Company owned

Description –This project ranked 21 for cost effectiveness at removing (preventing) phosphorus among all projects identified in this assessment. The purpose of the land purchase proposal is to eliminate the potential nutrient loading that would occur if the land use changes from the current forested undeveloped to medium density residential.

Two analyses were conducted to determine the effectiveness of purchasing the property: 1) A rough cost benefit analysis was completed to show the average cost of nutrient load prevented if the area was purchased (table 1) and 2) an analysis was completed to determine what the increase of nutrients loading would be to the lake if the area is developed (table 2).

An alternate and rather cheap option to protect this critical land is to ensure that County ordinances that require minimal removal of trees and installation of water quality protection projects during development are in place and enforced.

	land Purchase		
	Cost/Removal Analysis	New Development	% increase
Future Develop	Number of BMPs	16	
	Total Size of BMPs	8.2 acres	
	TP (lb/yr)	7.2	87.8%
	TSS (lb/yr)	2,582	84.6%
Cost	Administration & Promotion Costs*	$2,920	
	land Purchase	640,000	
	Total Estimated Cost	**$642,920**	
Efficien	**30-yr Average Cost/lb-TP**	**$2,976**	
	30-yr Average Cost/1,000lb-TSS	**$8,300**	

Table 1:

	land Purchase		
	Land Conversion	New Development	% increase
Future Development	Number of BMPs	16	
	Total Size of BMPs	8.2 acres	
	TP (lb/yr)	8.2	820.0%
	TSS (lb/yr)	3,052	649.4%

Table 2:

Lakeshore

DESCRIPTION

The lakefront, at the water's edge, was examined separately from upland treatment. This was done because erosion and runoff from the lakeshore is delivered directly into the lake. It is a problematic area, where residents attempt to balance recreational access, aesthetics, wave erosion, ice jacking and water quality.

Overall, Spectacle Lakeshore is highly developed with homes around the entire lake. However, steep slopes adjacent to the lake, the majority of the shoreline is still maintained with natural vegetation and habitat. Areas where natural vegetation is not present the land is commonly managed by mowing to the water's edge, sand beaches, beach raking and aquatic vegetation removal. Some landowners have used rock rip rap or retaining walls. These areas are candidates for a lakeshore restoration, including correcting erosion and installing vegetated buffers.

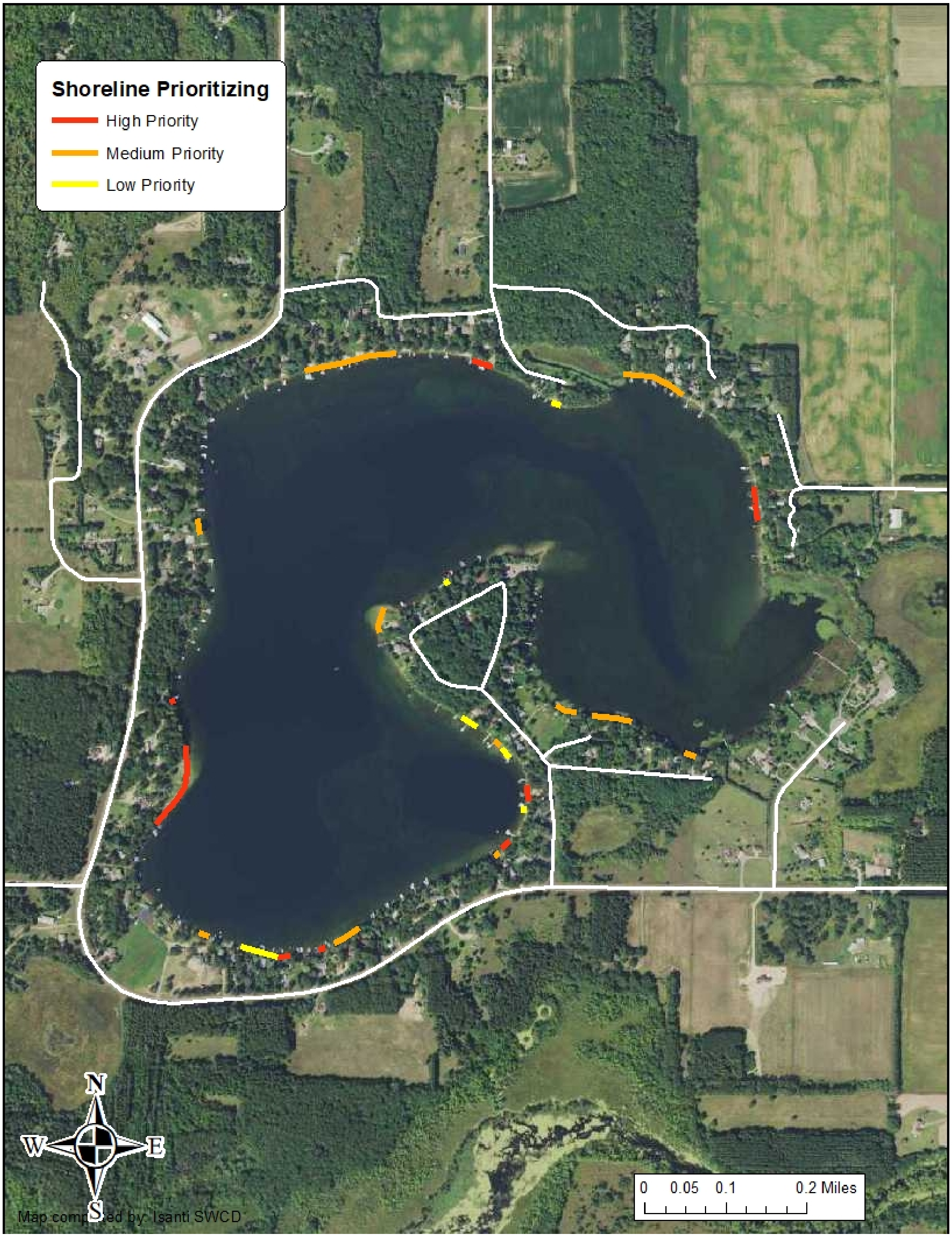
A total of 4,061 linear feet of shoreline was identified as a priority for restoration. Using a scoring system developed by the SWCD that include variables such as buffer depth, eroding face, upland slope, stream flow and shoreline erosion, we were able to rank areas around the lake as low, medium or high priority. Of the 4,061 ft of priority shoreline, 1,400 ft was identified as high priority or areas that have the highest potential for sediment and phosphorus loading.

EXISTING STORMWATER TREATMENT

Many properties have vegetated buffers, rip-rap or other measures to prevent erosion and filter overland flow before it reaches the lake. We did not quantify the benefits from these practices. We did quantify the pollutant loading from lakeshores that are high priority. These areas are presently contributing the pollutant loads to the lake that are listed in the table below.

Lakeshore Restorations

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Total Size of BMPs*	None			
	TP (lb/yr)	**13.0**	0.0	0%	**13.0**
	TSS (lb/yr)	**9,712**	0.0	0%	**9,712**

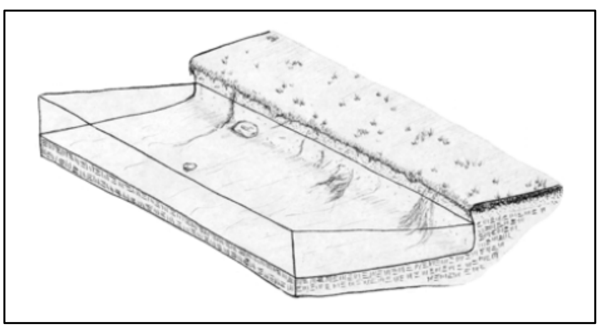

Shoreline Prioritizing
High Priority
Medium Priority
Low Priority
N
W
E
S
Map compiled by: Isanti SWCD
0 0.05 0.1 0.2 Miles

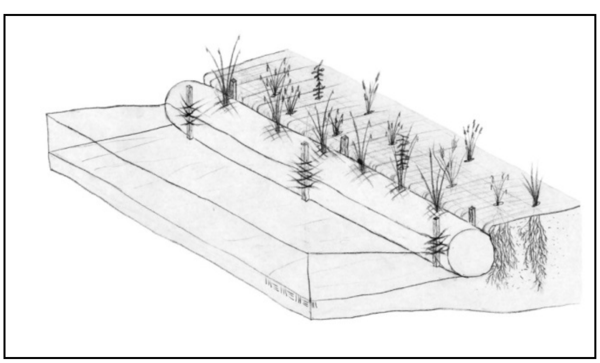
High priority site restoration: Restoring 1,400 linear ft of shoreline

Location – Dispersed around the lakeshore, see maps
Property Ownership – Private
Description – 4,061 linear feet of potential lakeshore restorations were identified in spring 2018. Using a scoring system that include variables such as buffer depth, eroding bank, upland slopes, stream flow and shoreline erosion, we were able to rank areas as low, medium or high priority. Of the 4,061 ft of priority shoreline, 1,400 ft was identified as high priority or areas that have the highest potential for sediment and phosphorus loading. The high priority areas were used to model cost benefits for removal of phosphorus and sediment.

At each candidate lakeshore site we assumed that 65% of the lakeshore (i.e. 65 ft of an average 100 ft frontage) would be stabilized to prevent future erosion and a un-mowed vegetated buffer that is 15 feet wide (i.e. spanning 15 ft from the water's edge to manicured lawn). Bioengineering techniques which utilize deep rooted native plants and biodegradable materials, such as coconut fiber logs and erosion blankets, are favored. Hard structures, including rock alone or retaining walls, are not favored because they lack habitat attributes.

Conceptual images –
Lakeshore restorations with bioengineering and native plants (source: Metro Conservation Districts)





Project ID: high priority lakeshore restorations

Location – Dispersed around the lakeshore, see maps
Property Ownership – Private
Description – Of the 4,061 linear feet of lakeshore restoration we identified, 1,400 ft was noted as the highest priority.

Cost effectiveness analysis
We modeled five different scenarios to determine the most cost beneficial option when restoring portions of the high priority selected lakeshore, 100ft, 400ft, 600ft, 1,000ft and the entire 1,400ft. Results showed that restoring 400ft of shoreline would be the most cost-effective option for phosphorus removal. However, the cost of phosphorus removal per year almost triples with a minimal cost increase per year of 79 dollars. If funding in available, it is recommended that the entire 1,400 linear feet of high priority lakeshore be restored.

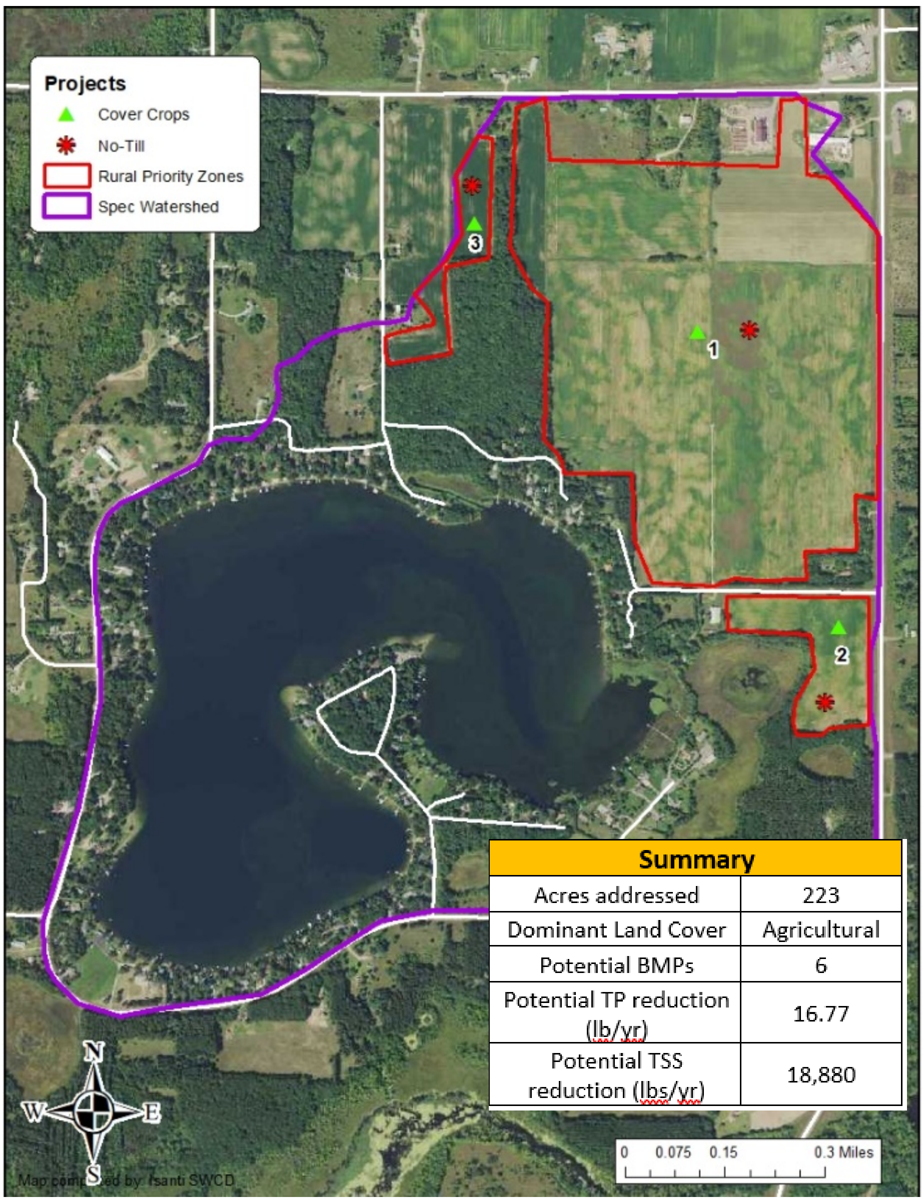
Lakeshore Restorations

	Existing Conditions	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	1		4		6		10		14	
	Total Size of BMPs*	100	ft	400	ft	600	ft	1,000	ft	1,400	ft
	TP (lb/yr)	0.9	6.6%	3.6	28.0%	5.1	39.0%	8.5	65.0%	9.1	70.0%
	TSS (lb/yr)	494	5.1%	1,976	20.3%	2,964	30.5%	4,940	50.9%	5,460	56.2%
Cost	Administration, Promotion & Design Costs	$4,015		$8,760		$10,950		$16,060		$21,170	
	Construction Costs**	$4,650		$18,600		$27,900		$46,500		$65,100	
	Total Estimated Project Cost	**$8,665**		**$27,360**		**$38,850**		**$62,560**		**$86,270**	
	Annual O&M***	$225		$900		$1,350		$2,250		$3,150	
Efficiency	**30-yr Average Cost/lb-TP**	**$597**		**$498**		**$522**		**$513**		**$662**	
	30-yr Average Cost/1,000lb-TSS	**$1,040**		**$917**		**$892**		**$878**		**$1,104**	

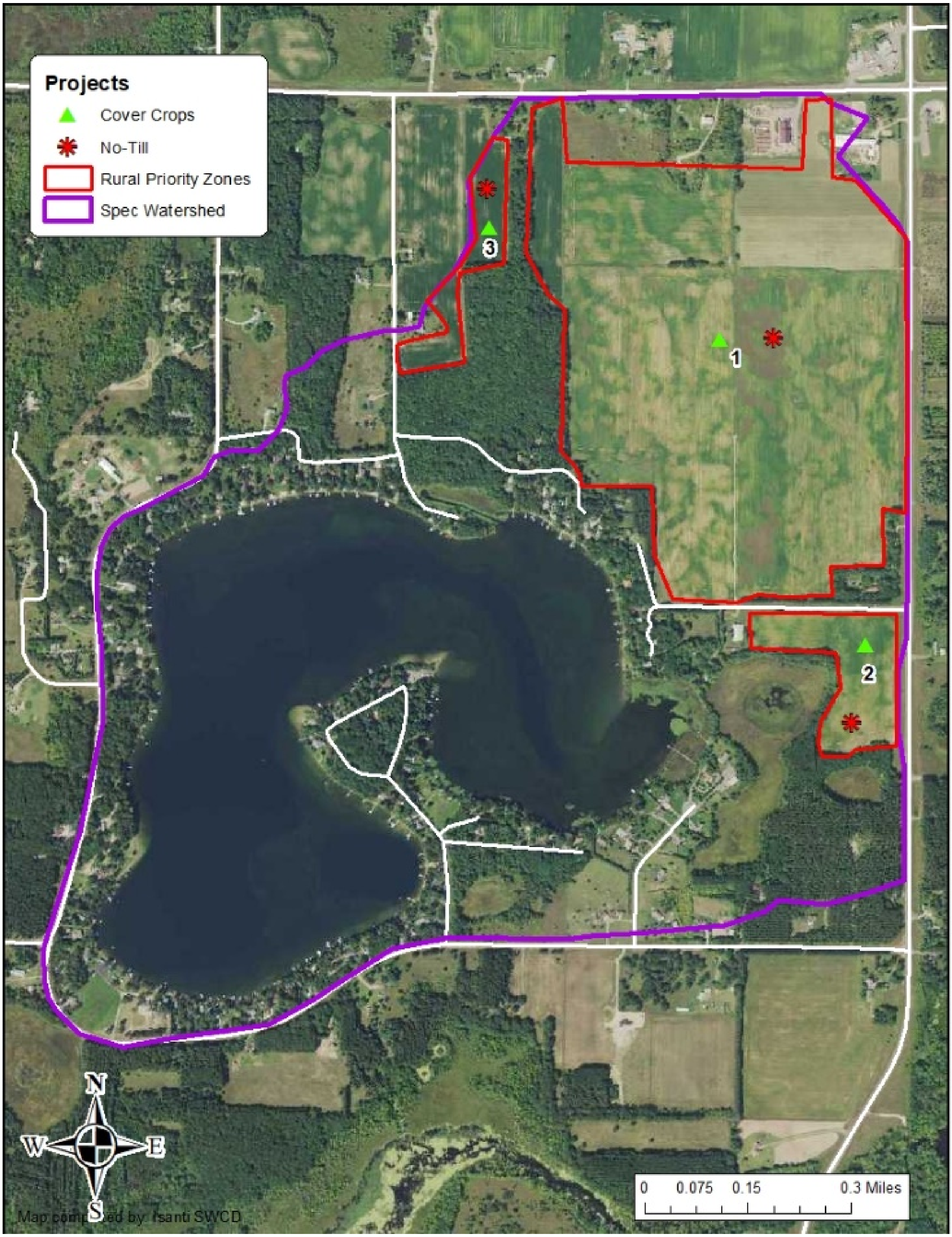
Catchment Profiles – Spectacle Lake Rural

Description

Spectacle Lake rural watershed was divided into 3 priority areas. These are the only three agricultural land use areas in the entire watershed. Because the area is minimal, we were able to analyze the entire 223 acres. Using the NRCS Engineering Tool we analyzed soils, topography, flow streams, digital elevation models and aerial photos to help pinpoint areas on the land that would benefit from installing water quality projects.



Summary	
Acres addressed	223
Dominant Land Cover	Agricultural
Potential BMPs	6
Potential TP reduction (lb/yr)	16.77
Potential TSS reduction (lbs/yr)	18,880

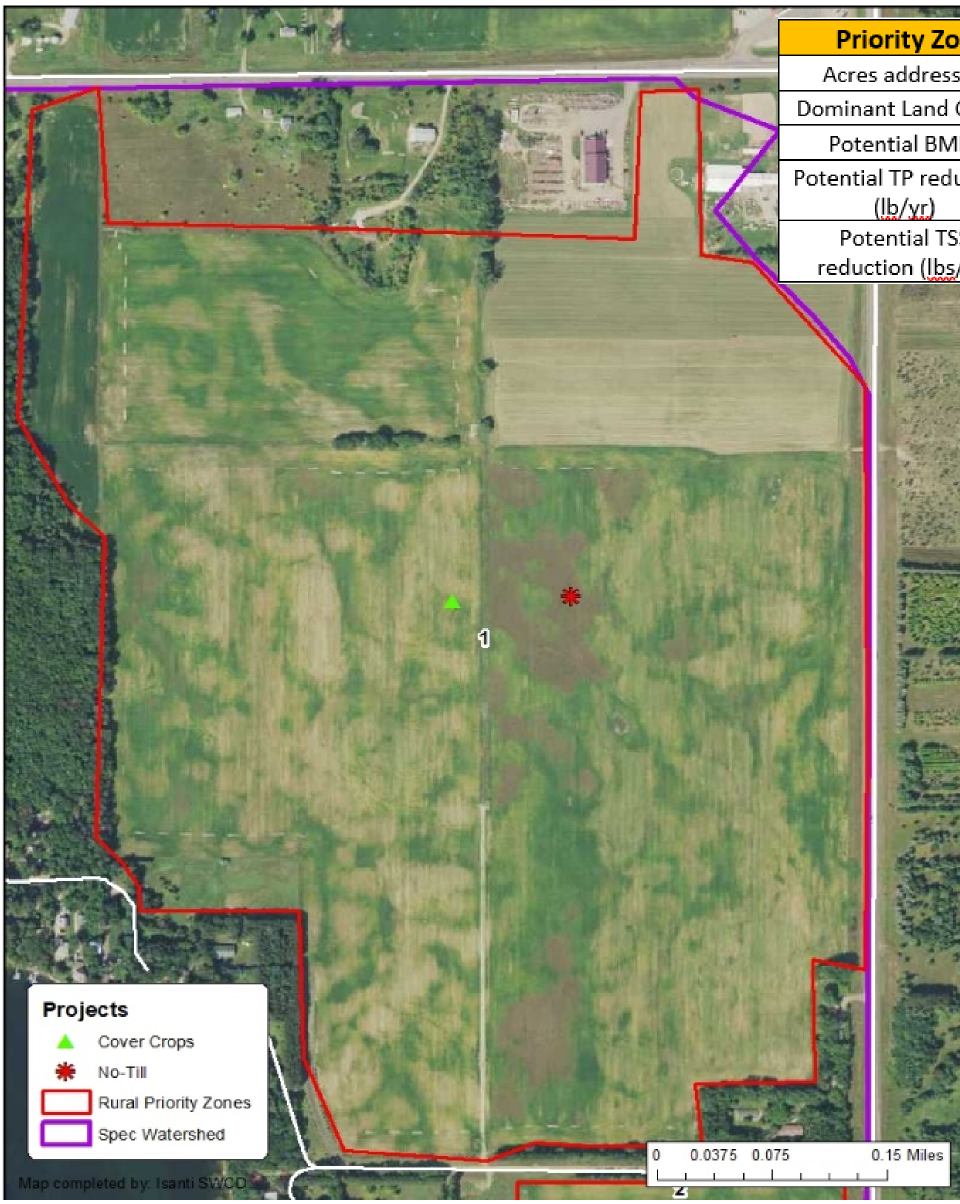


Projects
Cover Crops
No-Till
Rural Priority Zones
Spec Watershed
3
1
2
N
W
E
S
0 0.075 0.15 0.3 Miles
Map compiled by: Isanti SWCD

Priority Zone 1

Priority zone 1 is located to the north east of Spectacle Lake. Zone 1 is the largest of the three priority zones with 198 acres. The entire zone is agricultural land use with most of the soils being Zimmerman Fine Sand. Computer analysis concluded that the area has mild slopes averaging 5%. Furthermore, computer analysis concluded there are no apparent soil loss issues such as gullies, hillside washouts or stream brank erosion. However, based on the most likely crop rotations and tillage practices, there are options to reduce nutrient and sediment loss by implementing conservation practices.

Priority Zone 1 Summary	
Acres addressed	198
Dominant Land Cover	Agricultural
Potential BMPs	2
Potential TP reduction (lb/yr)	15.1
Potential TSS reduction (lbs/yr)	16,280



Description

Priority zone 1 was modeled for three different scenarios.

No-Till Farming:

We assumed this farming practice would require purchasing no till farming equipment. By practicing no-till on this field, soil structure and soil health would be improved. Eliminating conventional tillage greatly reduces the amount of loose soil. Thus, less sediment and nutrients have the potential to reaching Spectacle Lake

Cover Crops:

Cover crops are a great conservation practice that improves soil health, reduces fertilizer application and reduces soil and nutrient loss. Implementing cover crops would reduce the potential for sediment and nutrient loading into Spectacle Lake. This scenario is most cost effective for reducing phosphorus.

No-Till Farming and Cover Crops:

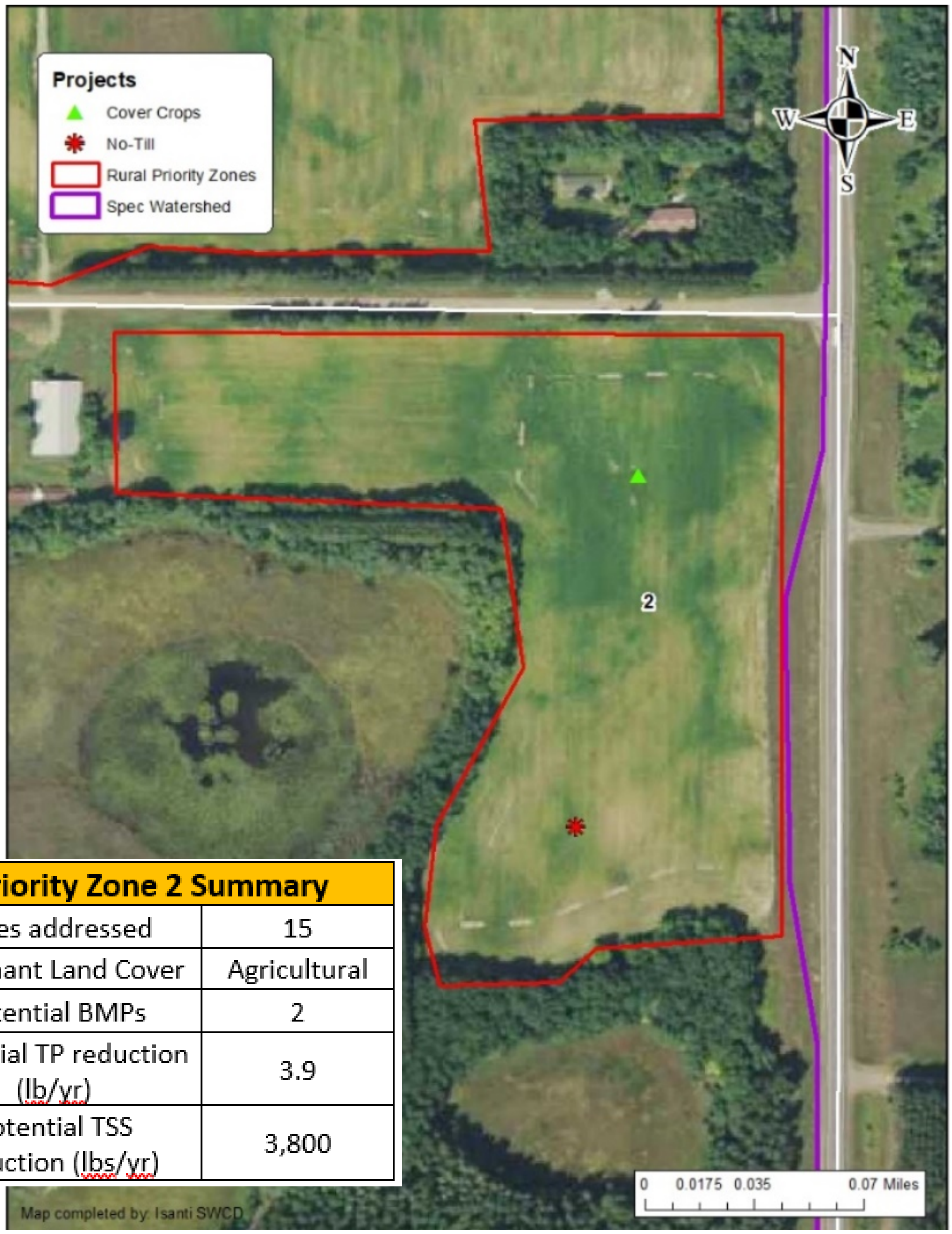
Combing both conservation practices will allow greater soil protection and reduce sediment and nutrient loss. The cost to implement this scenario is much higher than only implementing cover crops, however this scenario is recommended due to the increased reduction of phosphorus and sediment.

No-Till Farming	
Acres addressed	198
Dominant Land Cover	Agricultural
Potential BMPs	1
Potential TP reduction (lb/yr)	12.5
Potential TSS reduction (tons/yr)	13,660
Cover Crop	
Acres addressed	198
Dominant Land Cover	Agricultural
Potential BMPs	1
Potential TP reduction (lb/yr)	2.6
Potential TSS reduction (tons/yr)	2,960
No-Till and Cover Crop	
Acres addressed	198
Dominant Land Cover	Agricultural
Potential BMPs	2
Potential TP reduction (lb/yr)	15.1
Potential TSS reduction (tons/yr)	16,280

No-Till/Cover Crops							
	Cost/Removal Analysis	**New Develpoment**	**% increase**	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**
	BMP	**No-Till Farming**		**Cover Crops**		**No-Till & Cover Crops**	
Treatment	**Total Size of BMPs**	198 acres		198 acres		198 acres	
	TP (lb/yr)	12.5	30.9%	2.6	6.5%	15.1	37.3%
	TSS (lb/yr)	13,660	36.2%	2,960	7.8%	16,280	43.2%
Cost	**Administration & Promotion Costs***	$1,752		$1,752		$1,752	
	Design & equipment costs**	150,000		7,722		157,722	
	Total Estimated Project Cost	**$151,752**		**$9,474**		**$159,474**	
Efficiency	**30-yr Average Cost/lb-TP**	**$405**		**$121**		**$353**	
	30-yr Average Cost/1,000lb-TSS	**$370**		**$107**		**$327**	

Priority Zone 2

Priority zone 2 is located to the east of Spectacle Lake. Zone 2 is a total 15 acres and is the closets priority zone to Spectacle Lake. The entire zone is agricultural land use with most of the soils being Zimmerman Fine Sand. Computer analysis concluded that the area has mild slopes averaging 5%. Furthermore, computer analysis concluded there are no apparent soil loss issues such as gullies, hillside washouts or stream brank erosion. However, based on the assumed crop rotation and tillage practice, there are options to reduce nutrient and sediment loss by implementing conservation practices.



Priority Zone 2 Summary	
Acres addressed	15
Dominant Land Cover	Agricultural
Potential BMPs	2
Potential TP reduction (lb/yr)	3.9
Potential TSS reduction (lbs/yr)	3,800

Description

Priority zone 2 was modeled for three different scenarios. Proximity to the lake should be taken into consideration during the project selection process.

No-Till Farming:

We assumed this farming practice would require purchasing no till farming equipment. By practicing no-till on this field, soil structure and soil health would be improved. By eliminating conventional tillage, the amount of loose soil is greatly reduced. Thus, less sediment and nutrients have the potential for reaching Spectacle Lake

Cover Crops:

Cover crops are a great conservation practice that can improve soil health, reduce fertilizer application and reduce soil and nutrient loss. Implementing cover crops would reduce the potential for sediment and nutrient loading into Spectacle Lake. This scenario is most cost effective for reducing phosphorus.

No-Till Farming and Cover Crops:

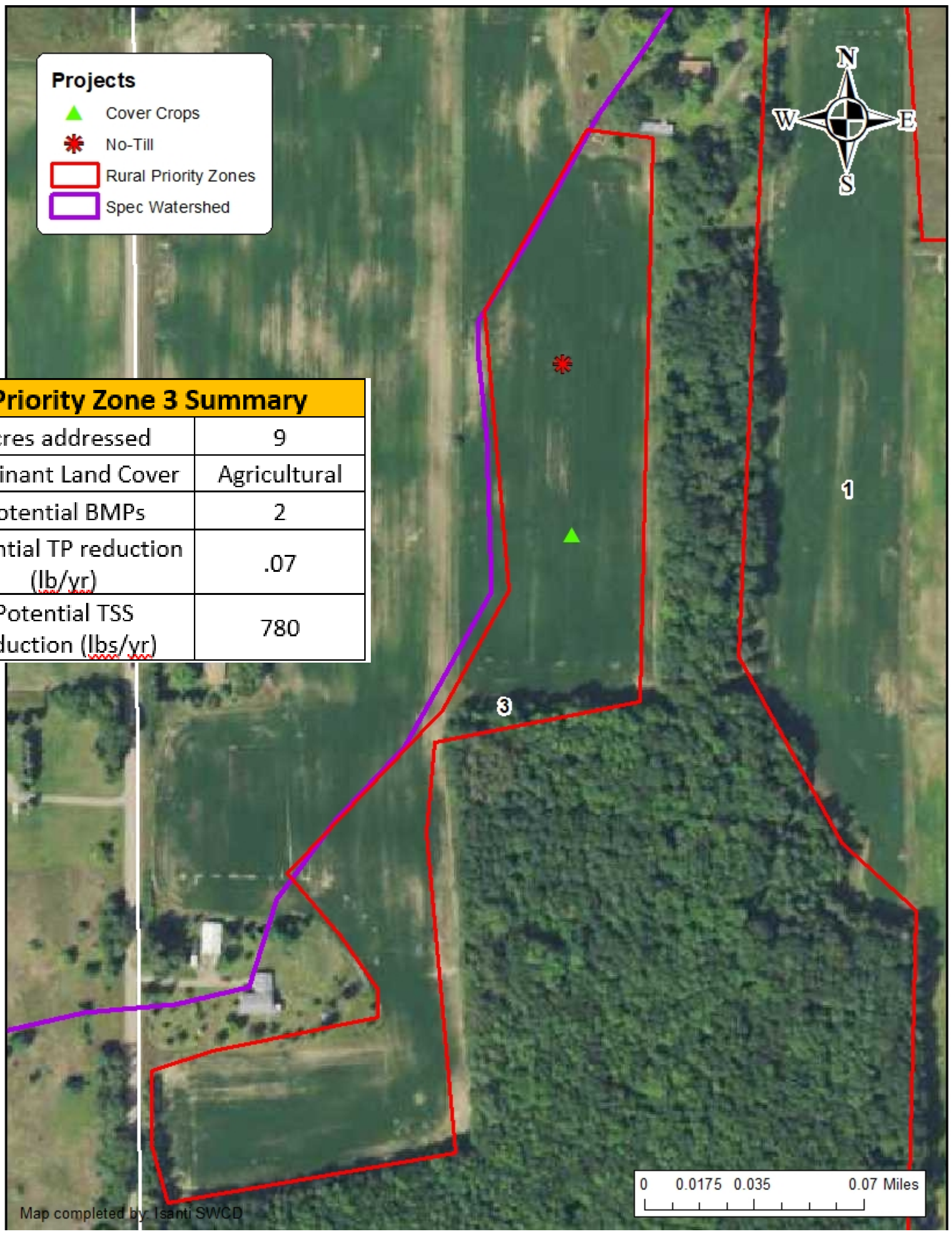
Combing both conservation practices will allow greater soil protection, increase soil health and reduce sediment and nutrient loss. However, the cost to implement a no-till practice may not be feasible.

No-Till Farming	
Acres addressed	15
Dominant Land Cover	Agricultural
Potential BMPs	1
Potential TP reduction (lb/yr)	1.3
Potential TSS reduction (tons/yr)	1,500
Cover Crop	
Acres addressed	15
Dominant Land Cover	Agricultural
Potential BMPs	1
Potential TP reduction (lb/yr)	.3
Potential TSS reduction (tons/yr)	320
No-Till and Cover Crop	
Acres addressed	15
Dominant Land Cover	Agricultural
Potential BMPs	2
Potential TP reduction (lb/yr)	1.6
Potential TSS reduction (tons/yr)	1,820

	No-Till/Cover Crops						
	Cost/Removal Analysis	New Develpoment	% increase	New Treatment	% Reduction	New Treatment	% Reduction
	BMP	No-Till Farming		Cover Crops		No-Till & Cover Crops	
Treatment	Total Size of BMPs	15 acres		15 acres		15 acres	
	TP (lb/yr)	1.3	33.2%	0.3	7.0%	1.6	40.7%
	TSS (lb/yr)	1,500	39.5%	320	8.4%	1,820	47.9%
Cost	Administration & Promotion Costs*	$1,752		$1,752		$1,752	
	Design & equipment costs**	150,000		5,160		155,160	
	Total Estimated Project Cost	$151,752		$6,912		$156,912	
Efficiency	30-yr Average Cost/lb-TP	$3,952		$853		$3,331	
	30-yr Average Cost/1,000lb-TSS	$3,372		$720		$2,874	

Priority Zone 3

Priority zone 3 is located to the north of Spectacle Lake. Zone 3 is a total 9 acres and is the furthest priority zone from Spectacle Lake. The entire zone is agricultural land use with most of the soils being Zimmerman Fine Sand. Computer analysis concluded that the area has mild slopes averaging 5%. Furthermore, computer analysis concluded there are no apparent soil loss issues such as gullies, hillside washouts or stream brank erosion. However, based on the assumed crop rotation and tillage practice, there are options to reduce nutrient and sediment loss by implementing conservation practices.



Priority Zone 3 Summary	
Acres addressed	9
Dominant Land Cover	Agricultural
Potential BMPs	2
Potential TP reduction (lb/yr)	.07
Potential TSS reduction (lbs/yr)	780

Description

Priority zone 3 was modeled for three different scenarios.

No-Till Farming:

We assumed this farming practice would require purchasing no till farming equipment. By changing to a no-till practice, soil structure and soil health would be improved. By eliminating conventional tillage, the amount of loose soil is greatly reduced. Thus, less sediment and nutrients have the potential for reaching Spectacle Lake

Cover Crops:

Cover crops are a great conservation practice that can improve soil health, reduce fertilizer application and reduce soil and nutrient loss. Implementing cover crops would reduce the potential for sediment and nutrient loading into Spectacle Lake. This scenario is most cost effective for reducing phosphorus.

No-Till Farming and Cover Crops:

Combing both conservation practices will allow greater soil protection, increase soil health and reduced sediment and nutrient loss. However, the cost to implement a no-till practice may not be feasible.

No-Till Farming	
Acres addressed	9
Dominant Land Cover	Agricultural
Potential BMPs	1
Potential TP reduction (lb/yr)	.6
Potential TSS reduction (tons/yr)	640
Cover Crop	
Acres addressed	9
Dominant Land Cover	Agricultural
Potential BMPs	1
Potential TP reduction (lb/yr)	.1
Potential TSS reduction (tons/yr)	140
No-Till and Cover Crop	
Acres addressed	9
Dominant Land Cover	Agricultural
Potential BMPs	2
Potential TP reduction (lb/yr)	.7
Potential TSS reduction (tons/yr)	780

No-Till and/or Cover Crops

	Cost/Removal Analysis	New Develpoment	% increase	New Treatment	% Reduction	New Treatment	% Reduction
	BMP	No-Till Farming		Cover Crops		No-Till & Cover Crops	
Treatment	**Total Size of BMPs**	9 acres		9 acres		9 acres	
Treatment	**TP (lb/yr)**	0.6	33.0%	0.1	6.7%	0.7	40.8%
Treatment	**TSS (lb/yr)**	640	39.5%	140	8.6%	780	48.1%
Cost	**Administration & Promotion Costs***	$1,752		$1,752		$1,752	
Cost	**Design & equipment costs****	150,000		2,997		152,997	
Cost	**Total Estimated Project Cost**	**$151,752**		**$4,749**		**$154,749**	
Efficiency	**30-yr Average Cost/lb-TP**	**$8,574**		**$1,319**		**$7,066**	
Efficiency	**30-yr Average Cost/1,000lb-TSS**	**$7,904**		**$1,131**		**$6,613**	

Appendix: Process, methods and data used to complete the assessment. Also includes ranking of projects per each studied area (rural, shoreline and Rural)

Summary of preferred stormwater retrofit opportunities ranked by cost-effectiveness with respect to total phosphorus (TP) reduction. (Near Shore Projects)

Project Rank	Subwatershed ID	Retrofit Type (refer to catchment profile pages for additional detail)	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2014 Dollars)	Estimated cost/ 1,000lb-TSS (30-year)	Estimated cost/ lb-TP (30-year)	Notes/Description
7	1	Rain Garden 3 - 600 sqft	1.5	555	$17,764	$225	$1,471	$556	Overflow is expected with rains events greater than 2.0"
8	1	Rain Garden 3 - 450 sqft	1.3	515	$15,664	$225	$1,451	$558	Overflow is expected with rains events greater than 1.5"
9	1	Rain Garden 3 - 750 sqft	1.5	565	$19,864	$225	$1,569	$594	
12	1	Trench Grate - Boat Landing	1.7	628	$21,480	$500	$1,936	$720	The current lakeshore buffer will need to be utilized for this project to be successful
13	2	Residential Rain Garden Series - 300 sq ft	3.8	1,609	$66,452	$700	$1,811	$769	Less raingardens can be installed if sq ft is increased
15	2	Residential Rain Garden Series - 450 sq ft	3.8	1,614	$81,152	$700	$2,110	$896	
16	2	Residential Rain Garden Series - 650 sq ft	3.8	1,614	$100,757	$700	$2,251	$1,068	
18	1	Rain Garden 2 - 300 sqft	0.4	159	$11,120	$225	$3,744	$1,435	
19	1	Rain Garden 2 - 400 sqft	0.4	168	$12,520	$225	$3,818	$1,450	
20	1	Rain Garden 2 - 200 sqft	0.4	142	$9,720	$225	$3,875	$1,484	
21	3	Land Protection - 8.2 acres	7.2	2582	$642,920	na	$8,300	$2,976	
24	1	Swale and Grate - Beach Area	0.1	51	$8,809	$225	$10,155	$4,987	This project will only be successful if projects are installed up in the watershed
25	1	Rain Garden 1 - 150 sqft	0.1	37	$9,020	$225	$14,292	$5,310	
28	1	Rain Garden 1 - 100 sqft	0.1	36	$5,186	$225	$11,132	$44,144	Pave gravel road that washes out into the lake, install 2 rain gardens.

Summary of preferred stormwater retrofit opportunities ranked by cost-effectiveness with respect to total phosphorus (TP) reduction. (Shoreline Projects)

Project Rank	Subwatershed ID	Retrofit Type (refer to catchment profile pages for additional detail)	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2014 Dollars)	Estimated cost/ 1,000lb-TSS (30-year)	Estimated cost/ lb-TP (30-year)	Notes/Description
4	Lakeshore	High Priority 400 ft	3.6	1,976	$27,360	$900	$917	$498	
5	Lakeshore	High Priority 1,000 ft	8.5	4,940	$62,560	$2,250	$887	$513	
6	Lakeshore	High Priority 600 ft	5.1	2,964	$38,850	$1,350	$892	$552	
10	Lakeshore	High Priority 100 ft	0.9	494	$8,665	$225	$1,040	$597	
11	Lakeshore	High Priority 1,400 ft	9.1	5,460	$86,270	$3,150	$1,104	$662	

Summary of preferred stormwater retrofit opportunities ranked by cost-effectiveness with respect to total phosphorus (TP) reduction. (Rural Projects)

Project Rank	Subwatershed ID	Retrofit Type (refer to catchment profile pages for additional detail)	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2014 Dollars)	Estimated cost/ 1,000lb-TSS (30-year)	Estimated cost/ lb-TP (30-year)	Notes/Description
1	Zone 1 - rural	Cover Crop - zone 1	2.6	2,960	$9,474	NA	$107	$121	
2	Zone 1 - rural	No-Till and Cover Crop - zone 1	15.1	16,280	$159,474	NA	$327	$353	
3	Zone 1 - rural	No-Till Farming zone 1	12.5	13,660	$150,560	$151,752	$370	$405	
14	Zone 2 - rural	Cover Crop - zone 2	0.03	320	$6,912	NA	$720	$853	
17	Zone 3 - rural	Cover Crop - zone 3	0.1	140	$4,749	NA	$1,131	$1,319	
22	Zone 2 - rural	No-Till and Cover Crop - zone 2	1.6	1,820	$156,912	NA	$2,874	$3,331	
23	Zone 2 - rural	No-Till Farming zone 2	1.3	1,500	$151,752	NA	$3,372	$3,952	
26	Zone 3 - rural	No-Till and Cover Crop - zone 3	0.7	780	$154,749	NA	$6,613	$7,066	
27	Zone 3 - rural	No-Till Farming zone 3	0.06	640	$151,752	NA	$7,904	$8,574	

Methods:

Selection of Watershed

Many factors are considered when choosing which watershed to assess for stormwater retrofits, but always focus on the drainage to an important lake, river, or stream. Assessments supported by a Local Government Unit with sufficient capacity (staff, funding, available digital mapping data, etc.) to greater facilitate the assessment also rank highly. The focus is always on a high priority waterbody.

Urban/residential Subwatershed Selection

This assessment includes the area of land draining directly to Spectacle Lake. These areas were chosen because its proximity to the lake translates into direct water quality impacts, it is the area of densest development in the watershed and has little or no stormwater treatment. Furthermore, near-lake landowners are often most vested in the lake's water quality and a Lake Improvement District (LID) covers this area and is a valuable partner for installing projects.

Rural Subwatershed Selection

This assessment includes the area of land draining to stream networks that eventually drain into Spectacle Lake. NRCS tools were used to identify subwatersheds.

Targeted Pollutants

Targeted pollutants for this study were total phosphorus and total suspended solids. Total phosphorus is a nutrient commonly associated with rural stormwater that causes excessive algae production and low oxygen levels in lakes and rivers. Total suspended solids was also chosen as a target pollutant because it is also commonly associated with stormwater and causes turbidity in lakes and rivers. Suspended solids are also important because many other pollutants, such as phosphorus or heavy metals, are attached to the particles.

Subwatershed Assessment Methods

Step 1: Retrofit Scoping

Retrofit scoping includes determining the objectives of the retrofits (volume reduction, target pollutant, etc.) and the level of treatment desired. It involves meeting with local land use managers and lake group members to determine the issues in the watershed. This step also helps to define preferred retrofit treatment options and retrofit performance criteria.

Step 2: Desktop Retrofit Analysis

The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. This step also identifies areas that don't need to be assessed because of existing stormwater infrastructure or current land uses. Accurate GIS data is extremely valuable in conducting the desktop retrofit analysis. Some of the most important GIS layers include: 2-foot or finer topography, hydrology, soils, watershed/subwatershed boundaries, parcel boundaries and high-resolution aerial photography.

Step 3: Retrofit Field Investigation

After identifying potential retrofit sites through the desktop search, a field investigation was conducted to evaluate each site and identify additional opportunities. During the investigation, the drainage area and stormwater infrastructure mapping data were verified. Site constraints were assessed to determine the most feasible retrofit options as well as eliminate sites from consideration. The field investigation may have revealed additional retrofit opportunities that went unnoticed during the desktop search.

In addition to in field investigation, a survey of the lakeshore was completed for Spectacle Lake by boat. This allowed staff to document stormwater outfalls, inventory the shoreline condition and see potential project locations from a different perspective.

Step 4: Treatment Analysis/Cost Estimates

Sites most likely to be conducive to addressing the pollutant reduction goals and appearing to have feasible design, installation, and maintenance were chosen for a cost/benefit analysis. Estimated costs included design, installation, and maintenance annualized across the anticipated project lifespan (10-30 yrs). Estimated benefits included are pounds of phosphorus and total suspended solids removed, though projects were ranked only by cost per pound of phosphorus removed annually.

Treatment analysis

Urban/Residential Catchments:
For each potential project pollutant removal estimates were obtained using the Wisconsin NRCS Erosion Calculator and the stormwater model WinSLAMM. WinSLAMM uses an abundance of stormwater data from the upper Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It is useful for determining the effectiveness of proposed stormwater control practices. It has detailed accounting of pollutant loading from various land uses and allows the user to build a model "landscape" that reflects the actual landscape being considered. The user is allowed to place a variety of stormwater treatment practices that treat water from various parts of this landscape. It uses rainfall and temperature data from a typical year, routing stormwater through the user's model for each storm. The output data gives an estimate of how much sediment is being lost in that area.

A "base" model was created which estimated pollutant loading from selected catchments in its present-day state. To accurately model the land uses in each catchment, we delineated each land use in each catchment using ArcGIS and assigned each a WinSLAMM standard land use file. This process resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment. For certain source areas critical to our models we verified that model estimates were accurate by measuring actual acreages in ArcGIS and adjusting the model acreages if needed.

Once the "base" model was created, each proposed stormwater treatment practice was added to the model and pollutant reductions were generated. Because neither a detailed design of each practice nor in-depth site investigation was completed, a generalized design for each practice was used. Whenever possible, site-specific parameters were included. Design parameters were modified to obtain various levels of treatment.

Rural Catchments:
Because the watershed draining to Spectacle Lake contained only three agricultural land use areas, each area was considered priority and was included in the analysis process. The NRCS Engineering Tool was utilized to determine average slopes, flow paths, soil type, topography and a digital elevation model. A desktop analysis was conducted using the engineering tool data and aerial photography to identify areas on the land that would benefit from a specific BMP.

Similar to the urban catchment exercise, "base" conditions were determined through use of RUSLE2 software. All fields were assumed to utilize a corn / soybean rotation (RUSLE setting Corn FC Disk Fld Cult-Soybeans FC Disk Fld Cult) and contouring was assumed at a middle value for the absolute row grade. Field estimates were inputted to the Board of Water and Soil Resources' (BWSR) Pollution Reduction Estimator spreadsheet to determine the level of phosphorus and sediment reduction on a given BMP practice.

Table 3. Rural catchment BMPS and modeling programs for Spectacle Lake Subwatershed Assessment.

Parameter / BMP	***Model***
No-till Farming	BWSR Spreadsheet – RUSLE2
Cover Crops	BWSR Spreadsheet - RUSLE2

Lakeshore Erosion and Runoff Pollutant Estimation

WinSLAMM modeling alone could not accurately estimate pollutants generated from eroding lakeshore, nor the pollutant reduction that may occur by installing a project. To estimate lakeshore pollutants, we used a two-step process that accounted for (1) overland flow from lakeshore backyards plus (2) the eroding lakeshore face.

1. Overland Flow - We used WinSLAMM to estimate pollutant generation from the backyards of lakeshore homes. We created a custom WinSLAMM standard land use that replicated typical high priority Spectacle Lakeshore properties, including home's roof, backyard and landscaping. In our base model the runoff from these surfaces flowed over sandy loam backyard soils to the lake. In our proposed project models the runoff was directed through a vegetated swale at the water's edge.

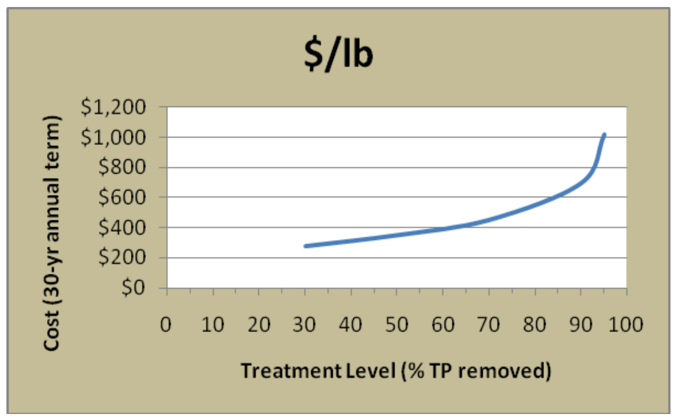
2. Eroding Lakeshore Face - We used a modified version of the Wisconsin NRCS streambank erosion method to calculate sediment loss from the lakeshore face. Assumptions for the NRCS bank erosion method included a 1 ft tall eroding face with a lateral recession rate of 0.1 feet/year (moderate erosion). The bulk density of the eroded material was assumed to be 100 lbs per cubic foot, the NRCS published value for sandy loam. This yielded an estimation of pounds of eroded material lost per year. The phosphorus content of that material was calculated based on a conversion factor of one pound of phosphorus per 1,481 pounds of soil, as derived from the BWSR erosion calculator.

We categorized candidate lakeshore restoration sites as either "low priority", "medium priority" or "high priority." A scoring system was used to determine what category a selected shoreline belongs in. Variables such as, buffer depth, eroding face, upland slope, extent of shoreline erosion, etc. were designated a number based on its potential for nutrient and sediment loading. High priority candidates fall within the range of 11 and up, medium priority candidates fall within the range of 6 to 10 and low priority candidates fall within the range of 0 to 5.

Cost Estimates

Urban/Residential Catchments:

Cost estimates were annualized costs that incorporated design, installation, installation oversight, and maintenance over a 30-year period. In cases where promotion to landowners is important, such as raingardens and lakeshore restorations, those costs were included as well. Design assistance from an engineer is assumed for practices in-line with the stormwater conveyance system, involving complex stormwater treatment interactions, or posing a risk for upstream flooding. It should be understood that no site-specific construction investigations were done as part of this stormwater assessment, and therefore cost estimates account for only general site considerations.



Rural Catchments:
Cost estimates were determined based on typical projects installed in Isanti County, yearly operation and maintenance over a 10 year period, design costs and installation oversight. The cost of the project is largely dependent on the size and complexity, so these estimates were determined to be mid-range expectations for the associated project types. Like the urban practices, it should be understood that detailed site specific construction investigations were not done as part of this assessment and therefore cost estimates account for only general site consideration.