TWO RIVERS LAKE TARGETED

CONSERVATION PRACTICE PLAN

Topical Report RSI-2492

prepared by

RESPEC

1935 West County Road B2, Suite 320
Roseville, Minnesota 55113

prepared for

Stearns County Soil and Water Conservation District
110 2nd Street South, Suite 128
Waite Park, Minnesota 56387

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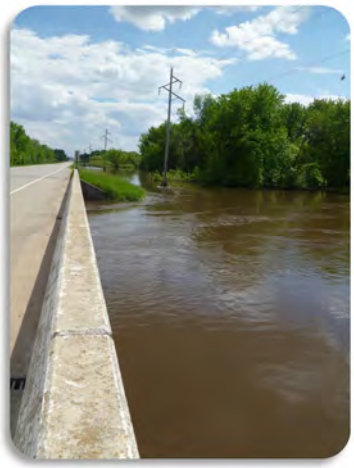
Prepared in cooperation with the City of Albany, Minnesota; the County of Stearns, Minnesota; the Friends of Two Rivers Lake, Avon, Minnesota; and the Stearns County Soil and Water Conservation District, Waite Park, Minnesota.

PLAN SUMMARY

Two Rivers Lake is located in Stearns County and is one of the largest lakes in the area. The lake provides one of the best options for recreational boating and fishing opportunities in northeastern Stearns County and southern Morrison County. Walleye stocking efforts are provided by both the Minnesota Department of Natural Resources (MN DNR) and the St. Anna/Holdingford Sportsman's Clubs. The MN DNR maintains a public lake access, and in 2009, Stearns County established Two Rivers Lake Park on the lake with public shelters, a fishing pier, and access to the Lake Wobegon Trail.

Sunset over Two Rivers Lake



Major Storm Event
May 26, 2014

The 600-acre lake has a contributing watershed of 37,750 acres. This large drainage area is primarily agricultural land and also contains the city of Albany (with a population of 2,561 in 2010). The shoreland area of Two Rivers Lake has been significantly developed in the last 70+ years. In 1938, approximately 6 cabins existed by the lake; today, over 150 properties are adjacent to the lake.

According to the MN DNR Status of the Fishery (July 13, 2009), "Water quality parameters were typically below average for the North Central Hardwoods ecoregion. Because of poor water quality there was a lack of aquatic plants and oxygen was present only to 16 feet." The Minnesota Pollution Control Agency (MPCA) lists Two Rivers Lake as being impaired for aquatic recreation (nutrients and eutrophication).

The Stearns County Soil & Water Conservation District (SWCD) received a grant to identify pollutant loading and best management practices (BMPs) to restore lake water quality. The goal of this project was to identify those areas of the watershed that were contributing the greatest amount of phosphorus (P) and sediment (measured as total suspended solids [TSS]) to the lake. This plan identified and prioritized targeted sites though a planning and modeling process conducted by RESPEC, a firm with experience in water quality, environmental modeling, and planning. The SWCD and its partners will work with individual landowners to discuss potential options to concerns identified in this project. This plan will also be distributed to partners (Stearns County SWCD, Stearns County, MPCA, MN DNR, Natural Resources Conservation Service (NRCS), city of Albany, and lake associations (i.e., Friends of Two Rivers and Pelican Lake Association of St. Anna) to direct future implementation efforts. Future efforts of these groups will be aligned to ensure that future implemented projects are impactful and cost effective in an effort to achieve the water quality goals of Two Rivers Lake.

Major Storm Event
May 26, 2014

Impacts from the following three different contributing landscapes were analyzed to assess the Two Rivers Watershed: agriculture, development around Two Rivers Lake, and the highly urbanized areas of the city of Albany. For each area, priorities were identified and a potential solution was suggested. The complete project plan and appendices follow this plan summary and provides detailed technical information regarding the creation of this plan, the modeling process, and data sheets on the individual proposed projects. Not all of the projects have been field verified and some may be determined unfeasible when additional information is collected. The location of the Two Rivers Lake Watershed within Stearns County is shown in Figure PS-1.

Figure PS-1. Two Rivers Lake Watershed Within Stearns County.

FOCUS AREA ONE — RURAL ANALYSIS AND RECOMMENDATIONS

Two Rivers Lake Watershed is mostly agricultural and highly erosive areas must be treated to minimize the nutrients and sediment leaving agricultural fields. Conservation practices such as grassed waterways, water and sediment control basins, and changes to field management are used to manage field erosion. Slowing and storing water (primarily wetland restorations or expansions) can also aid in reducing nutrients and sediment entering Two Rivers Lake. Landowners have many options if they are interested in doing these projects, which ranges from completing the project themselves to working with agencies such as the SWCD and NRCS, who can provide technical support and possible financial assistance. The maps in Figures PS-2 through PS-4 show the areas that have been identified as priority subwatersheds (the model predicts higher loads of sediment and nutrients from these areas entering the lake) as well as identified sites of concern.

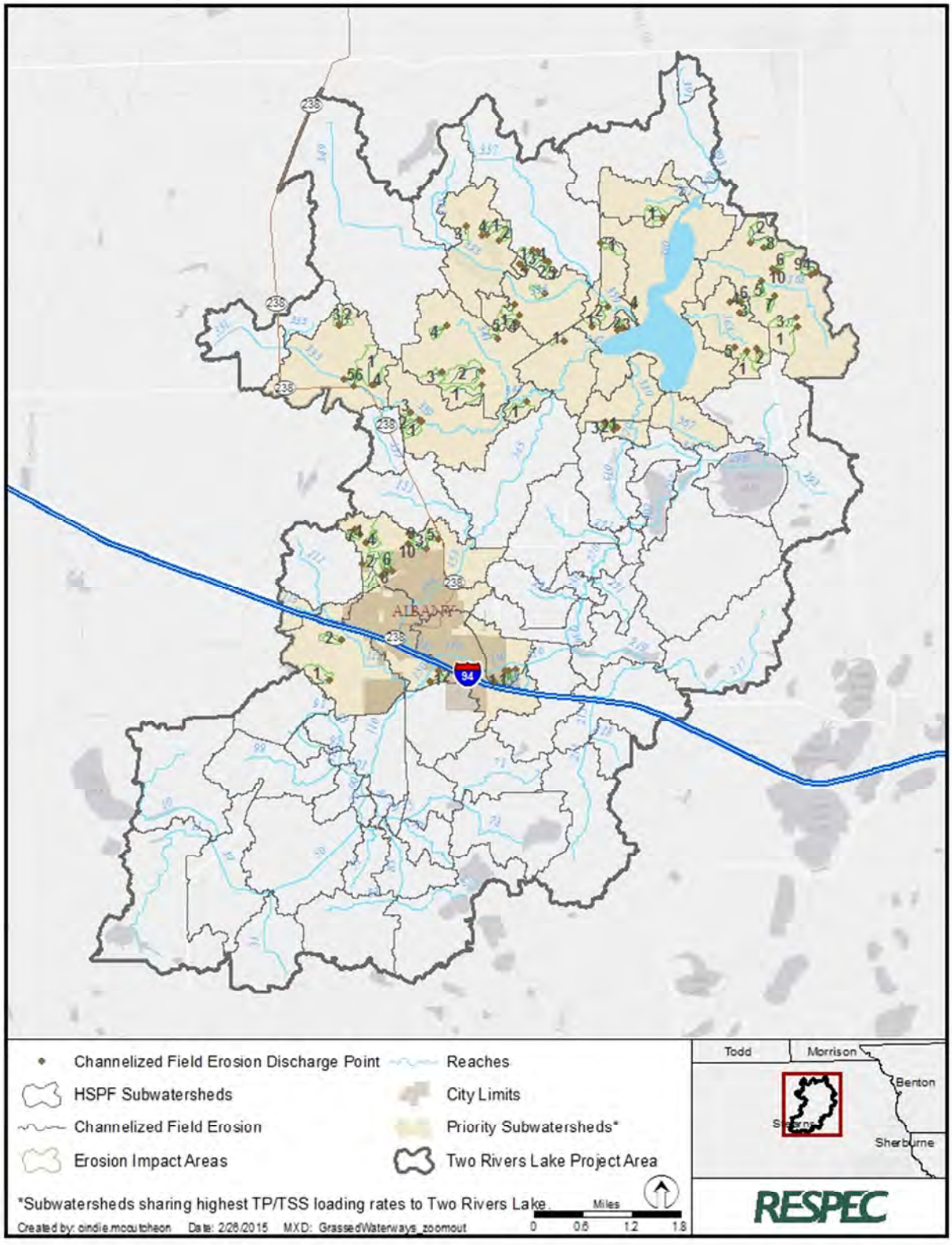


Figure PS-2. Locations of Channelized Field Erosion in Priority Subwatersheds.

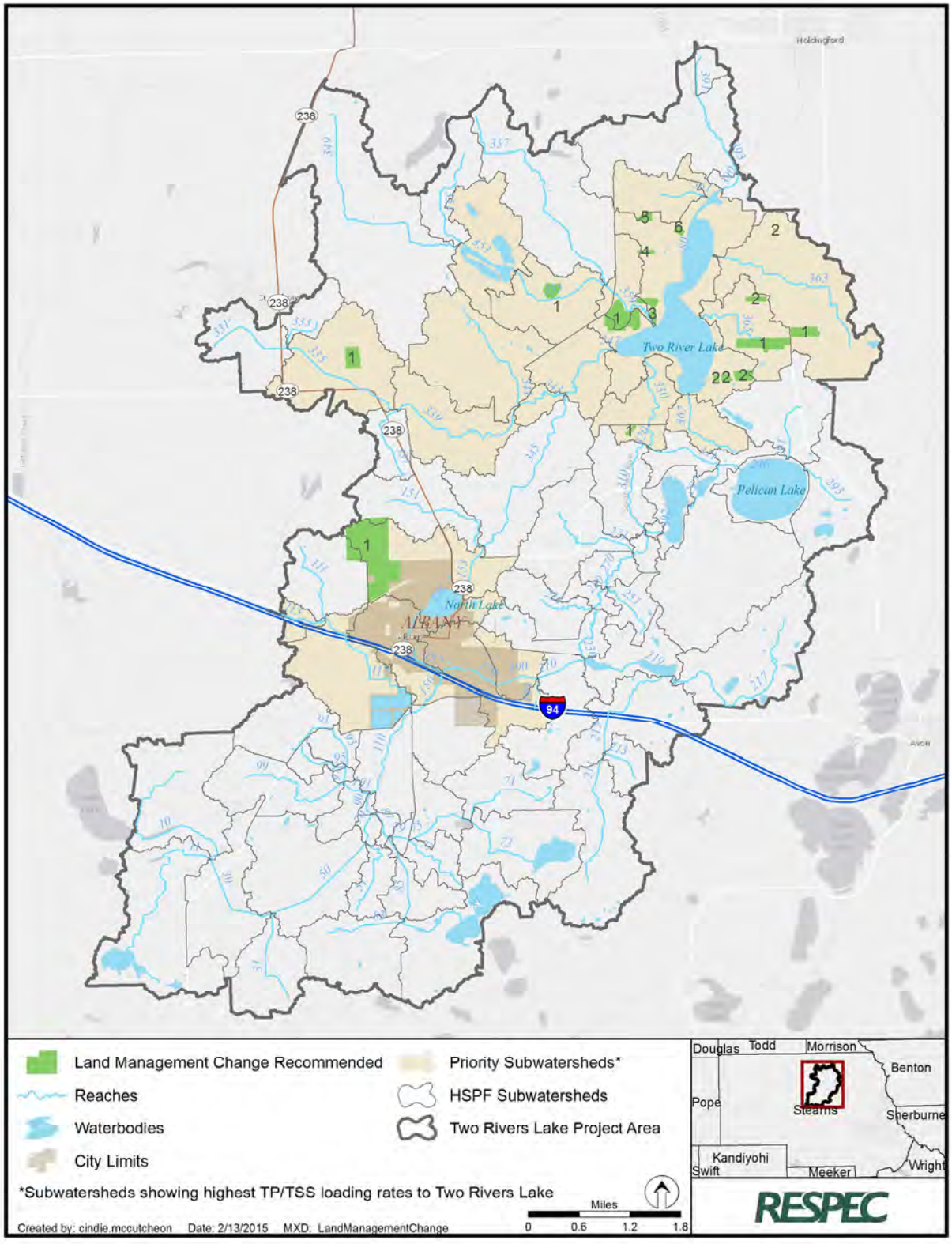


Figure PS-3. Ideal Locations Identified in Priority Subwatersheds for Land-Use Management Changes.

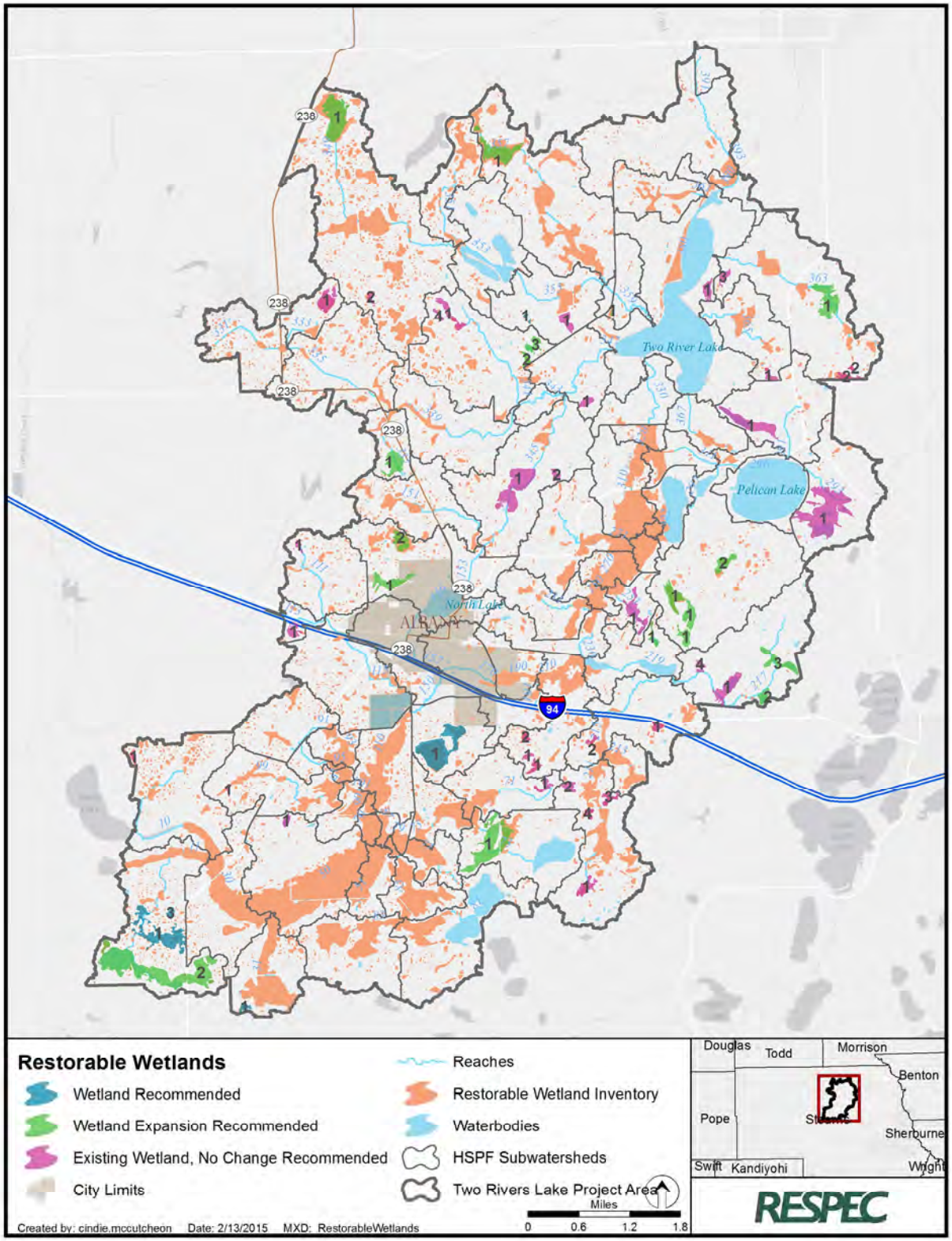


Figure PS-4. Areas Identified as Ideal for Wetland Restoration or Expansion.

FOCUS AREA TWO — LAKESHORE ANALYSIS AND RECOMMENDATIONS

The areas directly adjacent to Two Rivers Lake reviewed separately because associated nutrient/sediment loads can flow directly into the lake. The estimated loads associated with each land use are presented in Table PS-1. The highest contributions of total phosphorus (TP), in decreasing order, are pasture/hayland, septic systems (assumed based on typical septic failure rates), developed areas adjacent to the lake, and agriculture. The highest contributions of sediment (TSS), in decreasing order, are from the developed areas adjacent to the lake, pasture/hayland, and agriculture.

Table PS-1. Lakeshed Areas for Each Land Use and the Respective Pollutant Loadings

Land Use or Source	Area		TP		TN[(a)]		TSS	
	acre	%	lb/yr[(b)]	%	lb/yr[(b)]	%	lb/yr[(b)]	%
Pasture/Hay	618	51	58	39	1,097	43	1,621	17
Forest	247	20	2	1	42	2	56	1
Row Crops	135	11	21	14	421	16	893	9
Wetlands	103	8	1	< 1	15	<1	0	0
Grassland	65	5	1	< 1	20	< 1	30	< 1
Developed	51	4	22	15	308	12	6,862	72
Feedlots	2	< 1	1	< 1	13	< 1	42	< 1
Septic Systems	N/A[(b)]	N/A[(c)]	44	29	635	25	0	0

(a) TN = total nitrogen.
(b) lb/yr = pounds per year.
(c) Septic systems (30 units) were represented as a point source so area is not applicable.

To minimize contributions from the pasture/hayland and agricultural areas, landowners need to address any actively eroding areas; maintaining effective buffers is also important. For producers with livestock, a Comprehensive Nutrient Management Plan (CNMP) is important. For landowners who want assistance, the SWCD and the NRCS are available to provide technical support and possible financial assistance.

Developed areas around the lake consist of just 4 percent of the area, but they produce 22 percent of the phosphorus and 72 percent of the sediment from the lake's immediate drainage area. Stormwater management practices, such as redirecting water running off of roofs and impervious areas to areas where the water has an opportunity to infiltrate, are also important considerations. Shoreline buffers provide treatment practices and also provide secondary benefits such as bank stabilization and wildlife habitat. A survey of the existing septic systems compliance may be useful because faulty septic systems can potentially be a large source of nutrients to the lake. The map in Figure PS-5 shows the location of the areas defined in Table PS-1.

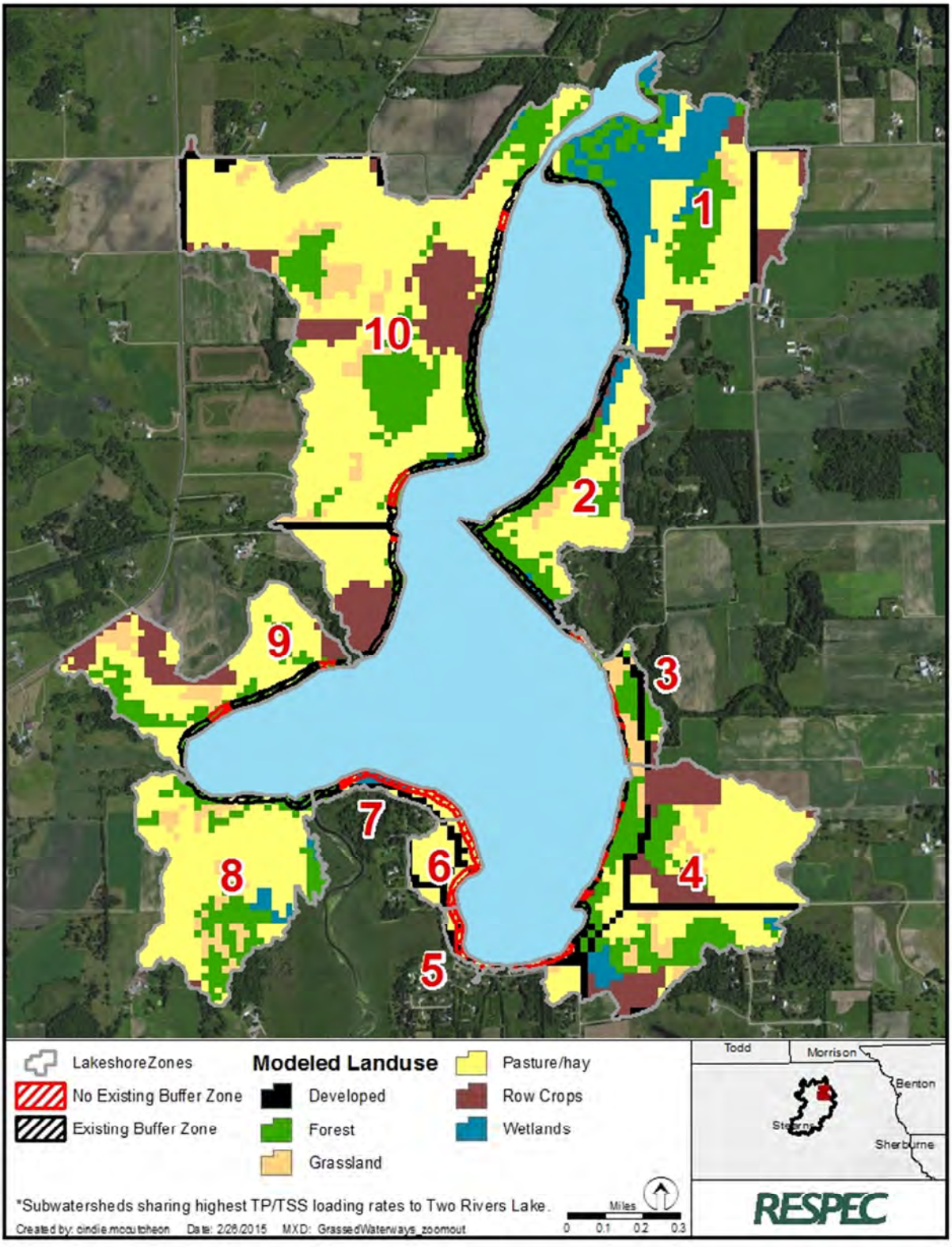


Figure PS-5. Land Use in Two Rivers Lakeshore Zones.

FOCUS AREA THREE — URBAN ANALYSIS AND RECOMMENDATIONS

The city of Albany, as shown in Figure PS-6, is a growing community in the heart of Stearns County (population of 2,561 in 2010), both in residential growth as well as commercial and industrial development. Stormwater leaving the city of Albany discharges into South Two River and is carried to Two Rivers Lake. The city has shown a strong commitment to reducing negative water quality effects downstream by installing a number of BMPs in recent years. These BMPs include shoreline buffers along North Lake, stormwater treatment ponds, and infiltration basins.

Figure PS-6. City of Albany, Minnesota.

A separate model was developed for the areas that contribute stormwater to the city to identify areas of high priority for phosphorus and sediment treatment. With assistance and input from the SWCD and RESPEC, the city identified several potential BMP projects. These BMPs would reduce the impact of the stormwater leaving the city of Albany by improving current BMPs and providing new treatment to currently untreated areas. The projects range from new or improved stormwater treatment ponds and bioretention basins to treatment swales, wetland restoration, and construction. Other possible treatment possibilities (e.g., rain gardens and tree boxes) are also discussed.

The SWCD will work with the city of Albany to pursue funding opportunities to implement these projects. The Stearns SWCD is also available to provide technical support as the city explores ways to implement these projects. The map in Figure PS-6 shows the estimated phosphorus loads throughout the subwatersheds within the city, and the existing and proposed BMPs that were identified in this project.

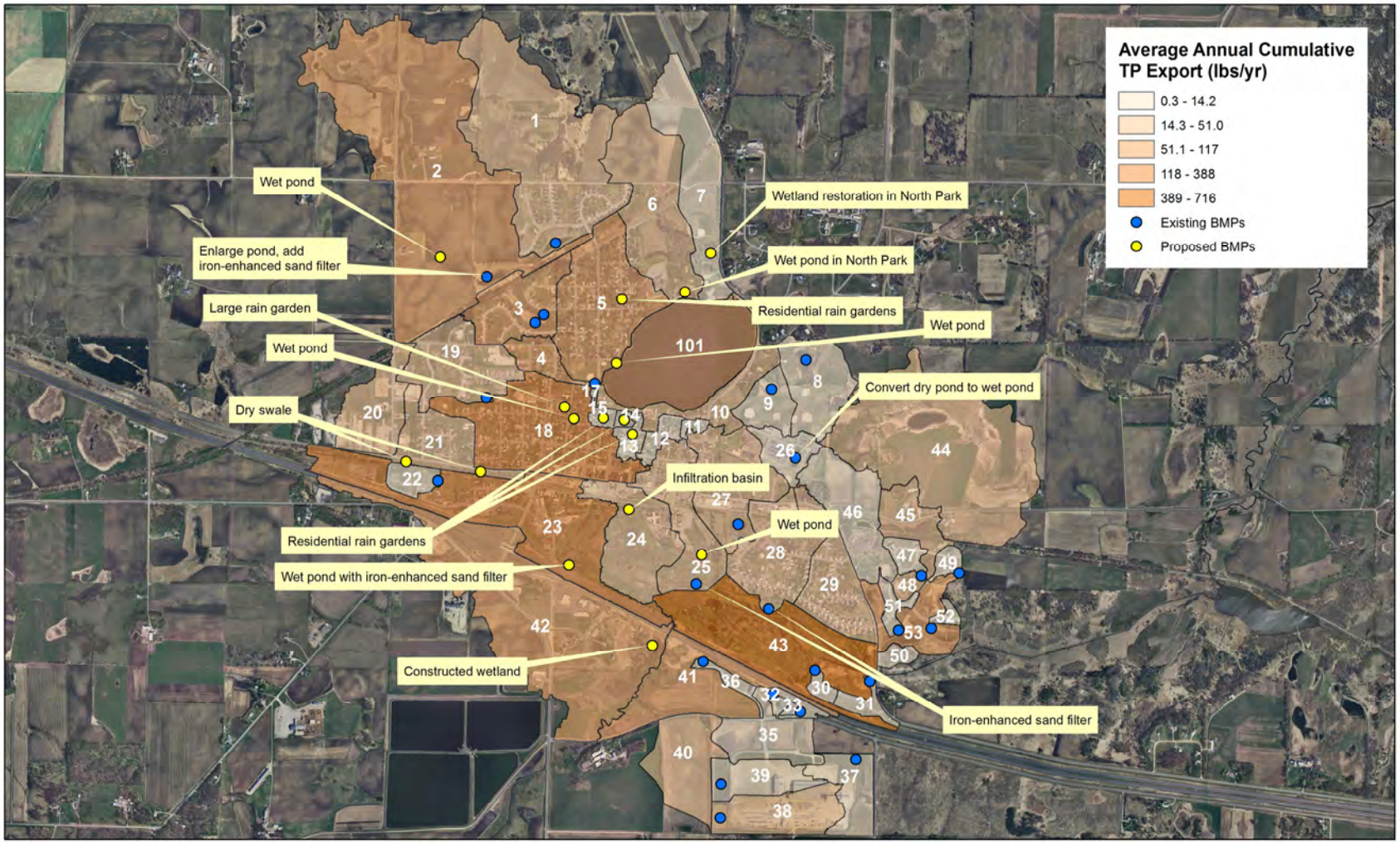


Figure PS-7. Map of Phosphorus Loads and Existing and Proposed Best Management Practices.

EXECUTIVE SUMMARY

A watershed analysis was completed to determine the upland sources of total phosphorus, total nitrogen, and total suspended solids that are being delivered to Two Rivers Lake, which is located in Stearns County, Minnesota. The analysis began with refining an existing Hydrologic Simulation Program – Fortran (HSPF) model that was developed for the Upper Mississippi River by the Minnesota Pollution Control Agency (MPCA). The objective of this effort was to be able to identify potential projects that would most positively impact the water quality of Two Rivers Lake in the rural, lakeshore, and urban areas of the watershed.

In the rural areas of the watershed, priority areas were selected based on data derived from the HSPF model that identified the subwatersheds with the highest per-acre delivery of pollutants to the lake. Within those areas, terrain analysis techniques, including the calculation of the Stream Power Index (SPI), was used to identify locations with the greatest potential for concentrated flow accumulation. High SPI values usually correlate to active erosion problems on the landscape. Structural practices, such as grassed waterways, water and sediment control basins, cover crops, or other practices, should be considered to combat active erosion that is confirmed by future site visits.

Another terrain analysis technique, called the Compound Topographic Index (CTI), was performed to identify areas where ponding naturally occurs in a watershed. This analysis was performed for the entire Two Rivers Lake Watershed and identified locations where wetland restorations may be feasible. Further site investigation and project feasibility will need to be performed to adequately determine the potential of each project identified.

For the area immediately adjacent to Two Rivers Lake, two scenarios were modeled to determine how adding lakeshore buffers or increasing development around the lake would impact water quality. Although the HSPF model only predicted a slight improvement in phosphorus loading if 25-foot buffers were implemented around the entire shoreline of the lake, the cost-per-pound removal was competitive with agricultural practices. In sharp contrast to the buffer scenario, the results showed significant degradation to water quality if residential development on the south side of the lake continued around the entire lake. Therefore, careful planning and stormwater management strategies have been identified and are encouraged for implementation.

To better understand the impacts to Two Rivers Lake from the city of Albany, a refined model called the Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds (P8) was built. Projects were identified in areas that either had no stormwater treatment or were severely undertreated.

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1.0 RURAL ANALYSIS AND RECOMMENDATIONS

1.1 MODELING METHODS

A Hydrologic Simulation Program–Fortran (HSPF) model application existed for Two Rivers Lake Watershed before this project began. This model was part of a larger effort by the Minnesota Pollution Control Agency (MPCA) to model the entire Upper Mississippi River Watershed. The existing model application delineated subwatershed boundaries based on a 30-meter Digital Elevation Model (DEM), but because a Light Detection and Ranging- (LiDAR-) based, hydrologically conditioned, 3-meter DEM was created as a part of this project, subwatershed sizes were substantially decreased, which added further refinement to the Two Rivers Lake Watershed. The Two Rivers Lake Project Area HSPF subwatersheds and reaches are illustrated in Figure 1-1.

1.2 LOADING RESULTS

The HSPF model currently estimates that the 60-square-mile watershed of Two Rivers Lake contributes a yearly average of 6,500 pounds of total phosphorus (TP), 57 tons of total nitrogen (TN), and 356 tons of total suspended solids (TSS) to the lake. The model indicates that the majority of the load is from point sources, such as septic systems; National Pollutant Discharge Elimination System- (NPDES-) permitted facilities; and surface runoff from the pasture/hay, agricultural (row crop fields), and developed lands. The watershed areas for each land use and the respective pollutant loadings are summarized in Table 1-1.

The results from the model were also analyzed by individual subwatershed and are summarized by the following three different outputs: upland loading to reach, upland loading to Two Rivers Lake, and a pollutant-delivery ratio.

1.2.1 Upland Loading to Reach

The first set of outputs shows the pollutant loading that moves from the upland areas in a subwatershed and is delivered at the outlet of that watershed through the main tributary or reach that runs through that subwatershed. The results show fairly uniform loading rates, with the exception of the urban area that delivers pollutants at a higher loading per acre. Subwatershed loadings of TP, TN, and TSS to each subwatershed's reach were exported directly from the HSPF model application and are summarized in Figures A-1 through A-3, respectively, in Appendix A.

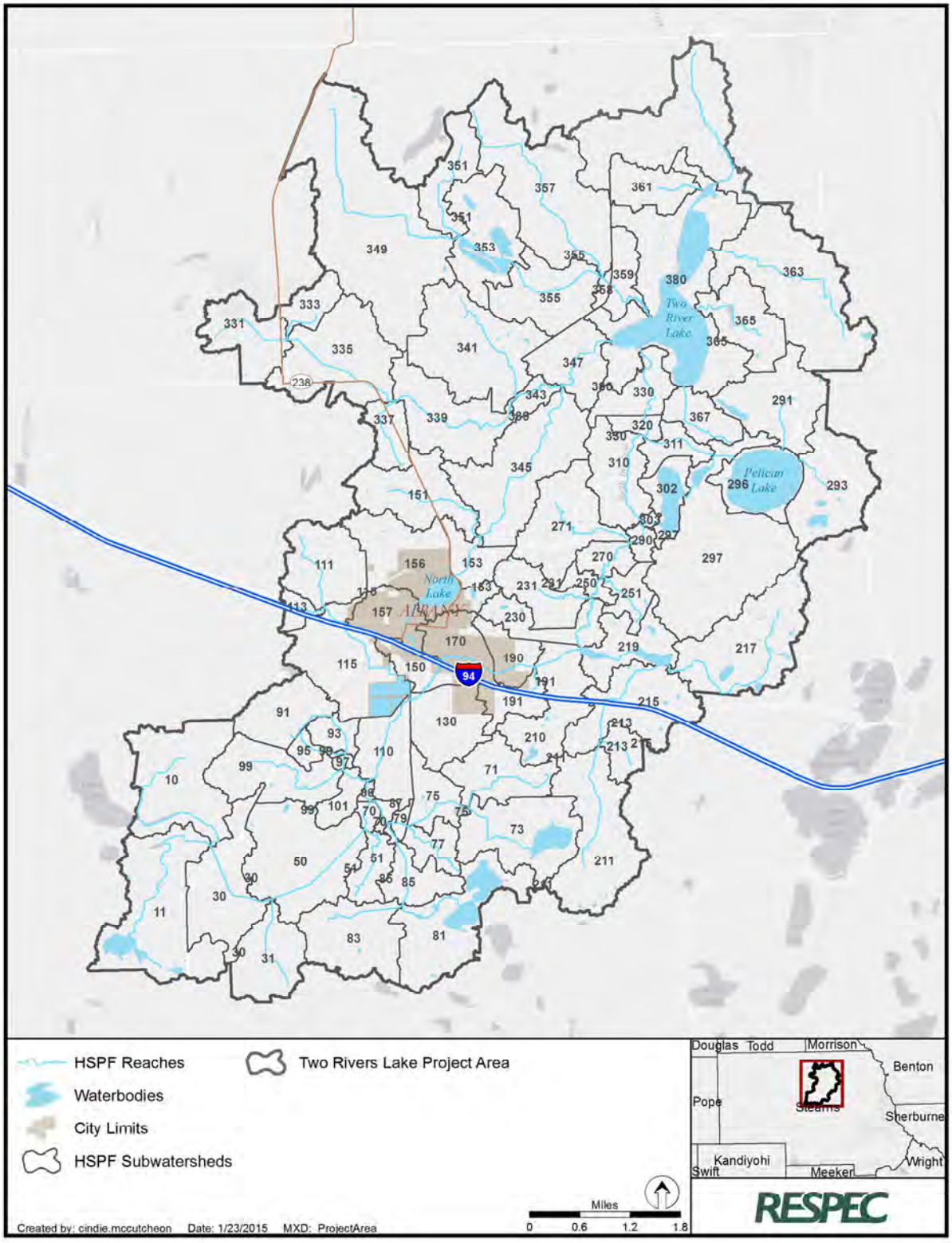

Figure 1-1. Two Rivers Lake Project Area.

Table 1-1. Watershed Areas for Each Land Use and Respective Pollutant Loadings

Source	Area		TP		TN		TSS	
	acres	%	lb/yr[(a)]	%	lb/yr[(a)]	%	lb/yr[(a)]	%
Pasture/Hay	15,199	40	1,529	24	29,614	26	79,102	11
Ag (Row Crops)	13,568	35	2,237	34	45,785	40	169,338	24
Forest	3,631	9	35	<1	726	<1	1,570	<1
Developed	2,978	8	1,419	22	19,860	17	451,728	63
Wetlands	1,733	5	21	<1	409	<1	2	<1
Grassland	1,070	3	17	<1	382	<1	1,086	<1
Feedlots	92	<1	965	15	14,008	12	0	0
Septic Systems	N/A[(b)]	N/A[(b)]	235	4	2,526	2	10,412	1
NPDES	N/A[(c)]	N/A[(c)]	44	<1	635	<1	0	0

(a) lbs/yr = pounds per year.
(b) Septic systems (662 units) were represented as a point source, so area is not applicable.
(c) NPDES point sources do not have an applicable area.

1.2.2 Upland Loading to Two Rivers Lake

The second set of outputs shows the pollutants that are generated in the upland areas of each subwatershed that are delivered to Two Rivers Lake. Loading for TP, TN, and TSS were exported from the HSPF model application and shown in Figures A-4 through A-6, respectively, in Appendix A.

These values differ from the previous analysis because not all pollutants that enter into the tributary system enter into the lake. Some pollutants, such as sediment, may fall out of suspension, while nutrients such as phosphorus and nitrogen may be used in biological processes en route to the lake.

1.2.3 Pollutant-Delivery Ratio

The last set of outputs represents the percentage of pollutants that originate in a given subwatershed that enter into the lake. This number can be used when calculating the benefit a best management practice (BMP) has on Two Rivers Lake.

Simple calculators, such as the Revised Universal Soil Loss Equation (RUSLE) or the Pollutant Reduction Calculator provided by the Board of Water and Soil Resources, can determine the pollutant removal of a practice at the edge of a field and to a nearby stream or tributary but are unable to calculate the reduction once suspended in a channel. The pollutant-delivery ratio is a value that represents the percentage of a pollutant that will enter into Two Rivers Lake once it leaves the subwatershed of origin. Table 1-2 provides the delivery ratios for each subwatershed to Two Rivers Lake and is illustrated in Figures A-7 through A-9 in Appendix A for TP, TN, and TSS, respectively.

Table 1-2. Pollutant-Delivery Ratio for Total Phosphorus (Page 1 of 3)

Reach	TP Delivery Ratio (%)	TN Delivery Ratio (%)	TSS Delivery Ratio (%)
10	49	67	86
11	49	66	85
30	52	71	88
31	48	67	88
50	51	71	89
51	49	66	85
70	48	72	78
71	40	62	84
73	42	64	86
75	50	70	88
77	40	63	88
79	49	71	88
81	44	65	85
83	44	66	87
85	46	69	91
87	50	72	82
90	56	75	90
91	46	68	87
93	47	70	85
95	49	69	87
97	46	71	95
99	45	67	88
101	51	73	95
110	51	73	89
111	42	64	87
113	58	66	85
115	23	37	63

Table 1-2. Pollutant-Delivery Ratio for Total Phosphorus (Page 2 of 3)

Reach	TP Delivery Ratio (%)	TN Delivery Ratio (%)	TSS Delivery Ratio (%)
130	54	75	91
150	76	83	91
151	59	68	90
153	74	76	90
156	69	77	90
157	85	86	91
170	83	86	92
190	68	81	91
191	59	75	90
210	61	80	92
211	44	67	86
213	38	63	83
215	61	76	89
217	39	63	86
219	55	77	94
230	61	81	90
231	51	75	89
250	64	82	83
251	50	74	88
270	65	83	84
271	58	79	91
290	70	86	76
291	0	1	1
293	0	1	1
296	0	2	1
297	6	11	12
302	8	12	11

Table 1-2. Pollutant-Delivery Ratio for Total Phosphorus (Page 3 of 3)

Reach	TP Delivery Ratio (%)	TN Delivery Ratio (%)	TSS Delivery Ratio (%)
303	71	82	100
310	73	87	89
311	55	77	93
320	81	91	91
330	86	93	91
331	71	78	89
333	68	77	92
335	76	82	91
337	71	78	90
339	79	86	91
341	76	83	91
343	84	90	83
345	74	80	90
347	88	92	91
349	72	79	88
351	66	74	88
353	81	87	90
355	88	92	91
357	74	81	89
358	94	96	92
359	95	97	93
361	84	89	95
363	93	94	91
365	100	100	91
367	76	83	94
380	100	100	99

1.3 CONSERVATION PRACTICE IDENTIFICATION AND PRIORITIZATION

A combination of loading rates and delivery ratios was used to prioritize watersheds to Two Rivers Lake. Catchments with a TP delivery ratio of 75 percent or higher were determined and are provided in Table 1-3. Additionally, catchments with higher TP (> 0.18 pound per acre [lb/acre]), TN (> 30 lb/acre), and TSS (> 4.2 lb/acre) loads were used to define the priority watersheds and are provided in Table 1-4.

Table 1-3. Catchments Delivering 75 Percent or More of Their Watershed-Supplied Total Phosphorus to Two Rivers Lake

Reach	TP Delivery Ratio (%)
380	100
365	100
359	95
358	94
363	93
347	88
355	88
330	86
157	85
361	84
343	84
170	83
320	81
353	81
339	79
367	76
341	76
335	76
150	76

Table 1-4. Catchments With the Highest Total Phosphorus, Total Nitrogen, or Total Suspended Solids Loads Being Delivered to Two Rivers Lake

Constituent	Reach	Load (lb/acre/year)
TP	157	0.62
	170	0.48
	150	0.26
	156	0.18
TN	157	8.17
	170	6.81
	150	4.23
TSS	157	243.3
	170	179.1
	150	89.7
	156	58.6
	113	54.8
	190	37.9
	153	36.8
	191	34.4
	115	30.1

1.3.1 Structural Agricultural Practices

A desktop analysis was performed to determine the potential BMP locations by using a combination of a Stream Power Index (SPI) analysis, a Compound Topographic Index (CTI) analysis, and an aerial photography review. The SPI, which is the product of the natural log of both slope and flow accumulation, is a measure of the potential erosive power of overland flow. The SPI identifies areas with high potential for erosion to occur based on flow accumulation and slope. Grassed waterways or water and sediment control basins may be ideally placed in areas of high SPI. Field investigation work will be needed to determine the best practice for each location. To provide a relative comparison of potential agricultural practices, grassed waterways were used in each situation. An editable database is being provided to Stearns County Soil and Water Conservation District (SWCD) to assist with further refinement of ranking the BMPs

when more detailed field information can be obtained. Note that some of the priority subwatersheds were highly urban with little or no agricultural land and some priority subwatersheds had few high SPI signatures. Therefore, agricultural BMPs were not recommended in all priority subwatersheds. Locations in which a grassed waterway and/or water and sediment control basin is recommended are represented by a point shown in Figure 1-2. For all of these points, a grassed waterway is also shown as a line reaching upstream of the point. The drainage areas that would be affected by each specific BMP, which were delineated by using the hydrologically corrected DEM in ArcHydro, are also shown in Figure 1-2. Areas in priority subwatersheds where an entire field was identified as having erosion issues and where grassed waterways may not remedy the issue were identified and are shown in Figure 1-3. These fields are recommended for a land-use management change, such as adding a cover crop or converting to perennial vegetation.

The most cost-effective agricultural practices are provided in Tables 1-5 and 1-6, and more in-depth details for each project are included in individual project profiles in Appendices B and C. Costs were based on 2015 payment rates for the Environmental Quality Incentive Program (EQIP) through the Natural Resource Conservation Service (NRCS). Pollutant-loading rates were determined by using the average pollutant-delivery rates for each subwatershed to Two Rivers Lake. Note that field verification has not taken place for any projects. Cost-benefit values will vary when more precise costs and pollutant-loading values can be calculated.

1.3.2 Wetland Restorations and Expansions

The CTI analysis identifies areas with high potential to pond water and indicates an area where a wetland restoration may be ideal. CTI, which is the quotient of slope and flow accumulation, was used to identify areas where a high potential exists for water to collect and pond. CTI determines the potential wetness in any portion of the landscape by combining the catchment area with slope. This analysis was used in conjunction with the 2-foot contours to identify areas where wetland restoration would be ideal; these areas are shown in Figure 1-4. The areas identified fall into the following three categories: (1) existing wetland, no restoration needed; (2) partial wetland, wetland expansion recommended; and (3) full wetland restoration recommended. The ideal locations for agricultural BMPs were limited to the priority watersheds; whereas, wetland restorations were investigated for the entire watershed. More wetland opportunities could be identified by reviewing the restorable wetland and altered watercourse database. The restorable wetlands are included in Figure 1-4, and the altered watercourses are located in Figure A-10 of Appendix A.

The most cost-effective wetland restorations are provided in Table 1-7 and more in-depth details for each project are included in individual project profiles in Appendix D. Construction costs were based on information provided by the Stearns County SWCD. Pollutant-loading rates were determined by using the average pollutant-delivery rates for each subwatershed to Two Rivers Lake. Note that field verification has not taken place for any projects. Cost-benefit values will vary when more precise costs and pollutant-loading values can be calculated.

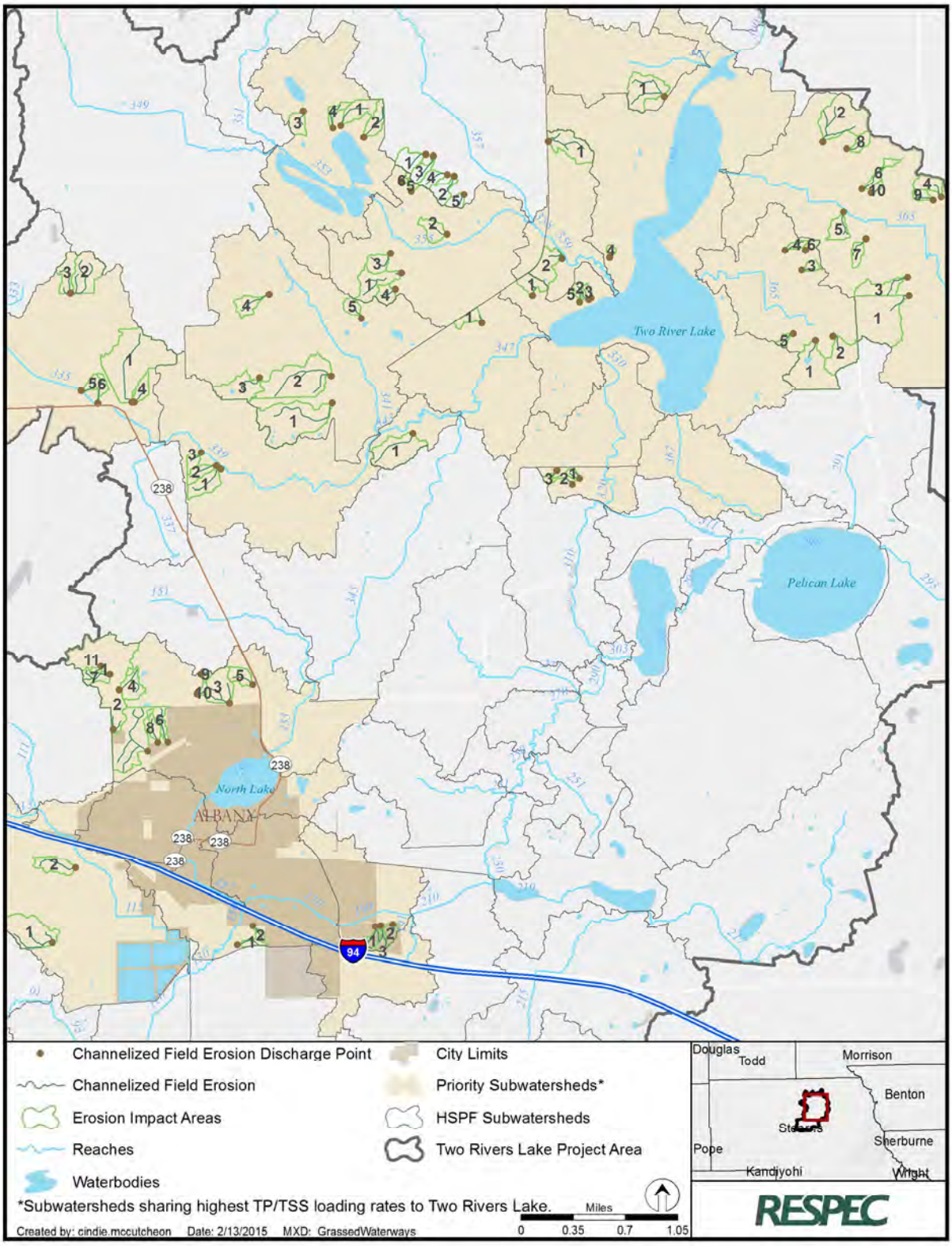

Figure 1-2. Ideal Locations in Priority Subwatersheds for Structural Practices.

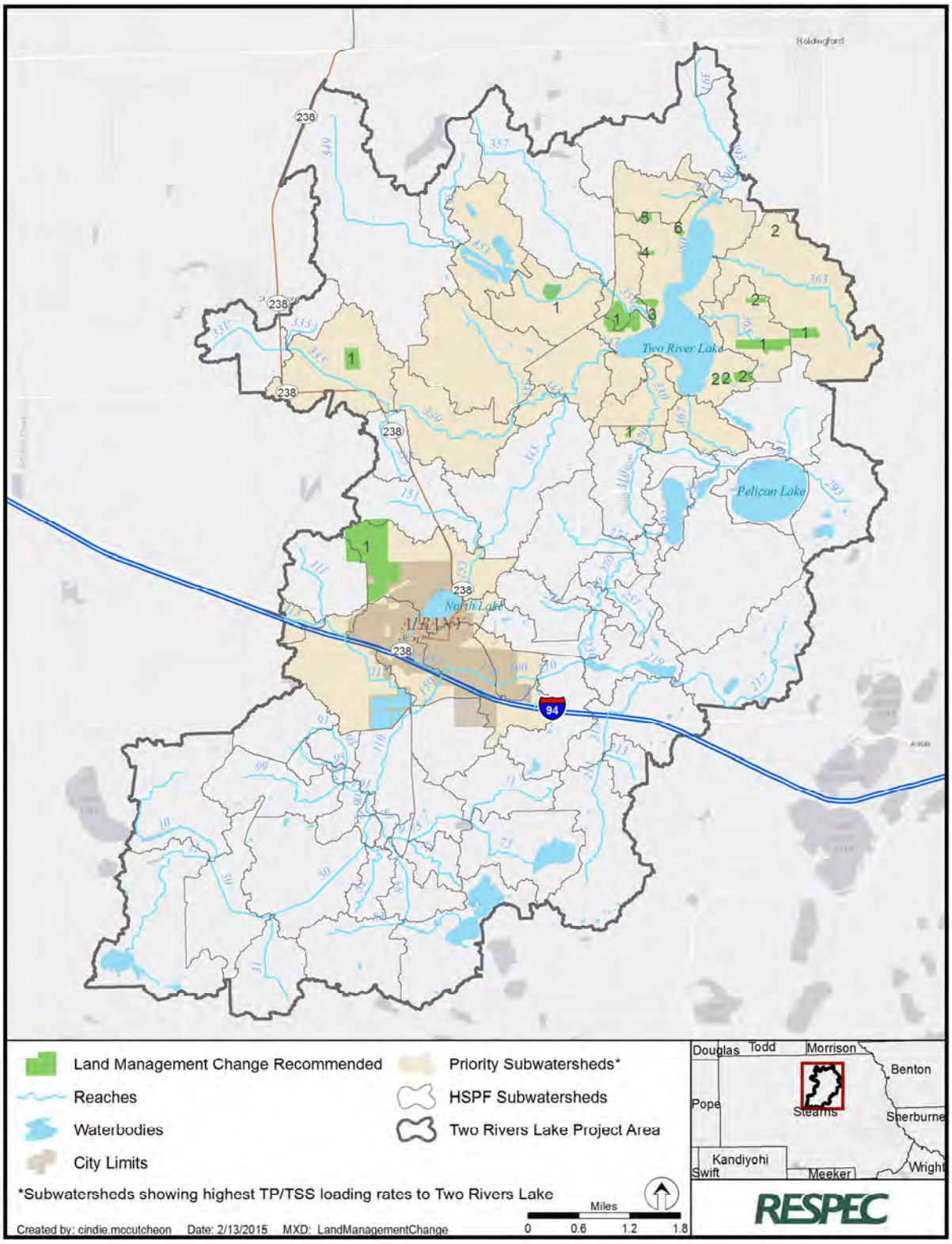

Figure 1-3. Ideal Locations Identified in Priority Subwatersheds for Land-Use Management Change.

Table 1-5. Top Twenty Most Cost-Effective Grassed Waterways for Removing Total Phosphorus From Two Rivers Lake

BMP I.D.	HSPF Subwatershed	Condition	SPI	Length (ft)	TP Reduction (lbs/yr)	TP Removal Cost ($ per pound)
156-GW-1	156	Substantial Visible Erosion	Medium High	988	8.58	15.55
363-GW-1	363	Some Visible Erosion	High	948	4.16	30.79
365-GW-1	365	Substantial Visible Erosion	Medium High	669	2.91	31.03
156-GW-2	156	Substantial Visible Erosion	High	4,664	16.02	54.45
365-GW-2	365	Some Visible Erosion	Medium High	686	1.46	63.35
335-GW-1	335	Substantial Visible Erosion	High	2,841	5.82	65.93
347-GW-1	347	Little Visible Erosion	High	290	0.44	89.09
359-GW-2	359	Some Visible Erosion	Medium High	1,048	1.57	90.07
363-GW-4	363	Some Visible Erosion	High	572	0.78	98.46
341-GW-3	341	Substantial Visible Erosion	Medium High	1,092	1.48	99.84
341-GW-1	341	Substantial Visible Erosion	High	2,940	3.81	104.20
343-GW-1	343	Substantial Visible Erosion	Medium High	1,827	2.31	106.83
156-GW-5	156	Substantial Visible Erosion	High	839	0.98	115.74
380-GW-1	380	Substantial Visible Erosion	Medium High	579	0.61	127.92
156-GW-3	156	Substantial Visible Erosion	Medium High	2,137	2.22	130.13
156-GW-9	156	Substantial Visible Erosion	Medium High	288	0.29	134.25
359-GW-1	359	Substantial Visible Erosion	High	2,151	2.14	135.52
363-GW-3	363	Some Visible Erosion	Medium High	1,078	1.07	135.69
363-GW-2	363	Some Visible Erosion	High	3,256	2.99	147.03
156-GW-4	156	Substantial Visible Erosion	Medium High	1,632	1.50	147.08

Note: Field verification has not been completed for any of these practices. These results are based purely on terrain analysis techniques. Actual results will vary when in-field analyses can be completed. Other practices, such as a water and sediment control basin, may be more suitable for the erosion concern that has been identified.

Table 1-6. Cost Effectiveness for Removing Total Phosphorus From Two Rivers Lake Through Land-Use Management Changes

BMP I.D.	HSPF Subwatershed	Condition	SPI	Field Size	TP Reduction (lbs/yr)	TP Removal Cost ($/lb)
156-LMC-1	156	Some Visible Erosion	High	238.5	37.2	89.08
335-LMC-1	335	Some Visible Erosion	Medium High	26.8	2.9	129.67
363-LMC-1	363	Some Visible Erosion	High	24.1	2.5	132.70
365-LMC-1	365	Some Visible Erosion	High	87.4	9.0	134.47
365-LMC-2	365	Some Visible Erosion	High	9.3	1.0	134.47
380-LMC-2	380	Some Visible Erosion	High	26.6	2.5	145.58
380-LMC-3	380	Substantial Visible Erosion	Medium High	19.6	1.9	145.58
380-LMC-1	380	Substantial Visible Erosion	Medium High	71.6	6.8	145.58
380-LMC-4	380	Some Visible Erosion	Medium High	8.0	0.8	145.58
380-LMC-5	380	Some Visible Erosion	Medium High	7.8	0.7	145.58
380-LMC-6	380	Substantial Visible Erosion	High	7.0	0.7	145.58
355-LMC-1	355	Some Visible Erosion	Medium High	18.3	1.7	146.87
320-LMC-1	320	Some Visible Erosion	Medium High	9.0	0.8	163.40

Note: Field verification has not been completed for these fields. These results are based purely on terrain analysis techniques and a review of aerial photographs. Actual results will vary when in-field analyses can be completed. Other practices, such as a water and sediment control basin or grassed waterways, may be more suitable for the erosion concern that has been identified.

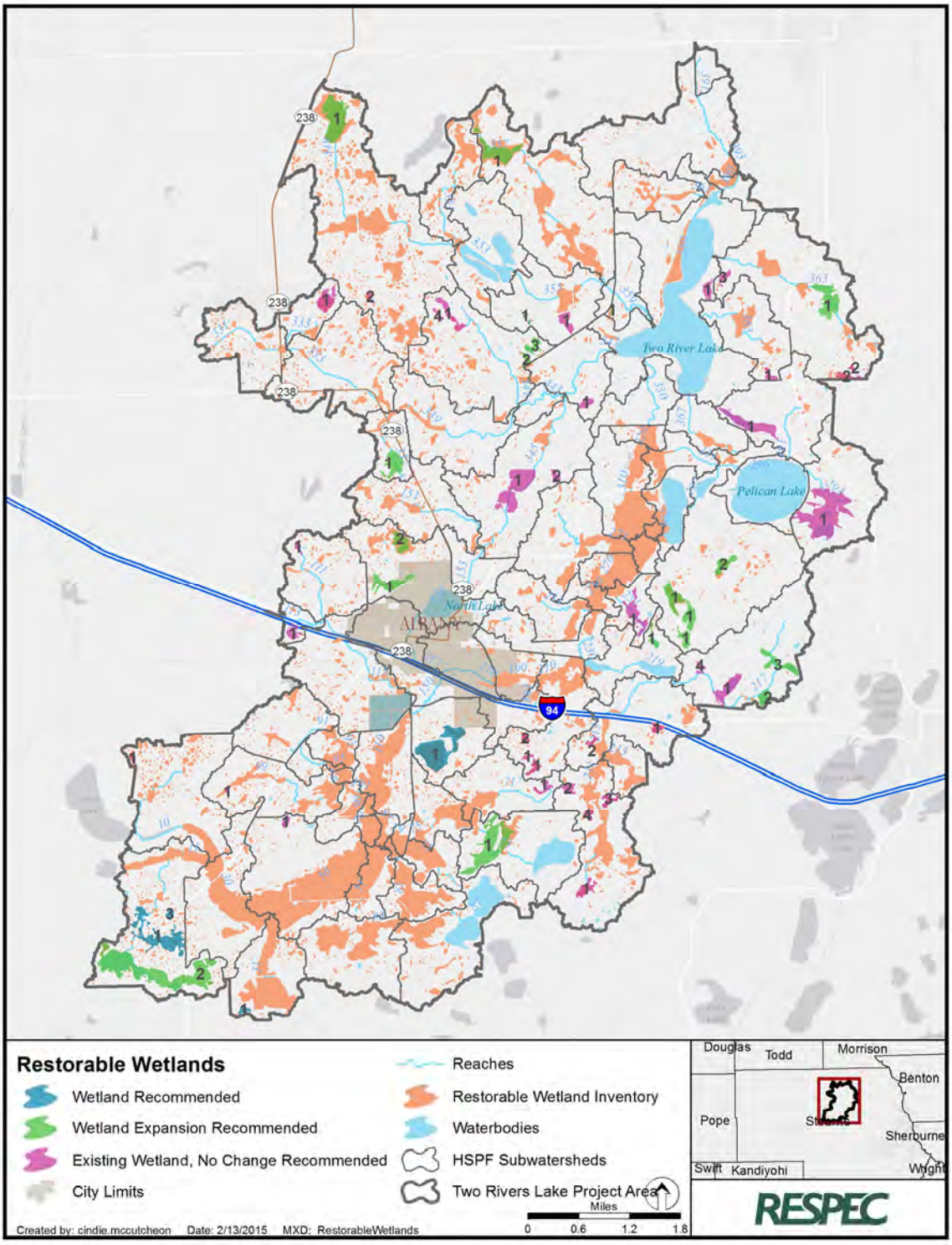

Figure 1-4. Areas Identified as Ideal for Wetland Restoration or Expansion.

Table 1-7. Cost-Benefit Analysis for Potential Wetland Restorations and Expansions (Page 1 of 2)

BMP I.D.	HSPF Subwatershed	Condition	Drainage Area (acre)	Proposed Wetland Area (acre)	Construction Cost ($)	Annual TP Reduction (lbs/yr)	TP Removal Cost ($/lb)
217-WR-2	217	High CTI	536.2	9.4	22,602	7.3	154
156-WR-1	156	High CTI	347.2	28.8	109,575	33.8	162
341-WR-2	341	High CTI	109.2	5.9	20,545	6.2	166
355-WR-2	355	No wetland present, high CTI	11.7	0.7	2,663	0.7	198
355-WR-1	355	No wetland present, high CTI	21.2	1.3	4,946	1.2	203
363-WR-1	363	High CTI	601.8	45.8	173,314	39.0	222
219-WR-1	219	High CTI	63.0	6.8	11,770	2.1	282
359-WR-1	359	High CTI	14.0	2.3	7,811	1.2	324
156-WR-2	156	No wetland present, high CTI	86.0	19.2	73,050	9.8	374
341-WR-3	341	High CTI	68.4	13.1	38,427	4.5	424
11-WR-1	11	No wetland present, high CTI	705.9	70.1	266,708	28.6	466
357-WR-1	357	High CTI	284.6	44.0	165,526	16.6	498
217-WR-3	217	High CTI	453.7	25.1	73,874	6.5	567
337-WR-1	337	High CTI	98.2	29.2	110,157	8.2	675
349-WR-1	349	High CTI	237.5	69.4	263,105	16.2	813
11-WR-2	11	High CTI	403.6	167.0	396,582	22.4	885
73-WR-1	73	High CTI	674.0	84.9	323,018	17.8	906
11-WR-3	11	No wetland present, high CTI	23.5	5.3	20,165	1.1	921
130-WR-1	130	High CTI	304.8	92.0	350,031	18.1	964

Table 1-7. Cost-Benefit Analysis for Potential Wetland Restorations and/or Expansions (Page 2 of 2)

BMP I.D.	HSPF Subwatershed	Condition	Drainage Area (acre)	Proposed Wetland Area (acre)	Construction Cost ($)	Annual TP Reduction (lbs/yr)	TP Removal Cost ($/lb)
31-WR-1	31	No wetland present, high CTI	21.3	5.1	19,404	1.0	998
297-WR-1	297	High CTI	382.9	58.8	216,106	1.7	6,415
297-WR-2	297	High CTI	87.1	17.4	62,397	0.4	7,748

Note: Field verification has not been completed for these projects. These results are based on terrain analysis techniques and a review of aerial photographs. Actual results will vary when in-field analyses can be completed. The pollutant-removal capacity of a wetland is highly variable, and some projects may actually result in an increase in pollutant loading. An extensive investigation is required before pollutant-removal rates can be confirmed.

1.3.3 Nutrient Management Planning

Although not a part of this study, additional research should be conducted to determine if the feedlots in the watershed are operating with solid nutrient management planning and using protocols that meet industry standards. The HSPF model predicts that 15 percent of the TP loads and 12 percent of the TN loads are likely coming from feedlots, even though they make up less than 1 percent of the land area. The locations of known feedlots are illustrated in Figure 1-5.

1.3.4 Water Quality Monitoring

One option to identify any type of disproportionately high loading rates is to implement a synoptic water quality monitoring program. During rainfall events, a field instrument called a "sonde" can measure water quality parameters, including pH, dissolved oxygen, conductivity, turbity, and temperature, without submitting samples to a laboratory. By taking measurements at several locations over the course of a storm event, areas contributing disproportionately high pollutant loads can be identified and isolated. Spikes in these values during a storm can often indicate a problem area immediately upstream.

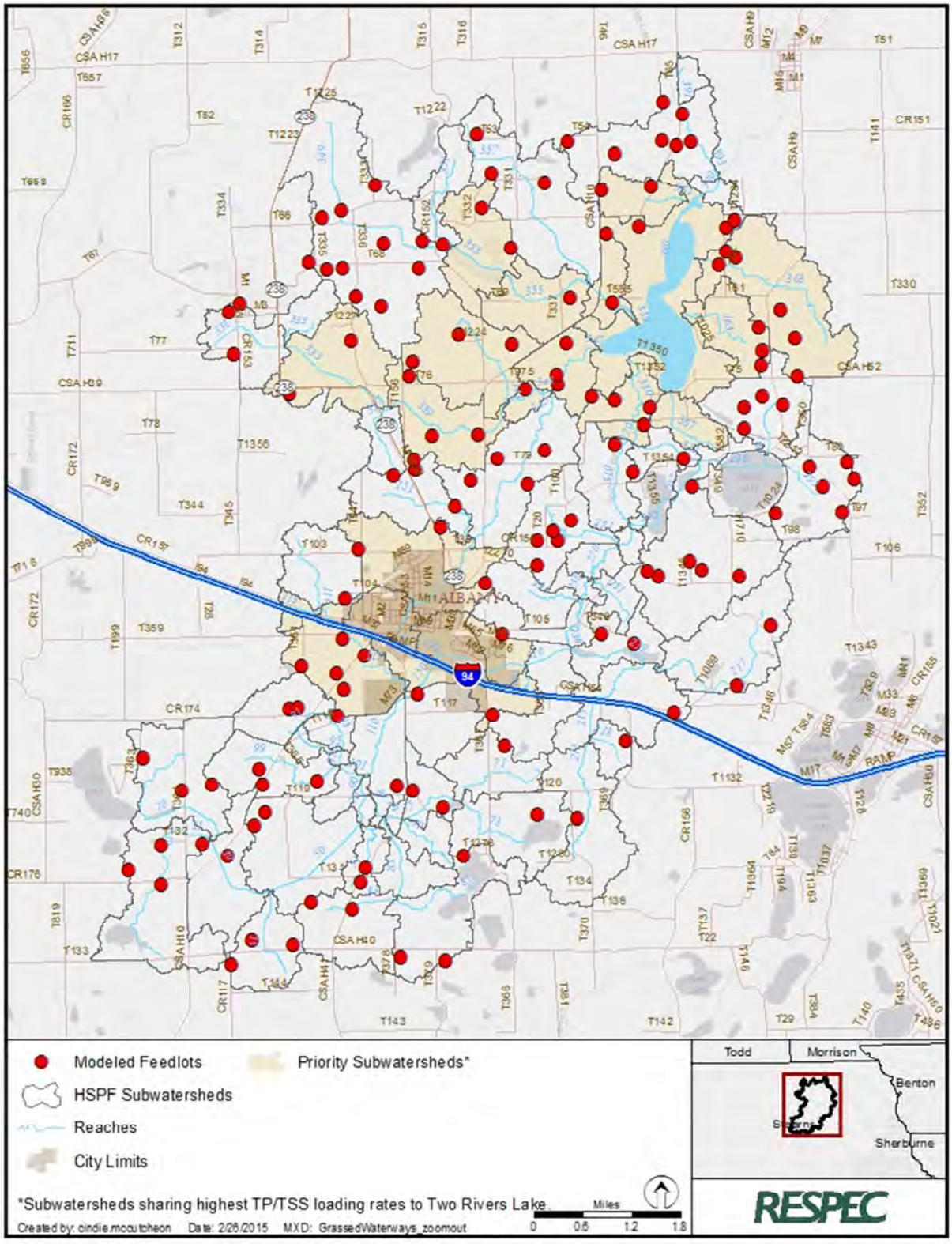

Figure 1-5. Feedlot Locations.

2.0 LAKESHORE ANALYSIS AND RECOMMENDATIONS

The HSPF model estimates that the 1,200-acre watershed immediately surrounding Two Rivers Lake (Subwatershed 380) is directly contributing a yearly average of 150 pounds of TP, 2,550 pounds of TN, and 4.8 tons of TSS to the lake. The model indicates that the majority of the loads are from septic systems and surface runoff from the pasture/hay, agricultural (row crops), and developed land areas.

The land being used for pasture and hay represents 51 percent of the total land use, yet it contributes less than its share of the total pollutant loading (39 percent, 43 percent, and 17 percent of the TP, TN, and TSS loads, respectively). The land being used for row crops represents 11 percent of the land area in this subwatershed and generates 14 percent, 16 percent, and 9 percent of the TP, TN, TSS loads, respectively. The developed areas of this subwatershed represent only 4 percent of the subwatershed, yet they yield significantly higher pollutant loading rates (15 percent, 12 percent, and 72 percent of the TP, TN, and TSS loads, respectively). Adding to the impact of the developed areas, septic systems contribute 44 percent and 25 percent of the TP and TN loads, respectively.

The HSPF model assumes that 15 percent of the septic systems are failing at any given time and are actively contributing pollutants to the system. The actual pollutant loading could be higher or lower, depending on the current state of the septic systems in this subwatershed. The watershed areas for each land use and the respective pollutant loadings from each source are summarized in Table 2-1.

Table 2-1. Lakeshed Areas for Each Land Use and the Respective Pollutant Loadings

Land Use or Source	Area		TP		TN		TSS	
	acre	%	lb/yr	%	lb/yr	%	lb/yr	%
Pasture/Hay	618	51	58	39	1,097	43	1,621	17
Forest	247	20	2	1	42	2	56	1
Row Crops	135	11	21	14	421	16	893	9
Wetlands	103	8	1	< 1	15	<1	0	0
Grassland	65	5	1	< 1	20	< 1	30	< 1
Developed	51	4	22	15	308	12	6,862	72
Feedlots	2	< 1	1	< 1	13	< 1	42	< 1
Septic Systems	N/A[(a)]	N/A[(a)]	44	29	635	25	0	0

(a) Septic systems (30 units) were represented as a point source, so the area is not applicable.

2.1 MODELING METHODS

To better understand how land-use management changes in this subwatershed could impact the water quality of Two Rivers Lake, the following two strategies, including both a restoration and a degradation scenario, were set up and run in the HSPF model:

- **Restoration Scenario**—provide a minimum 25-foot buffer around the entire perimeter of the lake.
- **Degradation Scenario**—increase development pressure by surrounding the lake with ¼-acre, single-family homes.

Each of these scenarios is discussed in the following sections.

2.1.1 Restoration Analysis—Increased Shoreline Buffers

The first HPSF model scenario (restoration) added a 25-foot grassland buffer in all areas around Two Rivers Lake that are currently not buffered. Buffered and nonbuffered areas were defined by research performed by the Stearns County SWCD and are shown in Figure 2-1.

To effectively model a completely buffered lake, all land uses within the 25-foot wide buffer area were converted from their existing land use to grassland and a pollutant reduction factor was applied to account for the removal capacity provided by a vegetated filter strip. Those values were based on research presented in the *Agricultural BMP Handbook for Minnesota* [Miller et al., 2012] that reported how TSS, TP, and TN removal can be calculated as a function of buffer width according to Equations 2-1 (TSS), 2-2 (TP) and 2-3 (TN), where y represents removal efficiency (%) and x represents buffer width (feet).

$$y = 8.5Ln(x) + 51.3 \quad (0\text{-}1)$$

$$y = 15.84Ln(x) + 5.9 \quad (0\text{-}2)$$

$$y = 20.24Ln(x) - 13.18 \quad (0\text{-}3)$$

Because approximately 71 percent of Two Rivers Lake has existing grassland buffers, the calculated efficiency factors were adjusted by using a fraction representing the possible load if no buffers existed. Table 2-2 shows the efficiency factors calculated with Equations 2-1 through 2-3 and the efficiency factors adjusted for existing buffers.

2.1.2 Degradation Analysis—Increased Shoreline Development

The second HSPF scenario (degradation) represented full residential buildout conditions within a 500-foot area surrounding the lake. Within that area, the following parameters were applied to areas that are not currently developed:

Figure 2-1. Existing 25-Foot Buffers Around Two Rivers Lake.

- Land use was changed to "Developed"
- The effective impervious area was set at 28 percent, which is the same effective impervious percent of the residential area in Subwatershed #157
- The average lot size was calculated to be 10,000 square feet (slightly under ¼ acre)
- One septic system was assigned to each lot
- The average household size was assumed to be 3.0 persons, which is the Stearns County average.

Table 2-2. Efficiency Factors Calculated by Using Equations 2-1 Through 2-3 and Efficiency Factors Adjusted for Existing Buffers

Constituent	Calculated Efficiency Factors (%)	Adjusted Efficiency Factors (%)
TSS	79	52
TP	57	28
TN	52	24

2.2 LOADING RESULTS

The results for the two scenarios are presented in the following sections.

2.2.1 Restoration Analysis—Increased Shoreline Buffers

Table 2-3 provides the change in discharge, as well as the TN, TP, and TSS loads and concentrations resulting from the shoreline buffer scenario. Completing the 25-foot lake buffer around the lake would result in a decrease of 28 pounds of phosphorus, 477 pounds of nitrogen, and 3 tons of sediment per year.

2.2.2 Degradation Analysis—Increased Shoreline Development

The increase in discharge, as well as the TN, TP, and TSS loads and concentrations from the 500-foot urban buildout scenario, is provided in Table 2-4. This scenario shows that urban buildout would result in an increase of 2,097 pounds of phosphorus, 29,981 pounds of nitrogen, and 54 tons of sediment per year to Two Rivers Lake.

2.3 CONSERVATION PRACTICE IDENTIFICATION AND PRIORITIZATION

Several recommendations are made for the immediate watershed areas surrounding Two Rivers Lake and are described in the following sections.

Table 2-3. 25-Foot Buffer Scenario Results

Average Annual Values	Existing Conditions	25-Foot Buffer Scenario Results	Average Annual Difference	Change to Two Rivers Lake (%)
Discharge (acre-ft/year)	16,057	16,061	negligible	0.0
TN (lb/year)	86,462	85,985	–477	–0.6
TP Load (lb/year)	4,589	4,561	–28	–0.6
TSS (ton/year)	408	405	–3	–0.6
TN Flow Weighted Concentration (mg/L)	1.98	1.97	–0.01	–0.6
TP Flow Weighted Concentration (mg/L)	0.105	0.104	–0.001	–0.6
TSS Flow Weighted Concentration (mg/L)	18.7	18.6	–0.1	–0.6

Mg/L = milligrams per liter.

Table 2-4. 500-Foot Urban Buildout Scenario Results

Average Annual Values	Existing Conditions	500-Foot Buffer Scenario Results	Average Annual Difference	Change to Two Rivers Lake (%)
Discharge (acre-ft/year)	16,057	16,492	+435	3
TN (lb/year)	86,462	116,443	+29,981	35
TP Load (lb/year)	4,589	6,686	+2,097	46
TSS (ton/year)	408	462	+54	13
TN Flow Weighted Concentration (mg/L)	1.98	2.60	+0.62	31
TP Flow Weighted Concentration (mg/L)	0.105	0.149	+0.049	42
TSS Flow Weighted Concentration (mg/L)	18.7	20.6	+1.9	10

2.3.1 Lakeshore Buffers

A cost-benefit analysis was performed to identify the most cost-effective areas around Two Rivers Lake, divided into the ten lakeshore zones shown in Figure 2-2, where construction of missing shoreland buffers would have the greatest impact on pollutant removal. Pollutant loading was estimated by using values from the HSPF model. Costs to implement the buffers in each zone were based on either the 2015 Environmental Incentives Program (EQIP) payment rates for shoreland buffers located in agricultural areas or average project costs, as provided by

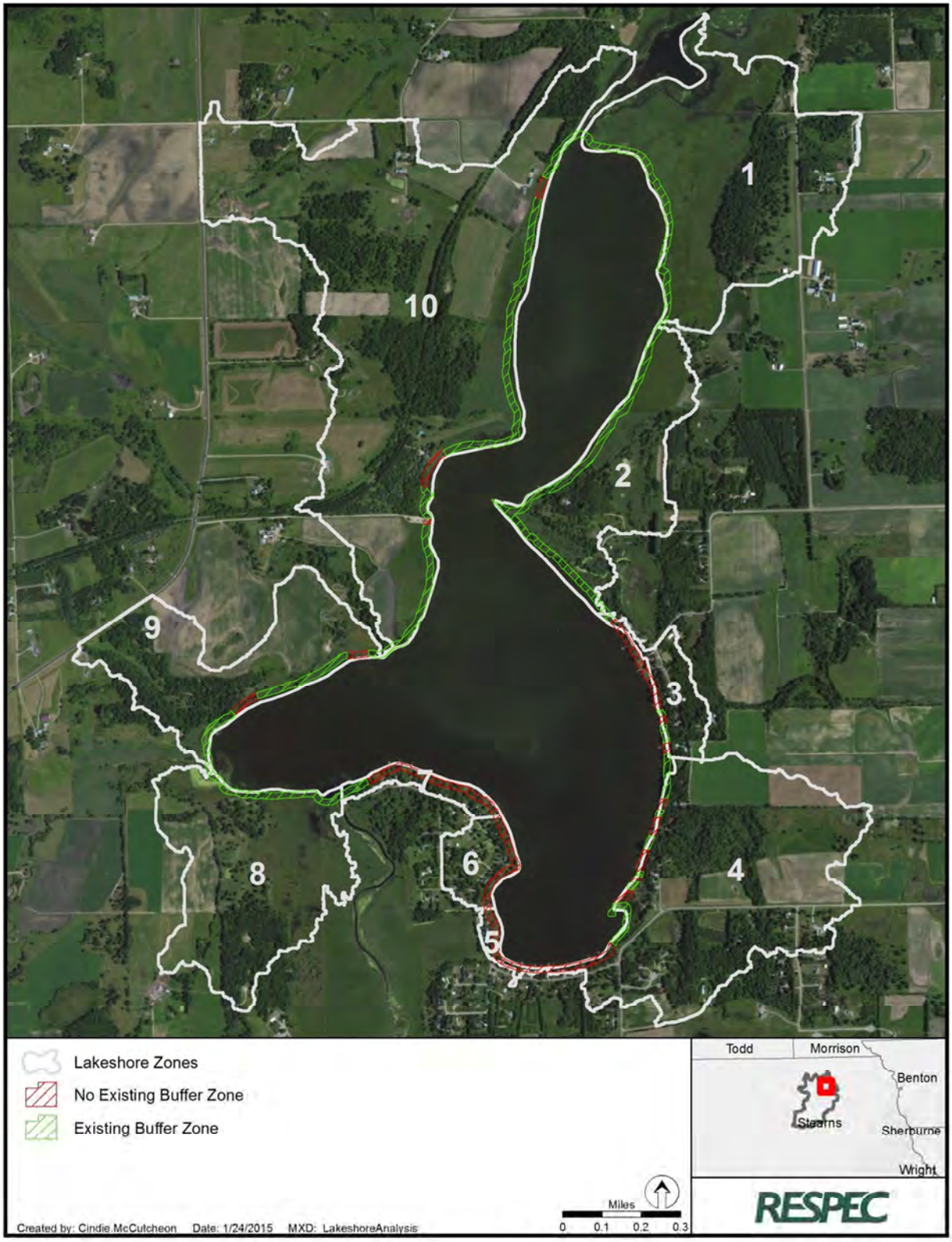

Figure 2-2. Two Rivers Lakeshore Zones.

the Stearns County SWCD, for shoreland buffers located in developed areas. The total cost to restore all 9,281 linear feet of missing buffers is estimated to be $1,036,845. Maintenance costs were assumed to be the responsibility of each owner and did not factor into the cost-benefit analysis.

Prioritization between buffers on individual properties can be further refined when the field investigation work is completed to provide more precise information on costs and pollutant loading. The cost-benefit results for the missing buffers in each lakeshore zone are summarized and ranked in Table 2-5. The project profiles located in Appendix E provide additional information.

2.3.2 Land Development Planning

Because significant impacts to water quality were observed under the increased development scenario, a comprehensive land development plan is recommended to be completed before additional residential development would be allowed to take place around the lake. Alternatives to individual sewage treatment systems, such as a centralized wastewater treatment facility, should be considered. Additionally, lakeshore buffers and low-impact development practices should be encouraged or required through ordinance for new homes located within 500 feet of the lake.

2.3.3 Septic System Improvements

Because 29 percent of the TP load and 25 percent of the TN load from this watershed is estimated to be coming from failing septic systems, it is critical that failing systems are immediately repaired or replaced, particularly in this subwatershed because of the close proximity to the lake. Based on the 15 percent failure rate, five failing septic systems in this watershed are likely contributing a total of 29 pounds of phosphorus to the lake each year. Various low-interest loan programs are available to assist homeowners with financing the construction of a new system.

2.3.4 Low-Impact Development Practices

Because 15 percent, 12 percent, and 72 percent of the TP, TN, and TSS loads, respectively, come from just 4 percent of the land area represented by residential development, the current homes around and near the lake have an incredible opportunity to positively impact pollutant loading to the lake. Practices such as rain gardens, rain barrels, impervious disconnections, infiltration swales, shoreland buffers, and fertilizer management will reduce pollutant loading to the lake. Table 2-6 shows a calculation of loading by lakeshore zone using the simple method and may assist in targeting low-impact development practices.

2.3.5 Agricultural Best Management Practices

Several agricultural BMPs could be implemented in this watershed and were analyzed and described in the previous chapter.

Table 2-5. Cost-Benefit Analysis for Implementing Shoreline Buffers Around Two Rivers Lake

BMP I.D.	HSPF Subwatershed	Condition	Lakeshore Zone	Unbuffered Shoreline (ft)	Implementation Cost ($)	Annual TP Reduction to Lake With BMP (lbs/yr)	TP Reduction to Lake With BMP Over 20 years (lbs)	20-Year TP Removal Cost ($/lb)
380-BUF-10	380	Unbuffered Shoreline	10	948	15,689	3.66	73.2	214
380-BUF-9	380	Unbuffered Shoreline	9	708	11,717	1.82	36.4	322
380-BUF-4	380	Unbuffered Shoreline	4	2,062	216,308	8.54	170.9	1,266
380-BUF-6	380	Unbuffered Shoreline	6	1,484	156,223	4.49	89.8	1,739
380-BUF-3	380	Unbuffered Shoreline	3	998	216,308	2.94	58.8	3,680
380-BUF-5	380	Unbuffered Shoreline	5	1,155	192,274	1.57	31.5	6,106
380-BUF-7	380	Unbuffered Shoreline	7	1,926	228,325	1.28	25.6	8,915

Note: Field verification has not been completed for these projects. These results are based on HSPF loading rates and impervious surface estimates. The actual results will vary when in-field analyses can be completed.

Table 2-6. Loading by Lakeshore Zones Based on the Simple Method[(a)]

Lakeshore Zone	Annual Load (lbs)	Annual Rainfall (in)	Fraction of Annual Events Producing Runoff	Percent Impervious Area (%)	Runoff Coefficient	Pollutant Concentration (mg/L)	Area (ac)	Load per Acre (lb/ac)	Presence of Urbanized Area
Area 1	24.41	28.25	0.9	1	0.059	0.4	180	0.14	No
Area 2	11.93	28.25	0.9	1	0.059	0.4	88	0.14	No
Area 3	8.90	28.25	0.9	14	0.176	0.4	22	0.40	Partial
Area 4	21.16	28.25	0.9	5.1	0.096	0.4	96	0.22	Minor
Area 5	3.00	28.25	0.9	22.3	0.251	0.4	5.2	0.58	Yes
Area 6	9.28	28.25	0.9	15.6	0.190	0.4	21.2	0.44	Yes
Area 7	3.81	28.25	0.9	9.3	0.134	0.4	12.4	0.31	Yes
Area 8	14.56	28.25	0.9	0.03	0.050	0.4	126	0.12	No
Area 9	12.48	28.25	0.9	0.6	0.055	0.4	98	0.13	No
Area 10	55.62	28.25	0.9	1.2	0.061	0.4	398	0.14	No
Total	**141.95**	**28.25**	**0.9**	**1**	**0.059**	**0.4**	**1,047**	**0.14**	**No**

(a) Annual loads were calculated from the methods described at *http://www.stormwatercenter.net/monitoring%20and%20assessment/simple%20meth/simple.htm*

3.0 URBAN ANALYSIS AND RECOMMENDATIONS

3.1 MODELING METHODS

The Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds (P8) was selected to model runoff and associated sediment and phosphorus loading. P8 is a water quality model that simulates runoff and associated sediment and pollutant runoff, transport, and removal from weather time series. Runoff and sediment transport are driven by precipitation inputs, while sediment and associated pollutant removal are determined by input BMP characteristics. TSS and TP were the pollutants considered as part of this analysis. Figure 3-1 illustrates the subwatershed delineation used in the P8 model, which was based on the city of Albany's existing water quality BMPs, regional outfalls, and proposed future improvements. More details on the model setup can be found in Appendix F.

3.2 LOADING RESULTS

P8 provides estimates of runoff, sediment transport, pollutant loading, and pollutant and sediment removal. Sediment and pollutant loading, concentrations, and removal are reported for each subwatershed and BMP. Hydraulic outputs include the overall water balance as well as statistics relating to mean, minimum, and maximum discharges and water levels for all BMPs.

3.2.1 Summary of Total Phosphorus and Total Suspended Solids Results

As identified in the HSPF model, the city of Albany is a source of TP and TSS that flows toward Two Rivers Lake. Approximately 1,140 pounds of TP and 355,000 pounds of TSS are generated within the study area annually, based on the P8 model. However, numerous existing BMPs treat runoff in the study area; annual removal is estimated at 352 pounds (31 percent) for TP and 168,400 pounds for TSS (56 percent). Reduction in watersheds with a BMP is actually 56 percent for TP and 86 percent for TSS. Table 3-1 provides a summary of loads and treatment level provided by existing BMPs.

3.2.2 Pollutant Load

Pollutant load is the model estimate of pollutant originating within the subwatershed. Pollutant load results for TP and TSS are shown by subwatershed in Appendix F (Table F-1, Figures F-1 and F-6 [load] and Figures F-2 and F-7 [load per acre]). Undeveloped areas have lower TP and TSS loads per acre than more developed areas such as those in the middle of Albany. However, the area of each subwatershed is typically the most important factor in determining total TP and TSS load in a subwatershed.

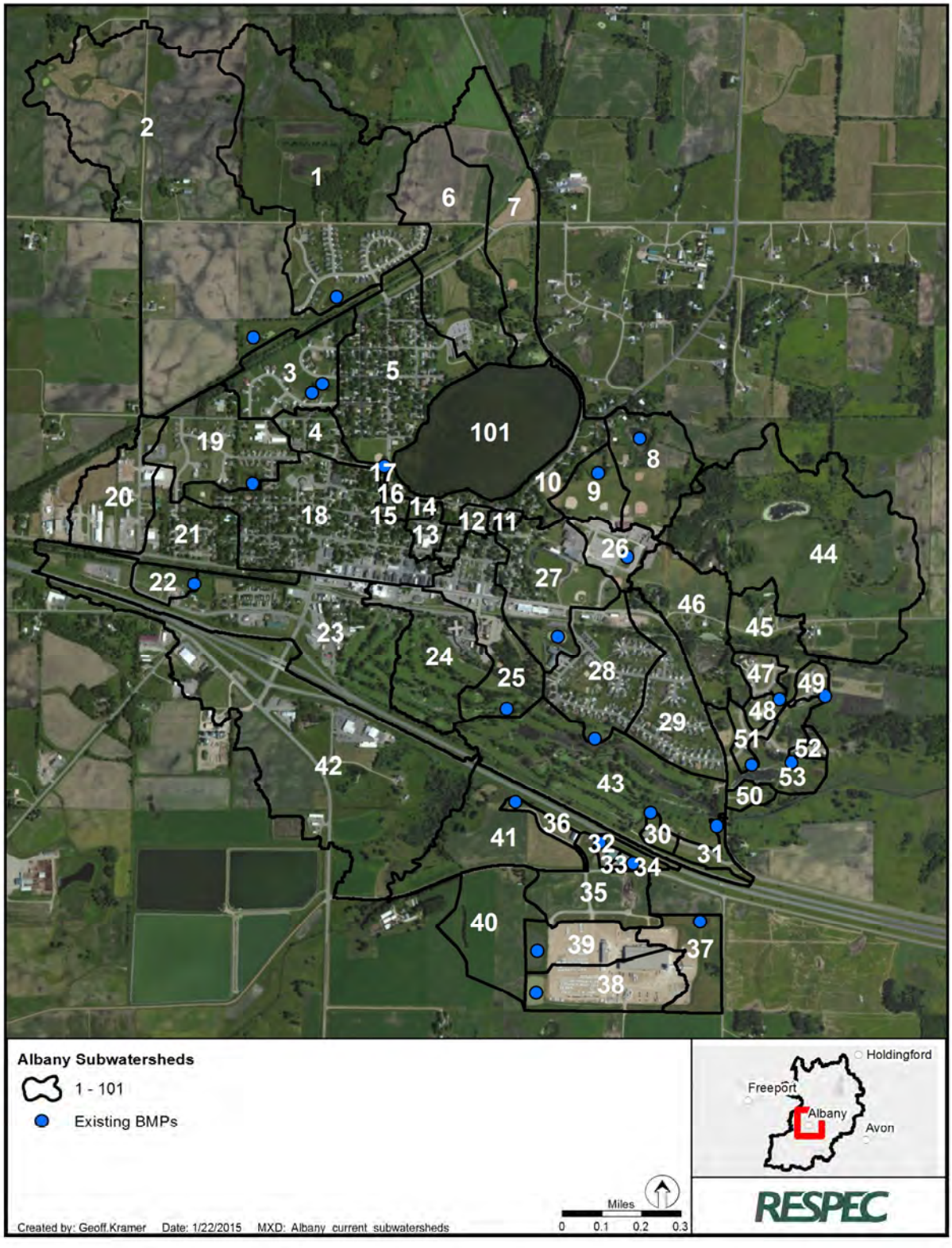

Figure 3-1. Map of Urban Analysis Subwatersheds and Existing Best Management Practices.

Table 3-1. Existing Conditions Load and Export in the Study Area

	TP		TSS	
	Treated Area Only (860 acres)	Total Study Area (1,950 acres)	Treated Area Only (860 acres)	Total Study Area (1,950 acres)
Load	625	1,137	196,300	356,300
Removal (lbs/yr)	352	352	168,400	168,400
Export	273	785	27,900	187,900
Reduction (%)	56	31	86	56

3.2.3 Pollutant Export

Pollutant export is the amount of pollutant that leaves each subwatershed regardless of where the pollutant originates. This recommendation is a more comprehensive way to interpret model results because it takes into account treatment by upstream BMPs, while pollutant load does not. Subwatersheds without BMPs typically have a higher pollutant export than those without. By using the pollutant export, data can highlight areas that have the potential to treat large pollutant loads with large regional water quality BMPs. Pollutant export is reported in Appendix F (Table F-1, Figures F-3 and F-8).

3.2.4 Pollutant Removal and Treatment Train Effects

The existing BMPs in the city of Albany are more efficient at removing TSS than TP. The existing BMPs remove pollutants by settling, which capture the larger particles that make up the most significant portion of the TSS load (by mass). TP removal rates are lower for two reasons. First, the existing BMPs are not designed to treat dissolved phosphorus, which generally constitutes more than 40 percent of TP in urban runoff. Secondly, particulate phosphorus attached to smaller, more difficult to settle, particles are often present in greater concentrations (mass of pollutant/mass of particles because of increasingly larger specific surface areas as particle size diminishes. Pollutant removal and cumulative pollutant removal of the existing BMPs within the study area are reported in Appendix F (Table F-1, Figures F-4, F-5, F-9, and F-10).

A treatment train is an effective tool to capture pollutants by using BMPs in series, but the effectiveness of each BMP decreases the further downstream in the watershed they are found. The treatment train in Subwatersheds 1–4 is an example of diminishing BMP performance: TP removal efficiency is reduced as flow moves downstream from Wet Pond 1 (35.1 percent) to Wet Pond 2 (13.8 percent) to Wet Ponds 3a and 3b (7.6 percent combined removal). The TP that is not removed in Wet Pond 1 is sent to Wet Pond 2, which is tasked with removing TP not only from its own runoff, but also from the finer particles with higher TP concentrations that were

not captured in Wet Pond 1. A similar effect is seen in the treatment train including Structures 26–28.

3.3 CONSERVATION PRACTICE IDENTIFICATION AND PRIORITIZATION

Potential locations for new BMPs were identified to enhance pollutant removal within the study area. Each subwatershed was analyzed for potential improvements of existing BMPs or implementing new BMPs while considering a wide range of factors, including land availability, future development potential, flood reduction, existing BMP retrofit potential, and educational opportunities and community involvement potential. Potential projects proposed by the city of Albany were also included in the analysis, except for the Hondl Pond, which was outside of the study limits.

A preliminary list of potential projects (Figure F-11 in Appendix F) was presented to Stearns County SWCD and the city of Albany in a meeting in Albany on January 13, 2015. With input from Stearns County SWCD and the city of Albany, a final list of 19 proposed new projects was produced. Figure 3-2 illustrates the locations and brief descriptions of the proposed projects.

The proposed improvements consist of several different BMP types located throughout the city. Two of the projects are pond retrofits, including pond expansion and creating a permanent pool within the existing dry pond in Subwatershed 26 and an expansion of the existing permanent pool in the pond within Subwatershed 2. Implementing new ponds is proposed within Subwatersheds 2, 5, 6, 18, 23, and 25. Constructed wetlands are proposed within Subwatersheds 7 (restoration) and 42 (new construction). Opportunities for bioretention (rain garden) projects are identified within Subwatersheds 5, 13, 14, 15, and 18. A location for a dry swale to treat runoff from Subwatersheds 20 and 21 is identified adjacent to Railroad Avenue within Subwatershed 21. An infiltration basin project was proposed to treat runoff from the largely impervious upper portion of Subwatershed 24. Finally, four iron-enhanced sand filters are proposed for the existing wet ponds in Subwatersheds 2, 25, and 28, as well as the potential new pond in Subwatershed 23.

P8 was used to evaluate the pollutant-removal potential of each of the proposed BMP projects. BMP sizes were estimated based upon water quality volume (WQV), which is the amount of runoff expected from a 1.1-inch rainfall event. In areas where sufficient land was unavailable to treat the WQV, the structure size was maximized within the site constraints. A rectangular geometry with 4:1 side slopes was assumed for determining relevant basin dimensions. The permanent pool depth was assumed to be 3 feet in wet ponds and wetlands. A maximum ponding depth of 18 inches and an infiltration rate of 1 inch per hour were assumed for bioretention BMPs, per the Minnesota Stormwater Manual [Minnesota Stormwater Manual Contributors, 2014].

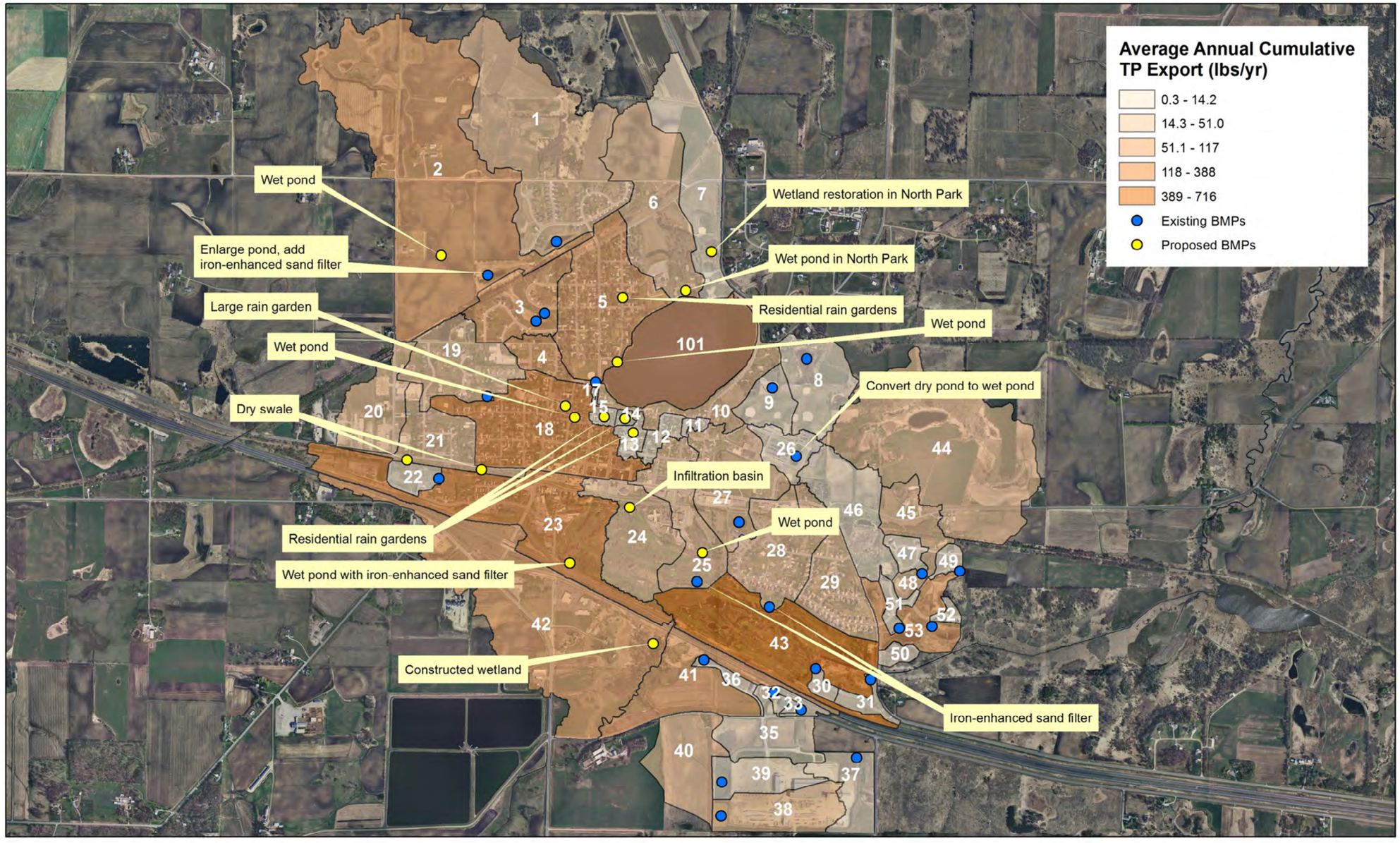

Figure 3-2. Map of Proposed Best Management Practices.

Removing dissolved phosphorus by iron-enhanced sand filters was estimated outside of P8. Iron-enhanced sand filters were assumed to remove 80 percent of dissolved phosphorus, based on Weiss et al. [2011]. Dissolved phosphorus was assumed to be 44 percent of TP, based on values reported for urban runoff in Erickson and Gulliver [2010].

3.3.1 Model Results

With implementation of all 19 BMP projects, the treated area increases from 860 acres to 1,459 acres (75 percent of the project area). TP removal is estimated to increase from 31 to 58 percent, with an additional 310 pounds removed annually. TSS reduction is estimated to increase from 47 to nearly 65 percent, with an extra 58,600 pounds removed annually. The overall pollutant removals for the existing and proposed BMPs are summarized in Table 3-2. The complete results from the proposed condition model are shown in Table F-2 in Appendix F, and a comparison of the existing conditions and proposed conditions model is shown in Table F-3 in Appendix F.

Table 3-2. Comparison of Pollutant Removal With Existing Best Management Practices and Implementing all Proposed Best Management Practices

	TP		TSS	
	Existing BMPs	Proposed BMPs	Existing BMPs	Proposed BMPs
Total load (lbs/year)	1,141.2		356,300	
Treated area (acres)	860.7	1,458.6	860.7	1,458.6
Total export (lbs/year)	787.5	478.0	187,900	129,300
Removal (lbs/year)	353.7	663.2	168,400	227,000
Total pollutant reduction (%)	31.0	58.1	47.3	64.7
Pollutant reduction for treated area (%)	56.2	69.7	85.8	76.5
Estimated additional removal (lbs/year)	—	309.5	—	58,600

3.3.2 Summary of Proposed Best Management Practice Costs

Cost estimates were generated for each of the proposed BMPs to help understand the funding required for implementation and to help prioritize the BMPs using a cost-benefit analysis. Table 3-3 ranks the proposed individual projects according to TP removal and also includes the total costs and annual pollutant removal. More detailed cost and effectiveness data for all projects are included in Table F-4 in Appendix F.

Capital costs and operation and maintenance (O&M) costs for the potential BMPs were estimated from several sources. Estimates for wet ponds, bioretention structures, and constructed wetlands were taken from Weiss et al [2007], and estimates for the dry swale were

Table 3-3. Ranking of Individual Projects by Total Phosphorus Removal Cost (2015 Dollars)

Watershed	Structure	Construction Cost ($)	Annual O&M[a] Cost ($)	Total Present Cost ($)	Additional Pollutant Removal		Price per Pound TP (for 20 Years) ($)	Price per Pound TSS (for 20 Years) ($)	TP Removal Rankings
					TP (lbs/yr)	TSS (lbs/yr)			
28	Iron-Enhanced Sand Filter (IESF)	44,100	500	54,100	32.6	0	80	—	1
25b	IESF	37,400	500	47,400	24.8	0	100	—	2
23a	Wet Pond With IESF	303,700	6,700	422,700	143.9	31,313	150	1	3
2b	Pond Expansion With IESF	144,300	500	154,300	42.4	124	180	62	4
42	Constructed Wetland	133,700	4,000	210,800	33.6	17,789	310	1	5
21	Dry Swale	67,200	4,900	142,500	16.5	11,186	430	1	6
18b	Wet Pond	53,900	2,700	111,200	8.0	3,206	700	2	7
24a	Infiltration Basin	102,600	3,500	141,600	6.2	977	1,100	7	8
5b	Wet Pond	54,900	2,700	100,900	3.9	2,645	1,300	2	9
6	Wet Pond	102,800	4,100	161,300	5.3	3,168	1,500	3	10
18a	Bioretention	118,400	3,900	154,600	4.6	1,488	1,700	5	11
25a	Wet Pond	175,700	5,600	279,600	5.9	1,708	2,400	8	12
13a	Bioretention	131,000	8,400	313,600	5.4	1,715	2,900	9	13
5a	Bioretention	215,800	14,700	534,400	9.0	2,930	3,000	9	14
15a	Bioretention	61,700	3,800	143,600	2.4	752	3,000	10	15
7a	Wetland restoration	60,500	2,900	106,100	1.7	1,191	3,100	4	16
26	Pond Expansion	20,100	0	20,100	0.3	64	3,300	16	17
14a	Bioretention	34,700	2,400	87,400	1.3	403	3,400	11	18
2a	Wet Pond	184,700	5,900	305,200	2.3	1,206	6,600	13	19

(a) O&M = operations and maintenance.

costs and operation and maintenance (O&M) costs for the potential BMPs were estimated from several sources. Estimates for wet ponds, bioretention structures, and constructed wetlands were taken from Weiss et al. [2007], and estimates for the dry swale were taken from Weiss et al [2005]. Estimates for installing iron-enhanced sand filters were extrapolated from Erickson and Gulliver [2010]. Estimates for the pond expansions were based on engineering judgment. The O&M costs for the two wet pond expansions are assumed to be negligible because they should not affect the O&M costs of the existing structures.

All costs were converted to 2015 dollars with an assumption of 3 percent annual inflation. The total present cost was determined as the total of construction cost and 20 years of O&M cost, assuming 3 percent annual inflation. TP removal cost was determined by using total present cost and the expected TP removal for the 20-year project term. The total cost to construct all of the proposed projects is approximately $2,050,000.

The TP removal rankings show that projects with iron-enhanced sand filters are the most cost-effective proposed BMPs, all with TP removal costs under $200 per pound. Other projects, such as the constructed wetland in Subwatershed 42 and the dry swale in Subwatershed 21, have TP removal costs under $500 per pound and would treat areas that are currently untreated. Individual project profiles can be found in Appendix G. The proposed BMPs upstream of North Lake had the lowest TP removal rate. P8 results show that while the BMPs upstream of North Lake would provide a benefit to water quality in North Lake, they do not provide an effective benefit to Two Rivers Lake. All projects upstream of North Lake (Subwatersheds 1–17) should, therefore, be considered for benefits to North Lake only. The one exception is installing an iron-enhanced sand filter into the existing Wet Pond 2b, which would remove dissolved phosphorus that is not targeted with existing BMPs in the study area.

3.3.3 Multiple Best Management Practice Considerations

Several cases exist where multiple, proposed BMPs would interact in series and affect their respective removal efficiencies. These cases were modeled individually to provide a complete summary of every possible combination of projects. While adding several BMPs in series may often be the only way to reach the preferred level of treatment, the marginal cost of the additional structures will always exceed that of the most cost-effective single structure. However, an important note to consider is that BMP combinations are in fact more cost effective than many of the individual BMP projects. Total present costs and TP removal costs for relevant BMP combinations are shown in Table 3-4. These costs are also reported with individual practices in Table F-4 in Appendix F.

The TP ranking from Table 3-4 shows the most cost-effective combinations involved in constructing a new wet pond in Subwatershed 18b and an iron-enhanced sand filter in Subwatershed 23. Nearly any combination of practices in Subwatersheds 18, 21, and 23 will provide high TP removal at a low per-pound cost.

Table 3-4. Ranking of Projects Involving Multiple Best Management Practices (2015 Dollars)

Watershed	Total Present Cost ($)	Additional Pollutant Removal		Price per Pound TP (for 20 Years) ($)	Price per Pound TSS (for 20 Years) ($)	TP Removal Rankings
		TP (lbs/yr)	TSS (lbs/yr)			
18b + 23a with IESF	533,919	158.4	35,985	169	0.74	1
21 + 23a with IESF[(a)]	565,192	155.6	35,548	182	0.79	2[(a)]
18a + 23a with IESF[(a)]	577,340	148.2	32,264	195	0.89	3[(a)]
18b, 21, 23a with IESF	676,374	170.1	40,167	199	0.84	4
18a, 21, 23a with IESF	719,795	172.7	40,463	208	0.89	5
18a, 18b, 23a with IESF[(a)]	688,522	149.3	32,669	231	1.05	6[(a)]
18a, 18b, 21, 23a with IESF	830,977	173.8	40,840	239	1.02	7
2a+2b expansion with IESF	459,509	44.7	1,321	514	17.40	8
18b + 21	253,637	24.6	14,391	516	0.88	9
18a + 21	297,058	27.1	14,110	548	1.05	10
18a, 18b, 21[(a)]	408,240	22.4	13,577	911	1.50	11[(a)]
24a + 25a	421,171	11.4	2,463	1,847	8.55	12
18a + 18b[(a)]	265,785	5.9	2,391	2,252	5.56	13[(a)]
5a+5b	635,313	11.2	4,040	2,836	7.86	14

(a) Not recommended because less expensive, more effective alternatives are available.

4.0 SUMMARY AND CONCLUSIONS

When reviewing the agricultural, lakeshore, and urban cost-benefit analyses, the greatest opportunities at the most cost-effective rates exist in the rural areas to reduce TP loading to Two Rivers Lake. Opportunities also exist to remove phosphorus by either adding an iron-enhanced sand filter to existing stormwater ponds in the city of Albany or building new ponds with iron-enhanced sand filters. All projects with a TP removal rate of $200 per pound or less are provided in Table 4-1.

Field verification and investigation on the feasibility for the projects identified in this report were limited because of the time of year at which this analysis was completed. Therefore, final cost-benefit values will vary when more refined costs and benefits are calculated.

Table 4-1. Practices Identified With Total Phosphorus Removal of $200 per Pound or Less (Page 1 of 2)

BMP I.D.	HSPF Subwatershed (unless noted)	BMP Type	Total Public Payment ($)	TP Reduction (lbs/yr)	TP Removal Cost ($/lb)
156-GW-1	156	Grassed Waterway	1,334	8.6	16
363-GW-1	363	Grassed Waterway	1,280	4.2	31
365-GW-1	365	Grassed Waterway	903	2.9	31
156-GW-2	156	Grassed Waterway	8,722	16.0	54
365-GW-2	365	Grassed Waterway	926	1.5	63
335-GW-1	335	Grassed Waterway	3,835	5.8	66
28-IESF-1	28 (in P8)	IESF Pond Retrofit	54,000	32.6	83
156-LMC-1	156	Land Management Change	66,243	37.2	89
347-GW-1	347	Grassed Waterway	392	0.4	89
359-GW-2	359	Grassed Waterway	1,415	1.6	90
25B-IESF-1	25B (in P8)	IESF Pond Retrofit	37,400	24.8	96
363-GW-4	363	Grassed Waterway	772	0.8	98
341-GW-3	341	Grassed Waterway	1,474	1.5	100
341-GW-1	341	Grassed Waterway	3,969	3.8	104
343-GW-1	343	Grassed Waterway	2,466	2.3	107
156-GW-5	156	Grassed Waterway	1,133	1.0	116
380-GW-1	380	Grassed Waterway	782	0.6	128
335-LMC-1	335	Land Management Change	2,500	2.9	130
156-GW-3	156	Grassed Waterway	2,885	2.2	130
363-LMC-1	363	Land Management Change	7,444	2.5	133
156-GW-9	156	Grassed Waterway	389	0.3	134
365-LMC-1	365	Land Management Change	5,083	9.0	134
365-LMC-2	365	Land Management Change	6,694	1.0	134
359-GW-1	359	Grassed Waterway	2,904	2.1	136
363-GW-3	363	Grassed Waterway	1,455	1.1	136
380-LMC-2	380	Land Management Change	24,275	2.5	146
380-LMC-3	380	Land Management Change	2,583	1.9	146

Table 4-1. Practices Identified With Total Phosphorus Removal of $200 per Pound or Less (Page 2 of 2)

BMP I.D.	HSPF Subwatershed (unless noted)	BMP Type	Total Public Payment ($)	TP Reduction (lbs/yr)	TP Removal Cost ($/lb)
380-LMC-1	380	Land Management Change	19,887	6.8	146
380-LMC-4	380	Land Management Change	7,388	0.8	146
380-LMC-5	380	Land Management Change	5,444	0.7	146
380-LMC-6	380	Land Management Change	2,222	0.7	146
355-LMC-1	355	Land Management Change	2,166	1.7	147
23A-WP-1	23A (in P8)	Wet Pond With IESF	206,000	143.9	147
363-GW-2	363	Grassed Waterway	4,396	3.0	147
156-GW-4	156	Grassed Waterway	2,203	1.5	147
335-GW-4	335	Grassed Waterway	838	0.6	151
217-WR-2	217	Wetland Restoration	22,602	7.3	154
353-GW-3	353	Grassed Waterway	792	0.5	156
341-GW-2	341	Grassed Waterway	5,696	3.6	157
355-GW-4	355	Grassed Waterway	813	0.5	158
355-GW-2	355	Grassed Waterway	1,079	0.7	159
156-WR-1	156	Wetland Restoration	109,575	33.8	162
355-GW-1	355	Grassed Waterway	2,184	1.3	162
320-LMC-1	320	Land Management Change	1,944	0.8	163
2B-WP-1	2B (in P8)	Wet Pond With IESF	47,000	42.4	165
341-WR-2	341	Wetland Restoration	20,545	6.2	166
115-GW-1	115	Grassed Waterway	3,996	2.4	166
357-GW-5	357	Grassed Waterway	535	0.3	173
357-GW-1	357	Grassed Waterway	1,162	0.7	174
363-GW-5	363	Grassed Waterway	1,307	0.7	179
335-GW-3	335	Grassed Waterway	1,916	1.0	186
339-GW-1	339	Grassed Waterway	1,881	1.0	193
355-WR-2	355	Wetland Expansion	2,663	0.7	198

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APPENDIX A

AGRICULTURAL LOADING RESULTS

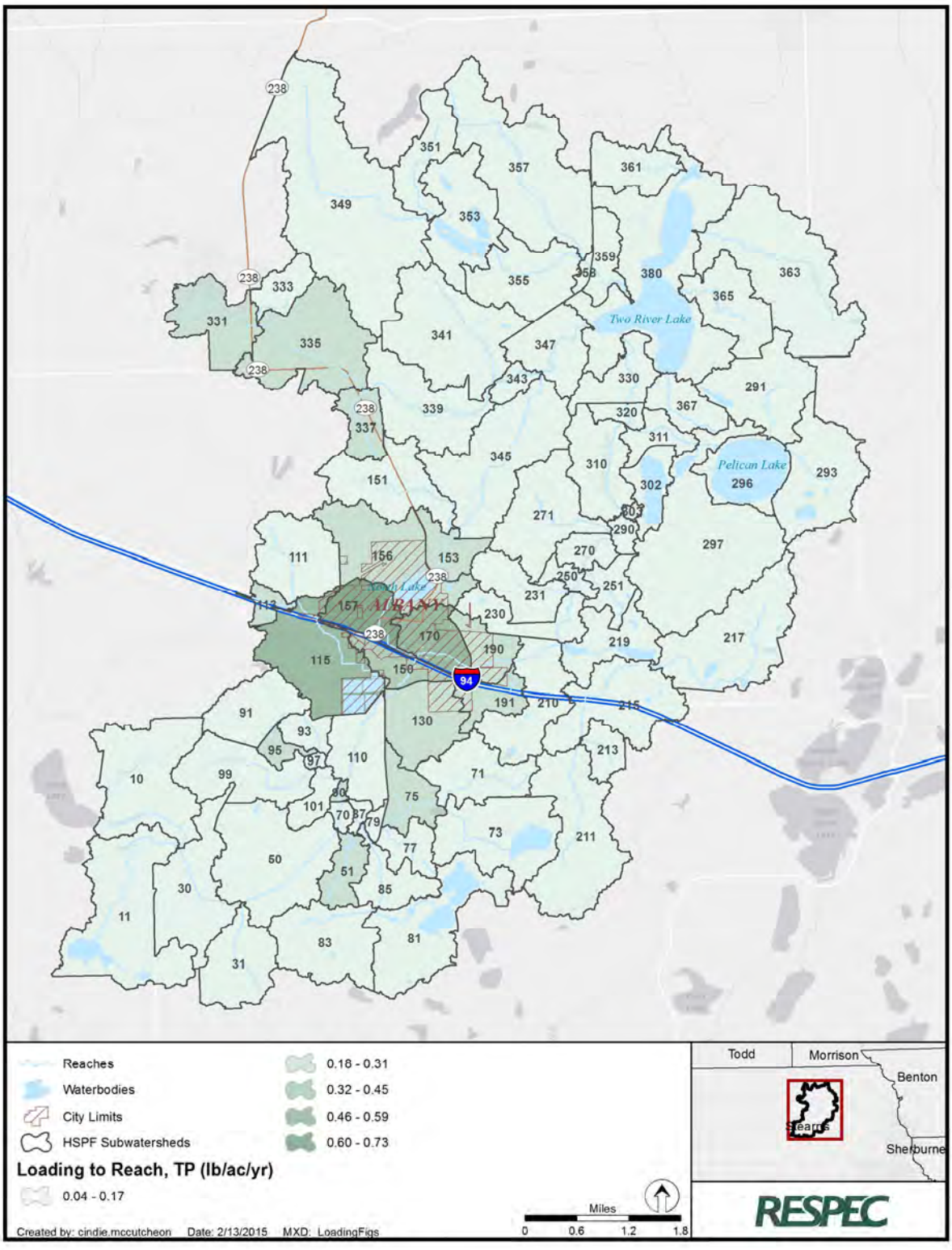


Figure A-1. Total Phosphorus Loading to the Subwatershed's Nearest Tributary.

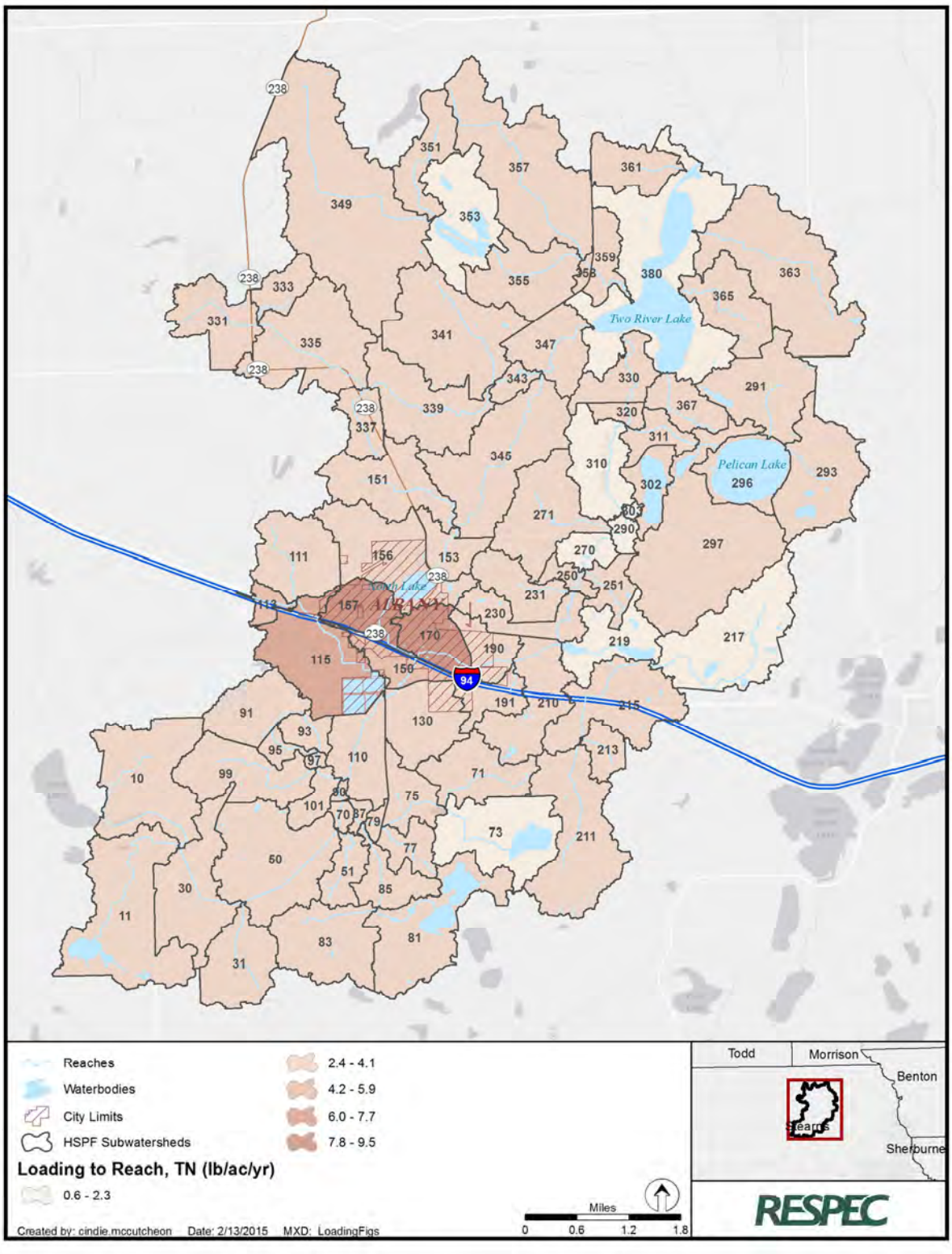


Figure A-2. Total Nitrogen Loading to the Subwatershed's Nearest Tributary.

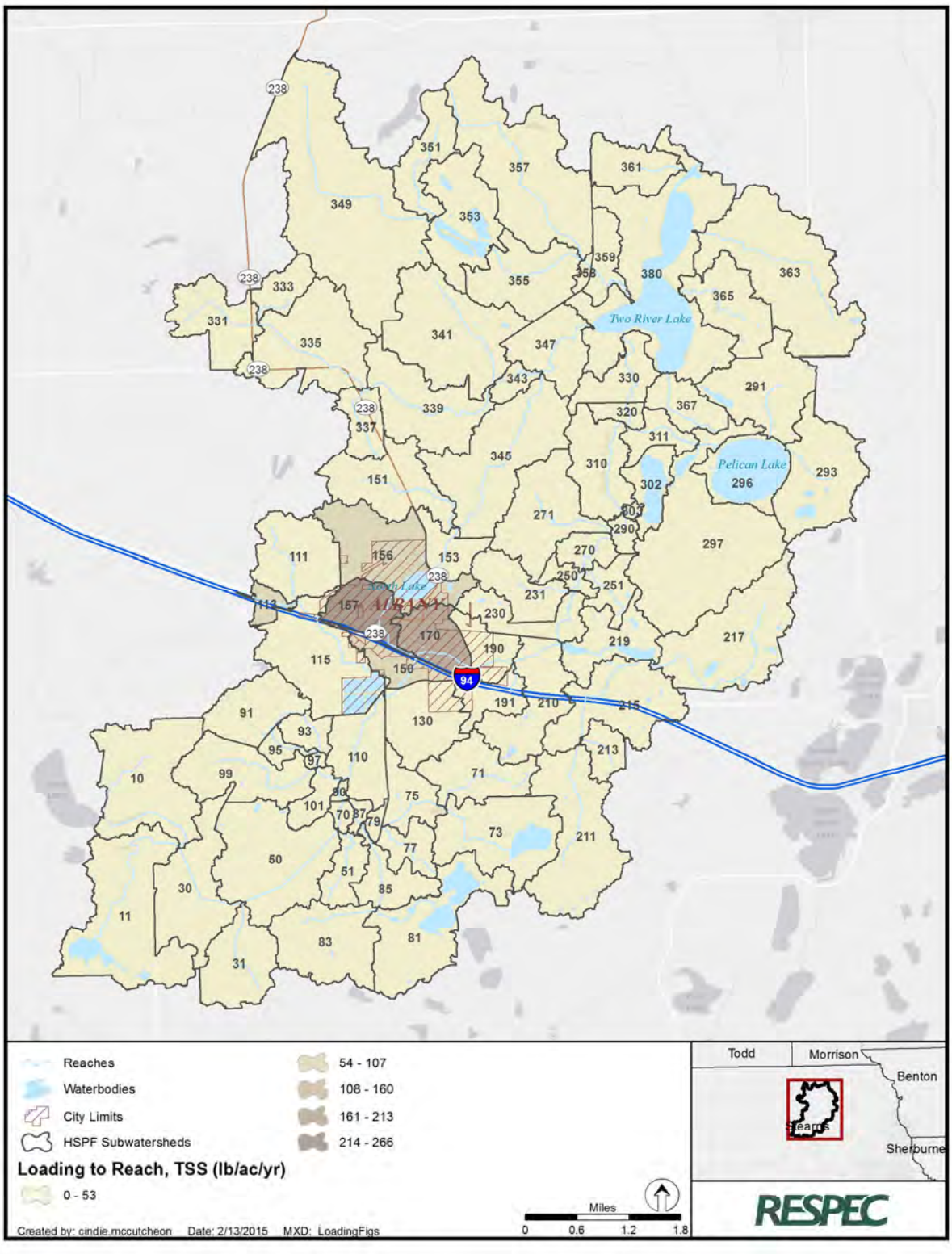


Figure A-3. Total Suspended Solids Loading to the Subwatershed's Nearest Tributary.

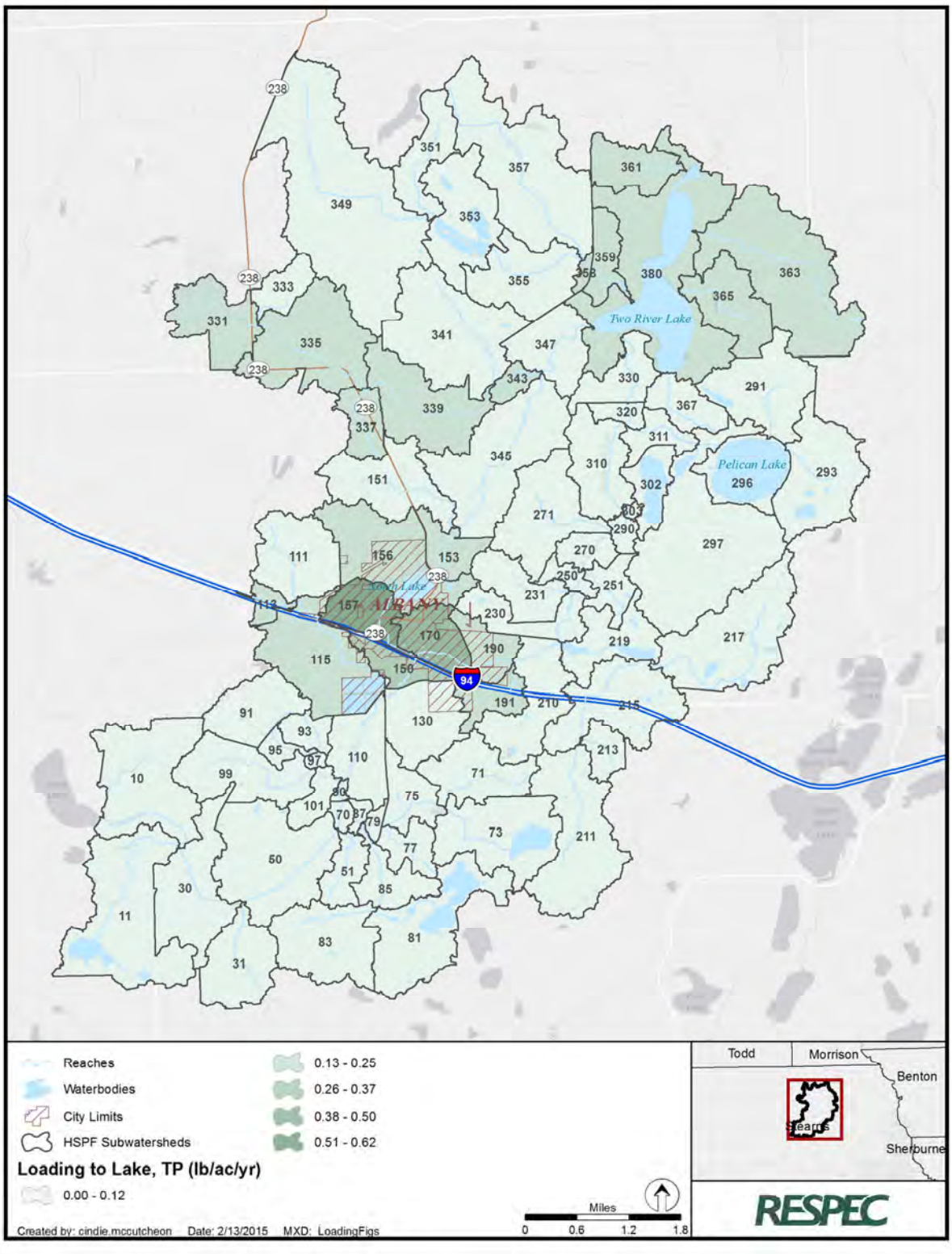


Figure A-4. Total Phosphorus Loading to Two Rivers Lake.

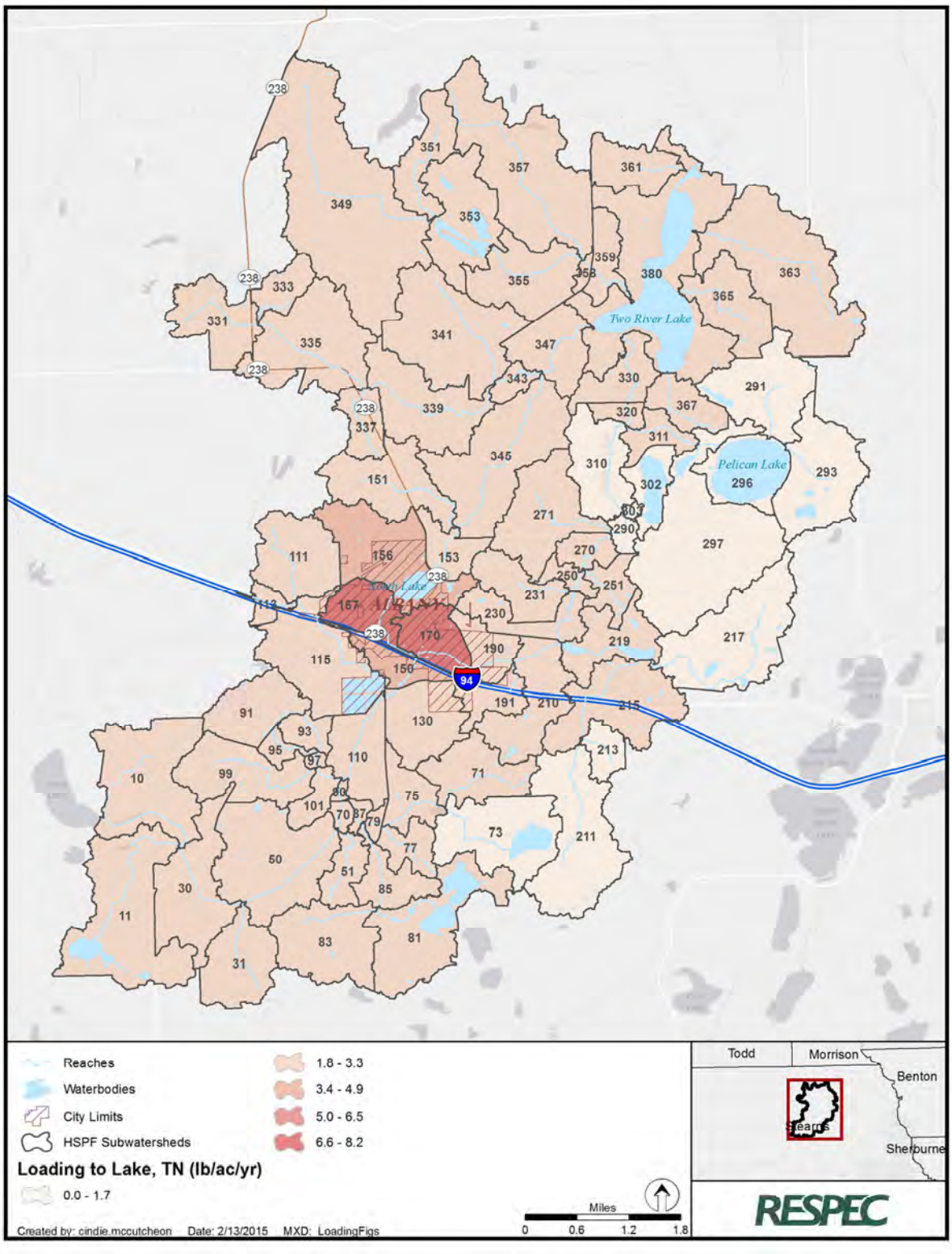


Figure A-5. Total Nitrogen Loading to Two Rivers Lake.

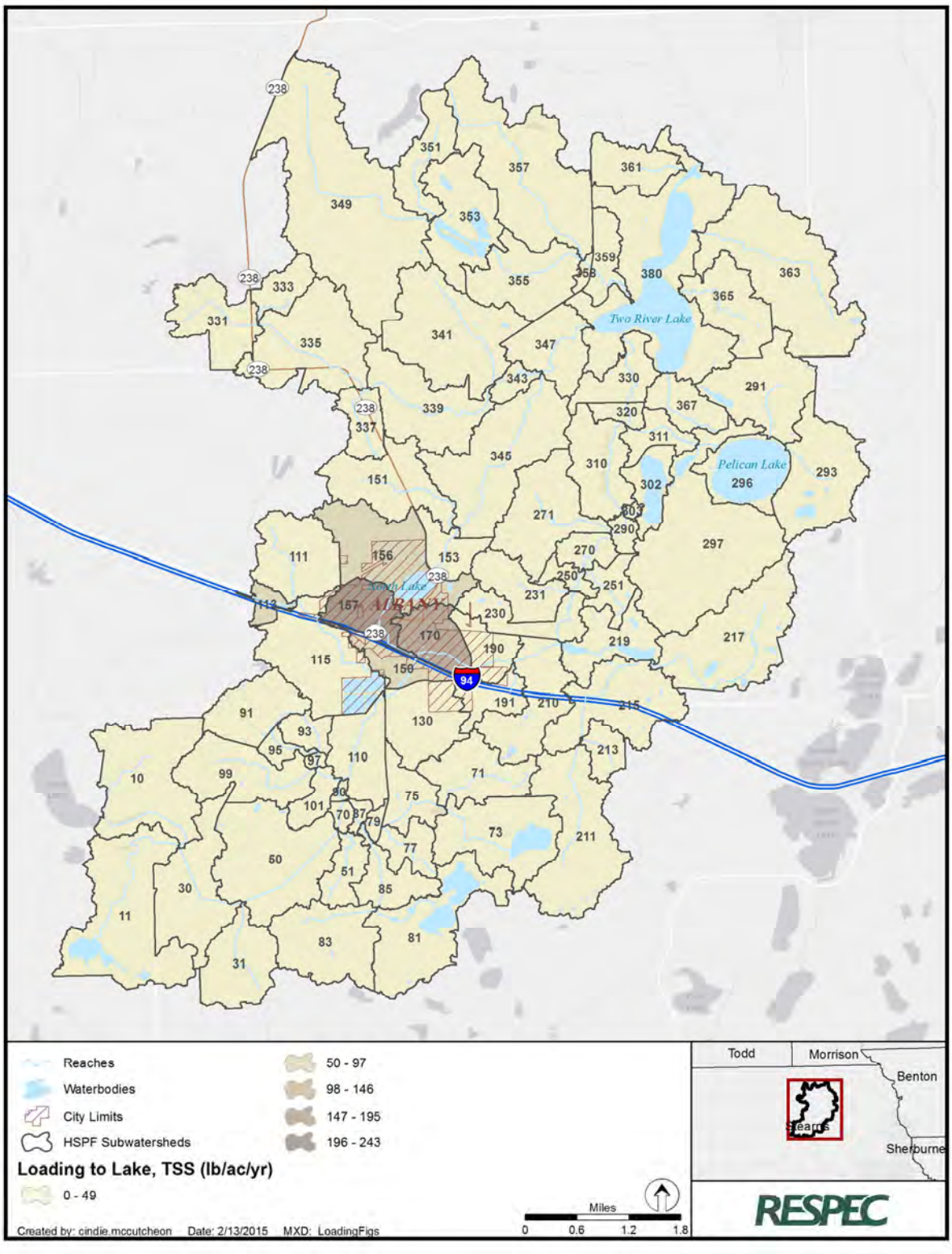


Figure A-6. Total Suspended Solids Loading to Two Rivers Lake.

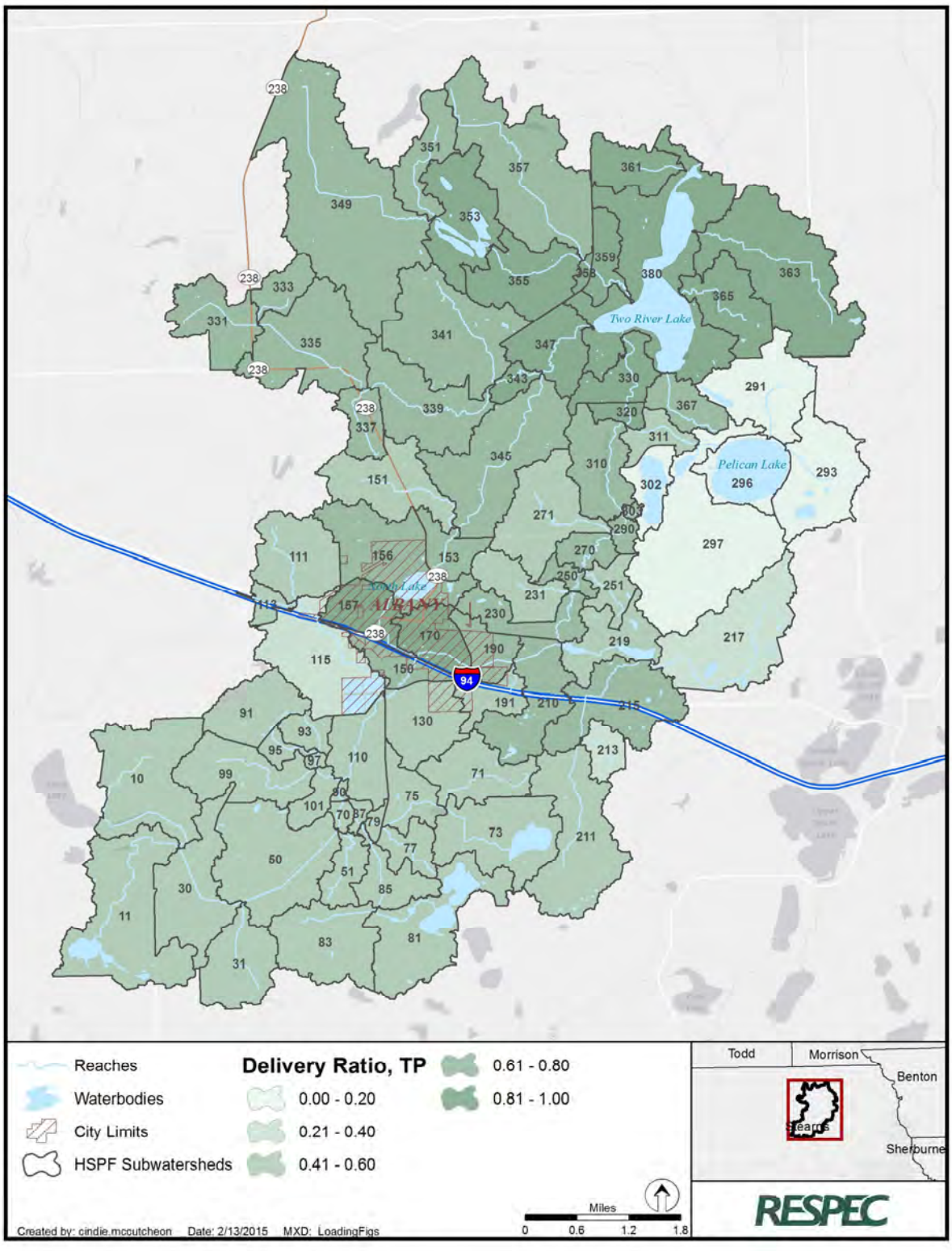


Figure A-7. Pollutant Delivery Ratio, Total Phosphorus.

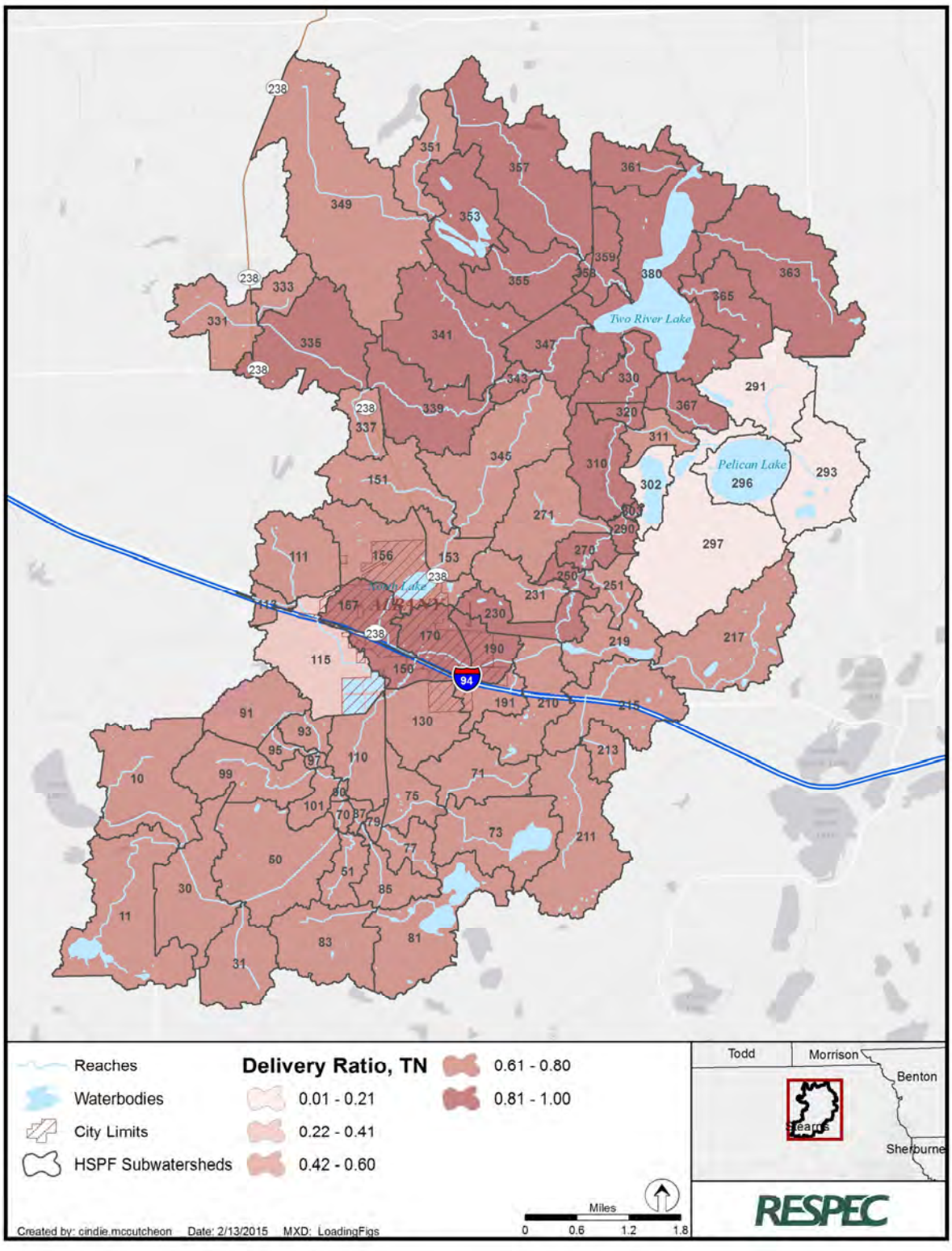


Figure A-8. Pollutant Delivery Ratio, Total Nitrogen.

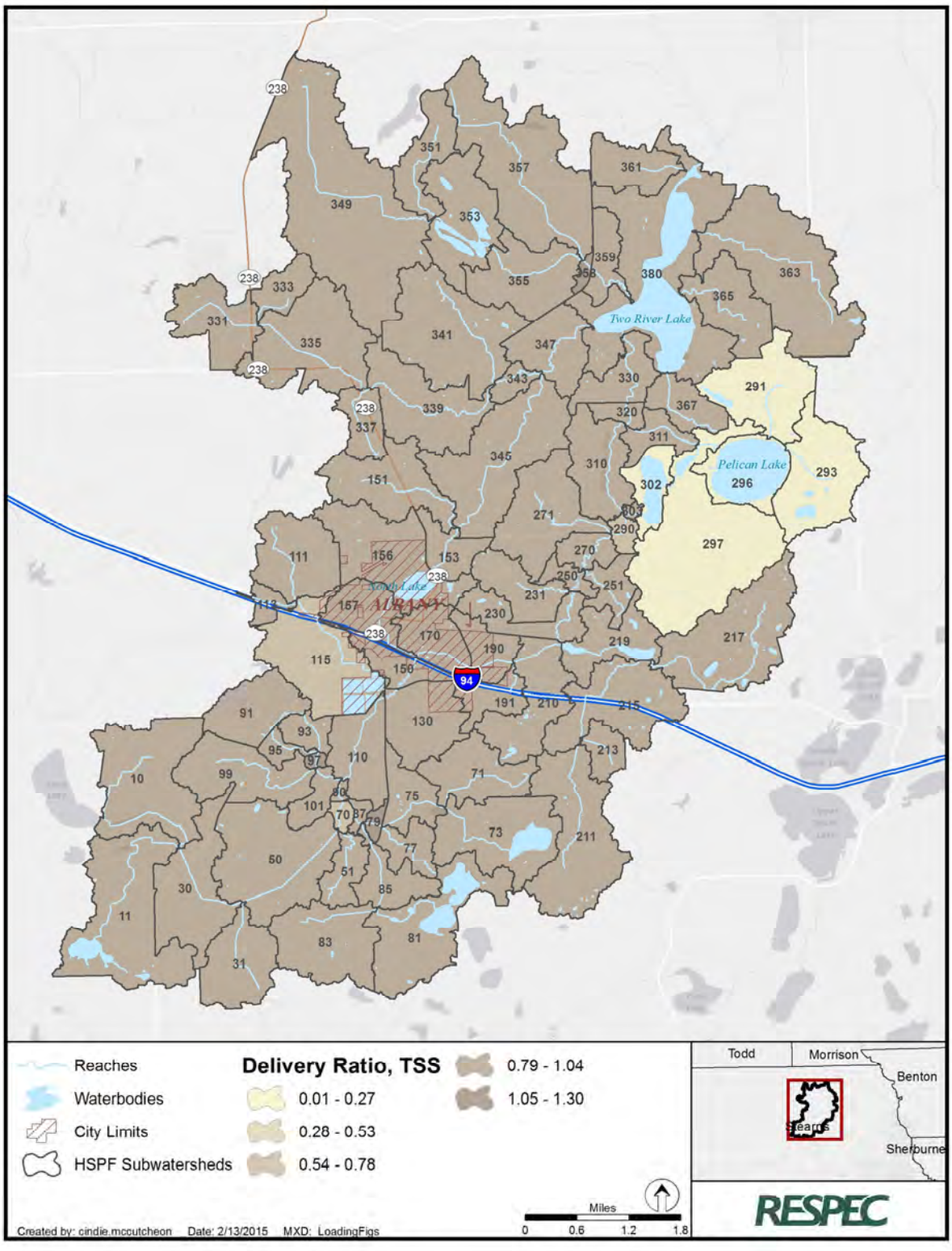


Figure A-9. Pollutant Delivery Ratio, Total Suspended Solids.

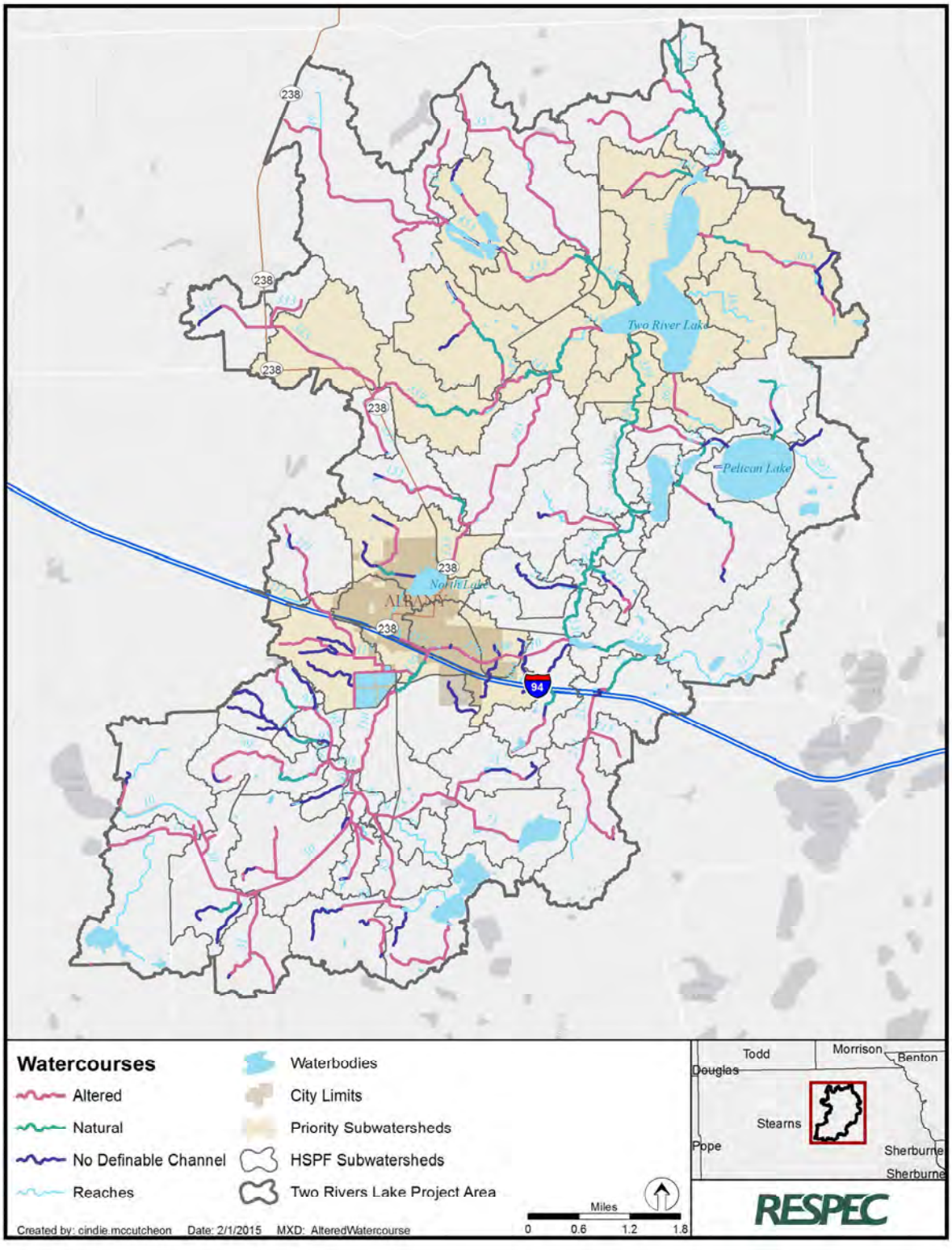


Figure A-10. Altered Watercourses.

APPENDIX B

AGRICULTURAL PROJECT PROFILES
CHANNELIZED FIELD EROSION

Table B-1. Cost-Benefit Analysis for Constructing Grassed Waterways Under the 2015 Environmental Quality Incentives Program (Page 1 of 3)

BMP I.D.	Length of Potential Grassed Waterway (ft)	Drainage Area of Suspected Erosion Concern (acres)	2015 EQIP Payment Rate for Grassed Waterway ($/LF)	Total EQIP Payment ($)	Total EQIP and Landowner Cost	Average TP Loading Rate to Lake (lb/ac/yr)[a]	Average TSS Loading Rate to Lake (lb/ac/yr)[a]	Current Annual TP Delivery to Lake (lbs/yr)	Current Annual TSS Delivery to Lake (lbs/yr)	BMP Efficiency for TP Removal[b]	BMP Efficiency for TSS Removal[b]	Annual TP Reduction to Lake With BMP (lbs/yr)	Annual TSS Reduction to Lake With BMP (lbs/yr)	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Removal Cost ($/lb)	TSS Removal Cost ($/lb)
115-GW-1	2,960	36.6	1.35	3,996	7,992	0.13	34.1	4.9	1,249	0.49	0.77	2.40	962	48.0	19,237	166.41	0.42
115-GW-2	1,524	15.4	1.35	2,057	4,115	0.13	34.1	2.1	526	0.49	0.77	1.01	405	20.2	8,094	203.62	0.51
150-GW-1	837	4.2	1.35	1,130	2,260	0.26	89.7	1.1	377	0.49	0.77	0.54	290	10.9	5,804	208.21	0.39
150-GW-2	579	2.7	1.35	782	1,563	0.26	89.7	0.7	242	0.49	0.77	0.35	187	7.0	3,731	224.05	0.42
156-GW-1	988	85.9	1.35	1,334	2,668	0.20	64.7	17.5	5,560	0.49	0.77	8.58	4281	171.6	85,626	15.55	0.03
156-GW-2	4,664	160.4	1.87	8,722	17,443	0.20	64.7	32.7	10,382	0.49	0.77	16.02	7994	320.4	159,888	54.45	0.11
156-GW-3	2,137	22.2	1.35	2,885	5,770	0.20	64.7	4.5	1,437	0.49	0.77	2.22	1106	44.3	22,129	130.13	0.26
156-GW-4	1,632	15.0	1.35	2,203	4,406	0.20	64.7	3.1	971	0.49	0.77	1.50	748	30.0	14,952	147.08	0.29
156-GW-5	839	9.8	1.35	1,133	2,265	0.20	64.7	2.0	634	0.49	0.77	0.98	488	19.6	9,769	115.74	0.23
156-GW-6	1,369	8.3	1.35	1,848	3,696	0.20	64.7	1.7	537	0.49	0.77	0.83	414	16.6	8,273	222.98	0.45
156-GW-7	1,466	8.2	1.35	1,979	3,958	0.20	64.7	1.7	531	0.49	0.77	0.82	409	16.4	8,174	241.69	0.48
156-GW-8	926	6.0	1.35	1,250	2,500	0.20	64.7	1.2	388	0.49	0.77	0.60	299	12.0	5,981	208.64	0.42
156-GW-9	288	2.9	1.35	389	778	0.20	64.7	0.6	188	0.49	0.77	0.29	145	5.8	2,891	134.25	0.27
156-GW-10	301	2.0	1.35	406	813	0.20	64.7	0.4	129	0.49	0.77	0.20	100	4.0	1,994	203.46	0.41
156-GW-11	304	1.9	1.35	410	821	0.20	64.7	0.4	123	0.49	0.77	0.19	95	3.8	1,894	216.30	0.43
190-GW-1	1,481	7.6	1.35	1,999	3,999	0.15	37.9	1.2	288	0.49	0.77	0.57	222	11.4	4,440	350.22	0.90
190-GW-2	819	5.9	1.35	1,106	2,211	0.15	37.9	0.9	224	0.49	0.77	0.44	172	8.9	3,446	249.48	0.64
190-GW-3	1,299	5.0	1.35	1,754	3,507	0.15	37.9	0.8	190	0.49	0.77	0.38	146	7.5	2,921	466.91	1.20
191-GW-1	199	0.9	1.35	269	537	0.14	34.4	0.1	31	0.49	0.77	0.06	24	1.2	476	448.26	1.13
320-GW-1	700	3.0	1.35	945	1,890	0.11	7.7	0.3	23	0.49	0.77	0.16	18	3.3	356	578.63	5.30
320-GW-2	346	2.7	1.35	467	934	0.11	7.7	0.3	21	0.49	0.77	0.15	16	2.9	321	317.79	2.91
320-GW-3	411	2.0	1.35	555	1,110	0.11	7.7	0.2	15	0.49	0.77	0.11	12	2.2	238	509.61	4.67
335-GW-1	2,841	84.8	1.35	3,835	7,671	0.14	18.3	11.9	1,549	0.49	0.77	5.82	1193	116.3	23,851	65.93	0.32
335-GW-2	3,053	28.4	1.35	4,122	8,243	0.14	18.3	4.0	519	0.49	0.77	1.95	399	39.0	7,988	211.55	1.03
335-GW-3	1,419	15.0	1.35	1,916	3,831	0.14	18.3	2.1	274	0.49	0.77	1.03	211	20.6	4,219	186.17	0.91
335-GW-4	621	8.1	1.35	838	1,677	0.14	18.3	1.1	148	0.49	0.77	0.56	114	11.1	2,278	150.87	0.74
335-GW-5	729	5.1	1.35	984	1,968	0.14	18.3	0.7	93	0.49	0.77	0.35	72	7.0	1,434	281.30	1.37
335-GW-6	940	4.8	1.35	1,269	2,538	0.14	18.3	0.7	88	0.49	0.77	0.33	68	6.6	1,350	385.39	1.88
339-GW-1	1,393	15.6	1.35	1,881	3,761	0.13	10.7	2.0	167	0.49	0.77	0.97	128	19.5	2,565	192.95	1.47
339-GW-2	1,060	8.1	1.35	1,431	2,862	0.13	10.7	1.0	86	0.49	0.77	0.51	67	10.1	1,332	282.78	2.15
339-GW-3	518	5.2	1.35	699	1,399	0.13	10.7	0.7	56	0.49	0.77	0.32	43	6.5	855	215.26	1.64

Table B-1. Cost-Benefit Analysis for Constructing Grassed Waterways Under the 2015 Environmental Quality Incentives Program (Page 2 of 3)

BMP I.D.	Length of Potential Grassed Waterway (ft)	Drainage Area of Suspected Erosion Concern (acres)	2015 EQIP Payment Rate for Grassed Waterway ($/LF)	Total EQIP Payment ($)	Total EQIP and Landowner Cost	Average TP Loading Rate to Lake (lb/ac/yr)[a]	Average TSS Loading Rate to Lake (lb/ac/yr)[a]	Current Annual TP Delivery to Lake (lbs/yr)	Current Annual TSS Delivery to Lake (lbs/yr)	BMP Efficiency for TP Removal[b]	BMP Efficiency for TSS Removal[b]	Annual TP Reduction to Lake With BMP (lbs/yr)	Annual TSS Reduction to Lake With BMP (lbs/yr)	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Removal Cost ($/lb)	TSS Removal Cost ($/lb)
341-GW-1	2,940	63.2	1.35	3,969	7,938	0.12	12.7	7.8	804	0.49	0.77	3.81	619	76.2	12,377	104.20	0.64
341-GW-2	4,219	60.2	1.35	5,696	11,391	0.12	12.7	7.4	766	0.49	0.77	3.63	589	72.6	11,790	156.98	0.97
341-GW-3	1,092	24.5	1.35	1,474	2,948	0.12	12.7	3.0	312	0.49	0.77	1.48	240	29.5	4,798	99.84	0.61
341-GW-4	1,224	10.9	1.35	1,652	3,305	0.12	12.7	1.3	139	0.49	0.77	0.66	107	13.1	2,135	251.53	1.55
341-GW-5	624	6.6	1.35	842	1,685	0.12	12.7	0.8	84	0.49	0.77	0.40	65	8.0	1,293	211.77	1.30
343-GW-1	1,827	36.3	1.35	2,466	4,933	0.13	8.3	4.7	302	0.49	0.77	2.31	232	46.2	4,649	106.83	1.06
347-GW-1	290	7.6	1.35	392	783	0.12	8.5	0.9	64	0.49	0.77	0.44	49	8.8	989	89.09	0.79
353-GW-1	1,365	15.8	1.35	1,843	3,686	0.11	9.0	1.7	141	0.49	0.77	0.84	109	16.8	2,179	219.78	1.69
353-GW-2	1,387	12.2	1.35	1,872	3,745	0.11	9.0	1.3	109	0.49	0.77	0.65	84	12.9	1,682	289.22	2.23
353-GW-3	587	9.6	1.35	792	1,585	0.11	9.0	1.0	86	0.49	0.77	0.51	66	10.2	1,324	155.55	1.20
353-GW-4	1,020	5.6	1.35	1,377	2,754	0.11	9.0	0.6	50	0.49	0.77	0.30	39	5.9	772	463.36	3.57
355-GW-1	1,618	22.2	1.35	2,184	4,369	0.12	10.4	2.7	230	0.49	0.77	1.34	177	26.9	3,540	162.46	1.23
355-GW-2	799	11.2	1.35	1,079	2,157	0.12	10.4	1.4	116	0.49	0.77	0.68	89	13.6	1,786	159.02	1.21
355-GW-3	1,121	10.5	1.35	1,513	3,027	0.12	10.4	1.3	109	0.49	0.77	0.64	84	12.7	1,674	237.98	1.81
355-GW-4	602	8.5	1.35	813	1,625	0.12	10.4	1.1	88	0.49	0.77	0.51	68	10.3	1,356	157.87	1.20
355-GW-5	393	2.4	1.35	531	1,061	0.12	10.4	0.3	25	0.49	0.77	0.15	19	2.9	383	365.01	2.77
355-GW-6	271	0.9	1.35	366	732	0.12	10.4	0.1	9	0.49	0.77	0.05	7	1.1	144	671.19	5.10
357-GW-1	861	12.1	1.35	1,162	2,325	0.11	10.0	1.4	121	0.49	0.77	0.67	93	13.4	1,868	173.95	1.24
357-GW-2	1,001	10.2	1.35	1,351	2,703	0.11	10.0	1.1	102	0.49	0.77	0.56	79	11.3	1,575	239.91	1.72
357-GW-3	1,117	8.2	1.35	1,508	3,016	0.11	10.0	0.9	82	0.49	0.77	0.45	63	9.1	1,266	333.01	2.38
357-GW-4	929	8.0	1.35	1,254	2,508	0.11	10.0	0.9	80	0.49	0.77	0.44	62	8.8	1,235	283.88	2.03
357-GW-5	396	5.6	1.35	535	1,069	0.11	10.0	0.6	56	0.49	0.77	0.31	43	6.2	865	172.87	1.24
359-GW-1	2,151	26.6	1.35	2,904	5,808	0.16	17.9	4.4	477	0.49	0.77	2.14	367	42.9	7,346	135.52	0.79
359-GW-2	1,048	19.5	1.35	1,415	2,830	0.16	17.9	3.2	350	0.49	0.77	1.57	269	31.4	5,385	90.07	0.53
361-GW-1	2,823	29.0	1.35	3,811	7,622	0.13	9.7	3.7	281	0.49	0.77	1.81	216	36.1	4,322	211.01	1.76
363-GW-1	948	62.0	1.35	1,280	2,560	0.14	8.1	8.5	501	0.49	0.77	4.16	386	83.1	7,711	30.79	0.33
363-GW-2	3,256	44.6	1.35	4,396	8,791	0.14	8.1	6.1	360	0.49	0.77	2.99	277	59.8	5,547	147.03	1.58
363-GW-3	1,078	16.0	1.35	1,455	2,911	0.14	8.1	2.2	129	0.49	0.77	1.07	99	21.5	1,990	135.69	1.46
363-GW-4	572	11.7	1.35	772	1,544	0.14	8.1	1.6	94	0.49	0.77	0.78	73	15.7	1,455	98.46	1.06
363-GW-5	968	10.9	1.35	1,307	2,614	0.14	8.1	1.5	88	0.49	0.77	0.73	68	14.6	1,356	178.85	1.93
363-GW-6	1,189	7.4	1.35	1,605	3,210	0.14	8.1	1.0	60	0.49	0.77	0.50	46	9.9	920	323.59	3.49

Table B-1. Cost-Benefit Analysis for Constructing Grassed Waterways Under the 2015 Environmental Quality Incentives Program (Page 3 of 3)

BMP I.D.	Length of Potential Grassed Waterway (ft)	Drainage Area of Suspected Erosion Concern (acres)	2015 EQIP Payment Rate for Grassed Waterway ($/LF)	Total EQIP Payment ($)	Total EQIP and Landowner Cost	Average TP Loading Rate to Lake (lb/ac/yr)[a]	Average TSS Loading Rate to Lake (lb/ac/yr)[a]	Current Annual TP Delivery to Lake (lbs/yr)	Current Annual TSS Delivery to Lake (Ibs/yr)	BMP Efficiency for TP Removal[b]	BMP Efficiency for TSS Removal[b]	Annual TP Reduction to Lake With BMP (lbs/yr)	Annual TSS Reduction to Lake With BMP (lbs/yr)	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Removal Cost ($/lb)	TSS Removal Cost ($/lb)
363-GW-7	804	7.0	1.35	1,085	2,171	0.14	8.1	1.0	57	0.49	0.77	0.47	44	9.4	871	231.32	2.49
363-GW-8	761	7.0	1.35	1,027	2,055	0.14	8.1	1.0	57	0.49	0.77	0.47	44	9.4	871	218.95	2.36
363-GW-9	877	4.9	1.35	1,184	2,368	0.14	8.1	0.7	40	0.49	0.77	0.33	30	6.6	609	360.46	3.89
363-GW-10	347	2.6	1.35	468	937	0.14	8.1	0.4	21	0.49	0.77	0.17	16	3.5	323	268.79	2.90
365-GW-1	669	44.0	1.35	903	1,806	0.14	5.3	5.9	231	0.49	0.77	2.91	178	58.2	3,562	31.03	0.51
365-GW-2	686	22.1	1.35	926	1,852	0.14	5.3	3.0	116	0.49	0.77	1.46	89	29.2	1,789	63.35	1.04
365-GW-3	448	3.9	1.35	605	1,210	0.14	5.3	0.5	20	0.49	0.77	0.26	16	5.2	316	234.43	3.83
365-GW-4	768	3.8	1.35	1,037	2,074	0.14	5.3	0.5	20	0.49	0.77	0.25	15	5.0	308	412.46	6.74
365-GW-5	531	3.2	1.35	717	1,434	0.14	5.3	0.4	17	0.49	0.77	0.21	13	4.2	259	338.65	5.53
365-GW-6	319	2.9	1.35	431	861	0.14	5.3	0.4	15	0.49	0.77	0.19	12	3.8	235	224.49	3.67
380-GW-1	579	10.0	1.35	782	1,563	0.12	7.9	1.2	79	0.49	0.77	0.61	61	12.2	1,217	127.92	1.28
380-GW-2	671	3.6	1.35	906	1,812	0.12	7.9	0.4	28	0.49	0.77	0.22	22	4.4	438	411.80	4.14
380-GW-3	380	2.4	1.35	513	1,026	0.12	7.9	0.3	19	0.49	0.77	0.15	15	2.9	292	349.82	3.51
380-GW-4	313	2.2	1.35	423	845	0.12	7.9	0.3	17	0.49	0.77	0.13	13	2.7	268	314.34	3.16
380-GW-5	285	1.2	1.35	385	770	0.12	7.9	0.1	9	0.49	0.77	0.07	7	1.5	146	524.73	5.27

(a) Loading rates are specific to each subwatershed and were calculated using the Two Rivers HSPF model.

(b) Removal efficiency is the minimum value from Minnesota's Ag BMP Handbook, Appendix B Table 32.

(c) Removal efficiency is the minimum value from Minnesota's Ag BMP Handbook, Appendix B Page 167.

(d) Assumes the producer would keep the practice in place for 20 years even though the contract only requires a 10-year commitment.

Potential Project 115-GW-1

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

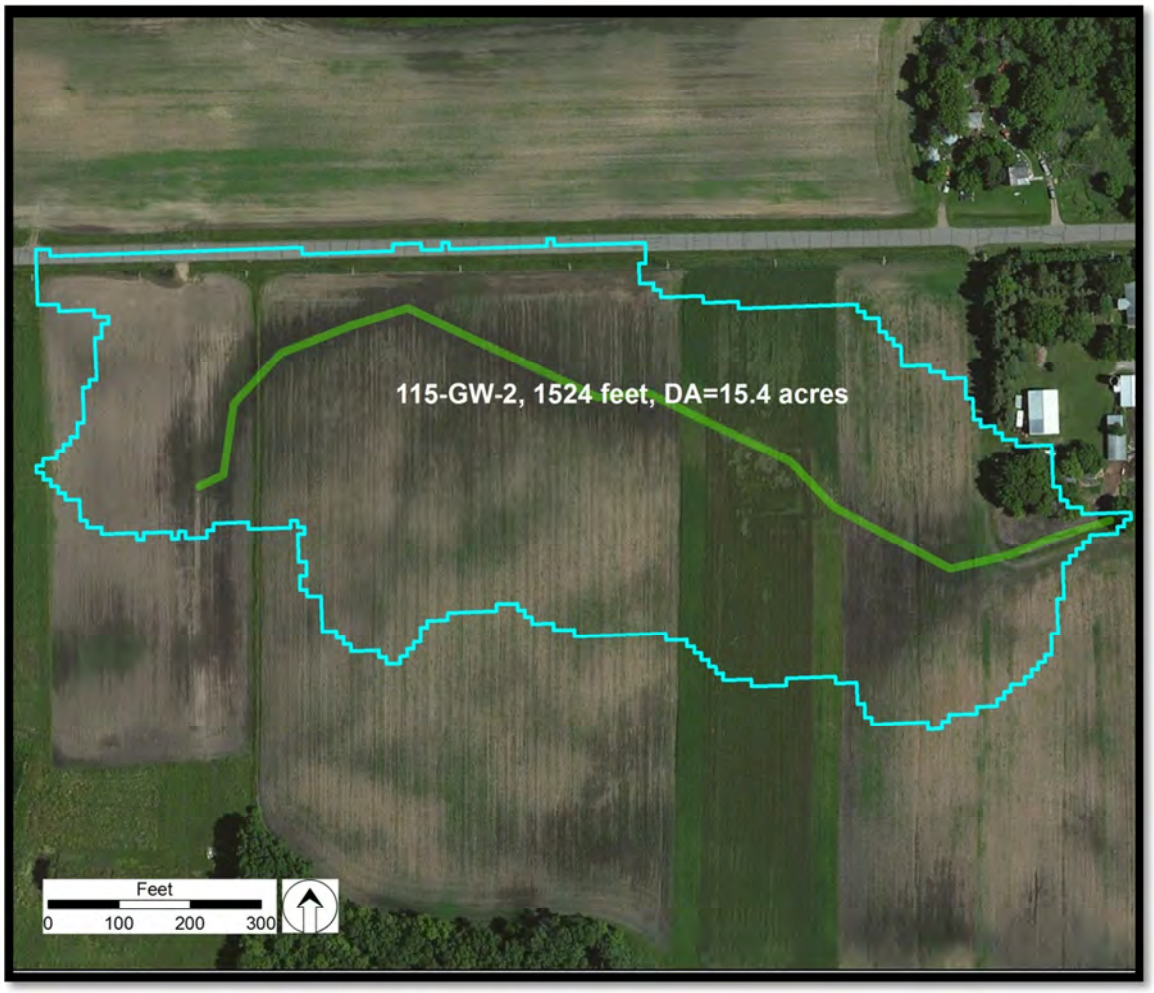
Total Phosphorus (TP) Reduction to Two Rivers Lake	2.45 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	962 lbs	Represents the annual reduction to the lake
Project Installation Cost	$7,992	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$163	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.42	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 115-GW-2

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.03 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	405 lbs	Represents the annual reduction to the lake
Project Installation Cost	$4,115	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$200	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.51	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

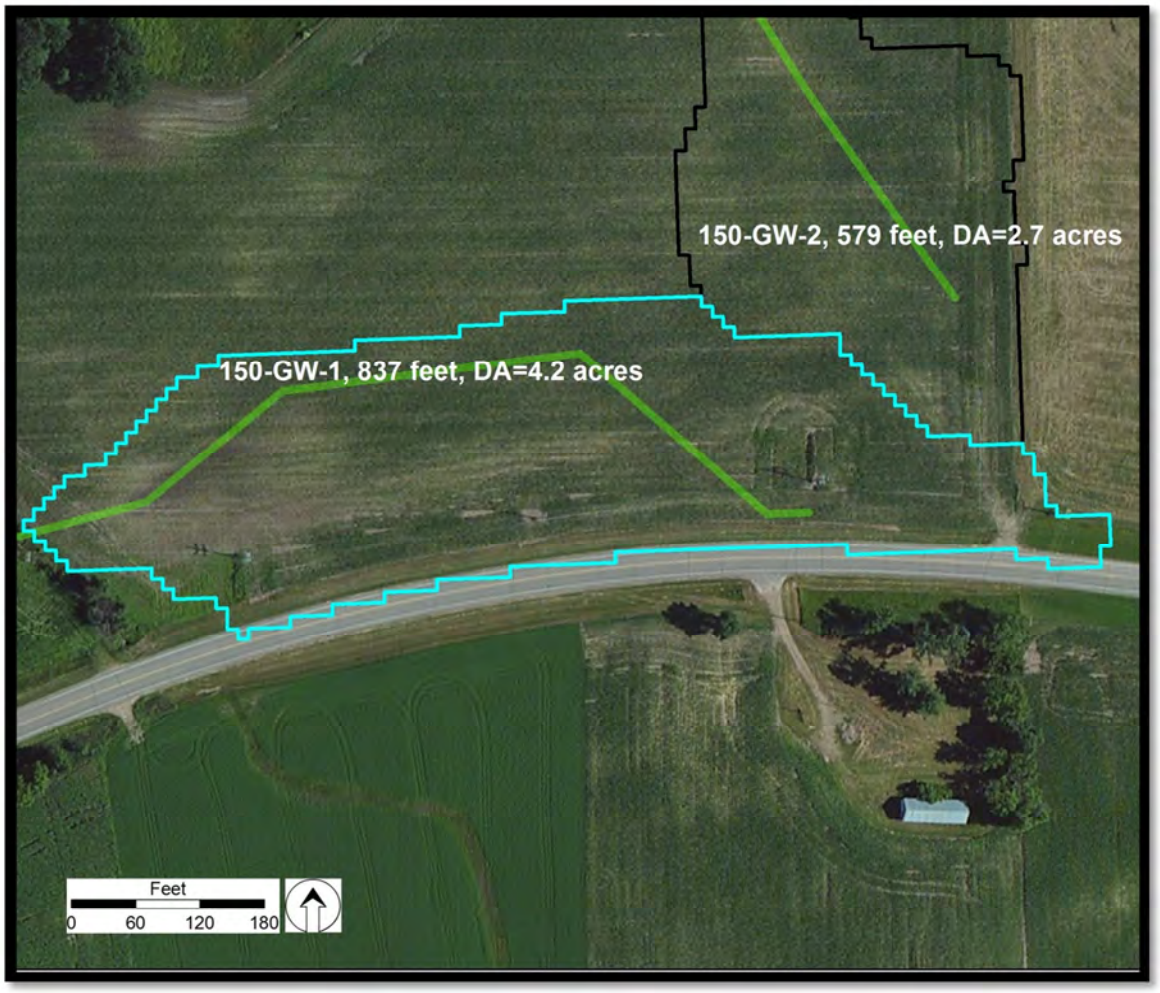


Potential Project 150-GW-1

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.55 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	290 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,260	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$204	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.39	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

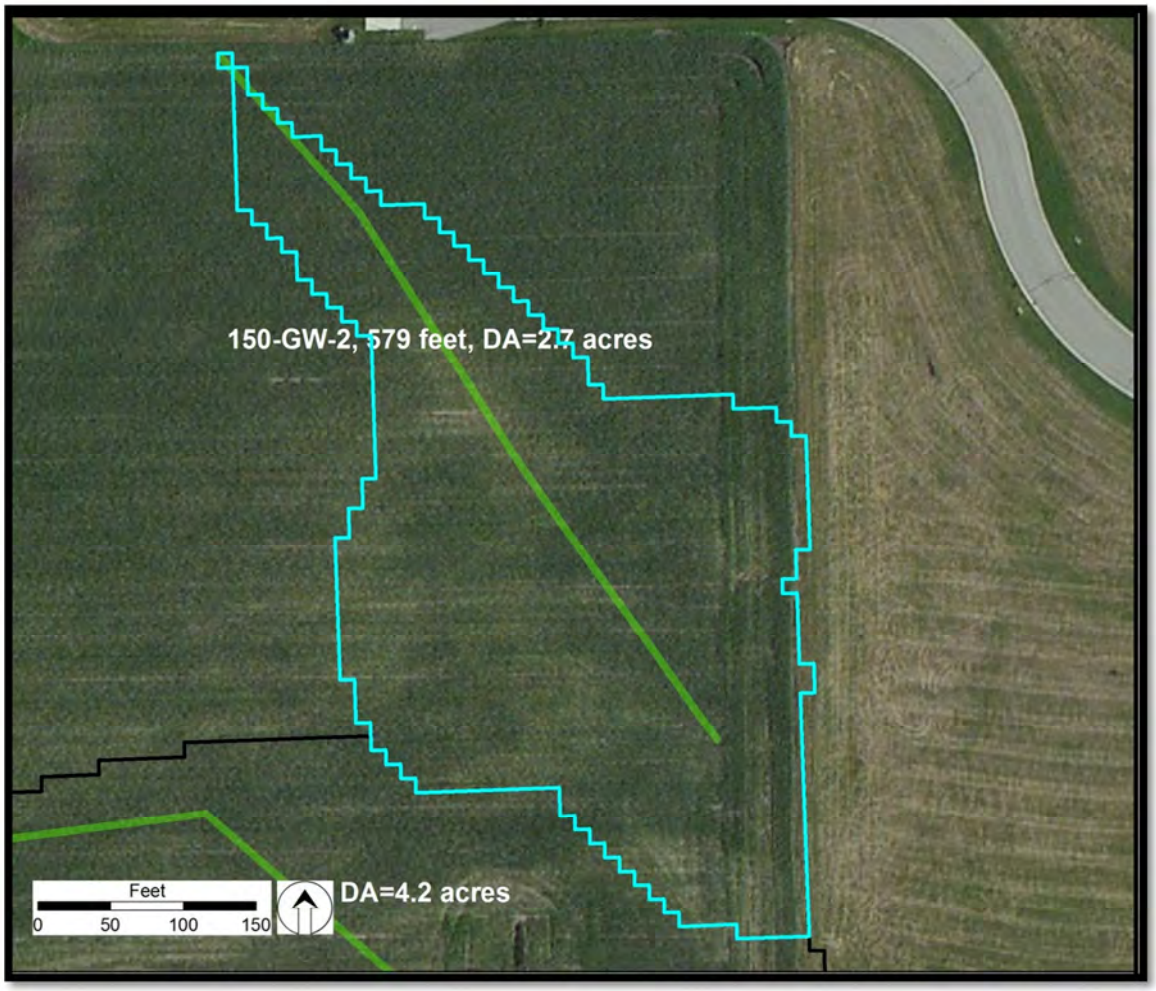


Potential Project 150-GW-2

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.36 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	187 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,563	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$220	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.42	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

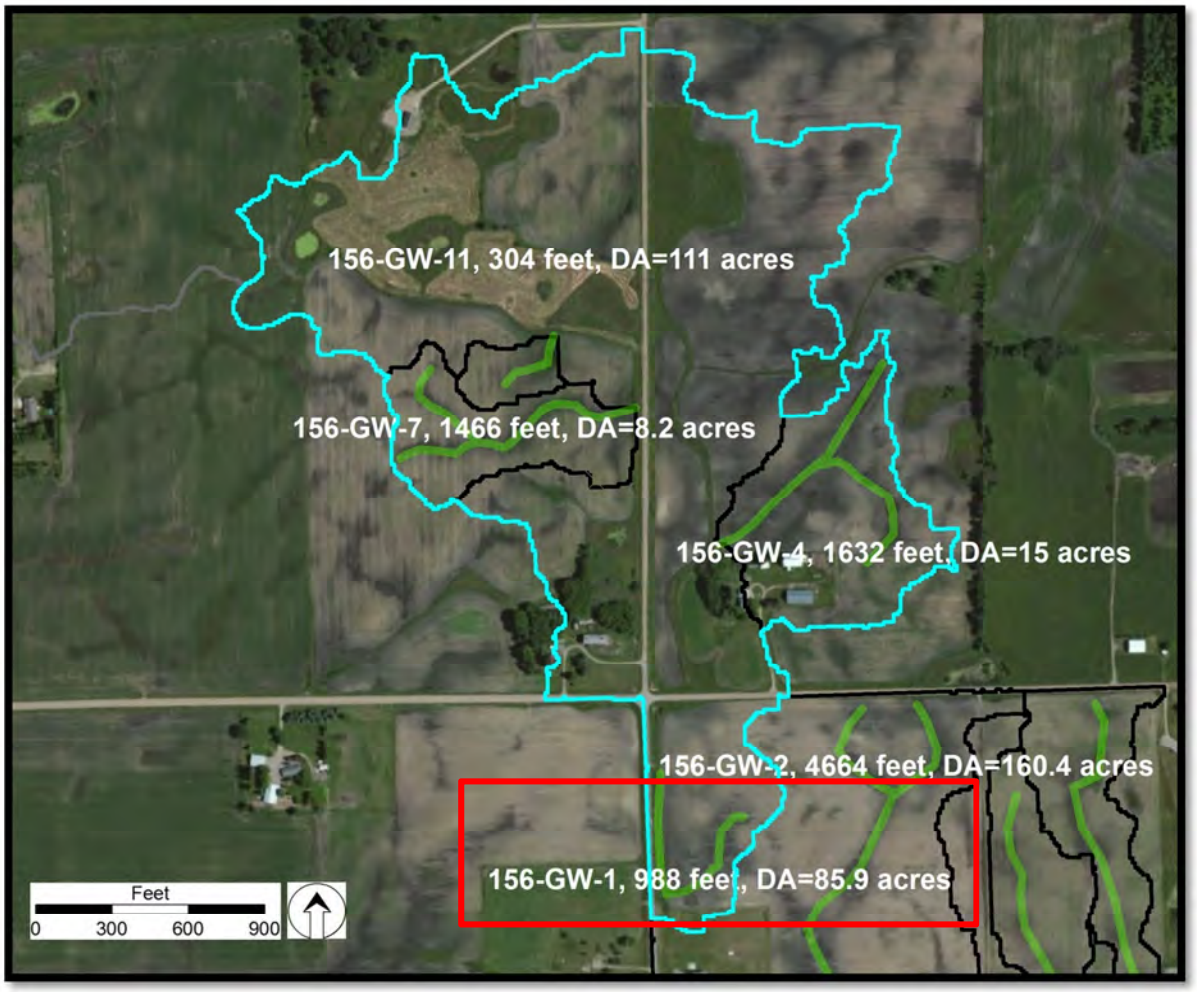


Potential Project 156-GW-1

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 156-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	8.75 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	4281 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,668	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$15	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.03	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

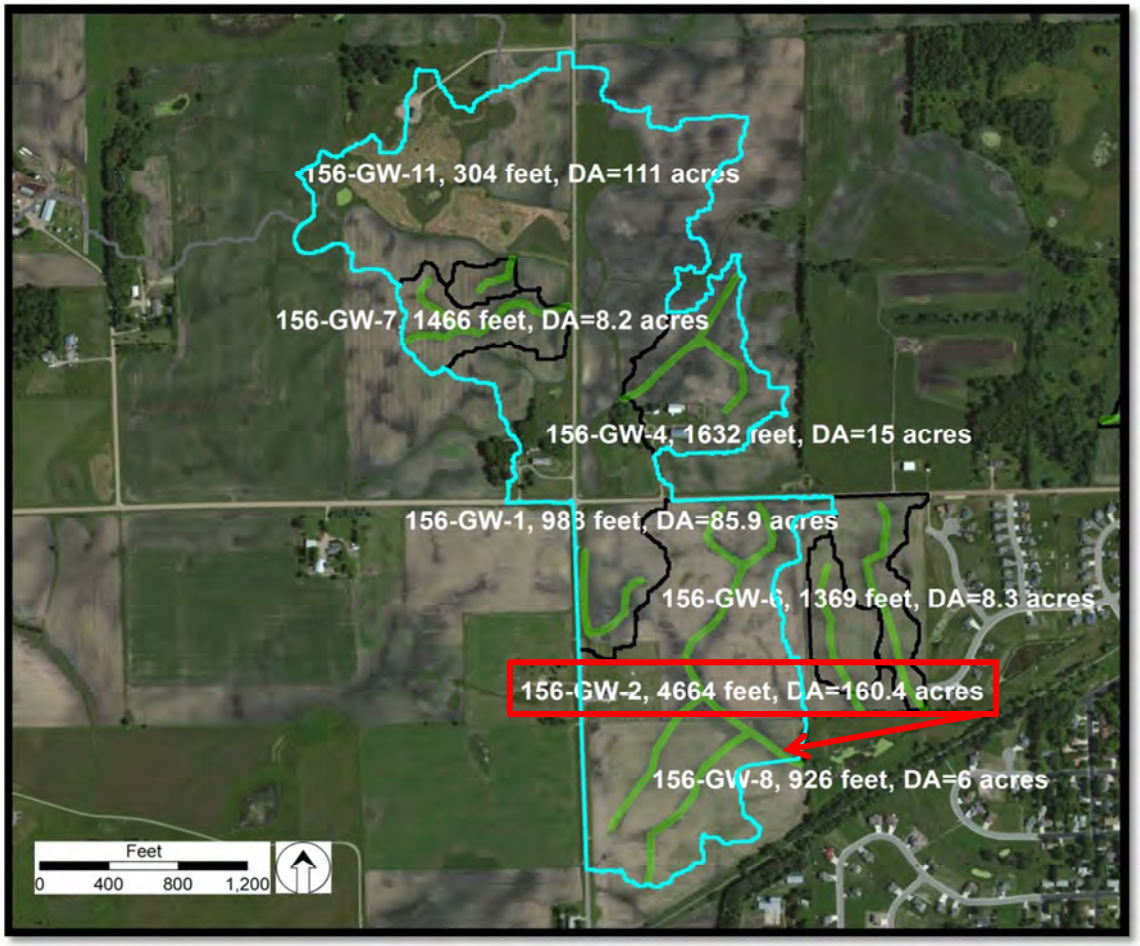


Potential Project 156-GW-2

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, Land Management Change (See 156-LMC-1), or Wetland Restoration (See Potential Project 156-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	16.34 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	7994 lbs	Represents the annual reduction to the lake
Project Installation Cost	$17,443	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$53	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.11	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

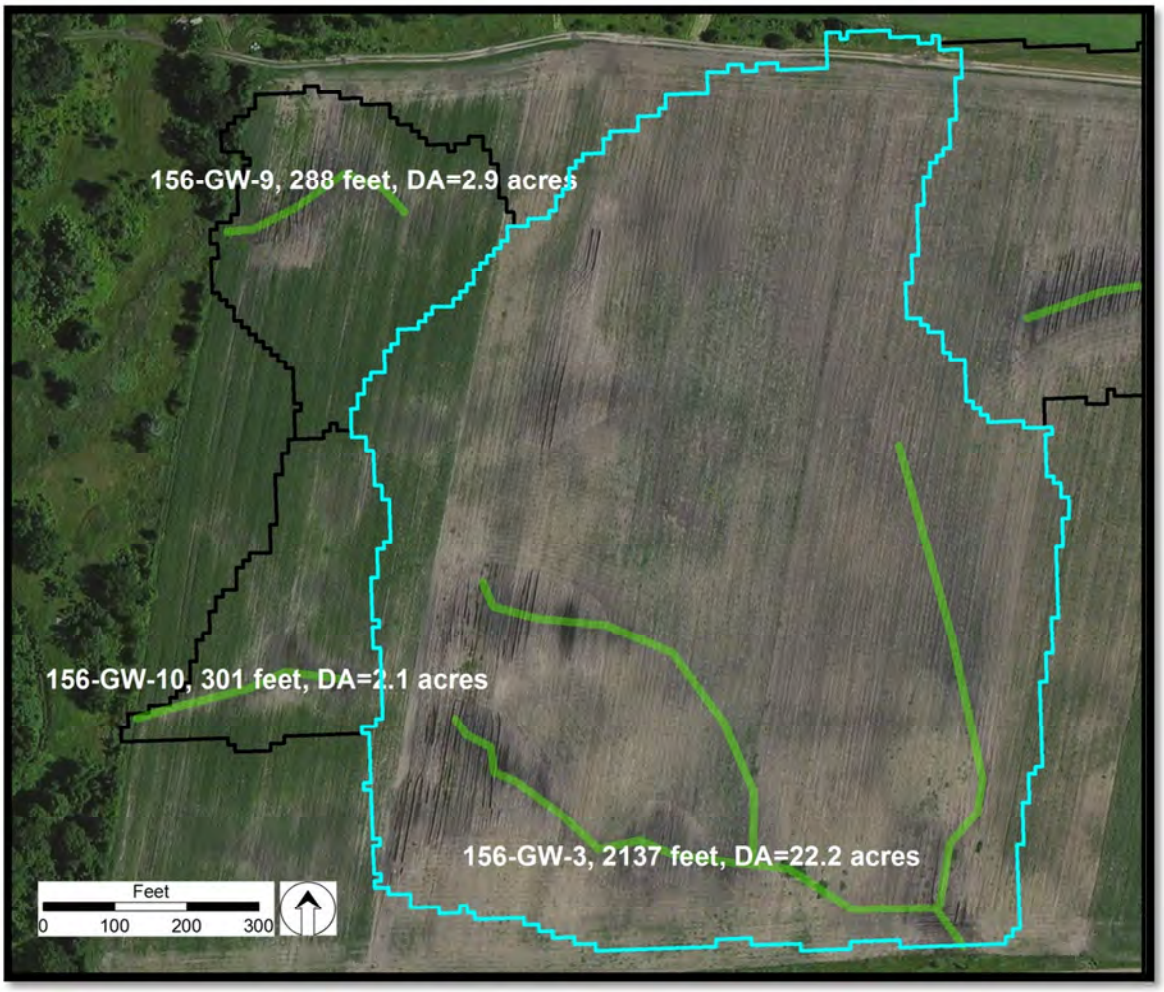


Potential Project 156-GW-3

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	2.26 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1,106 lbs	Represents the annual reduction to the lake
Project Installation Cost	$5,770	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$128	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.26	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 156-GW-4

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 156-LMC-1)

Notes

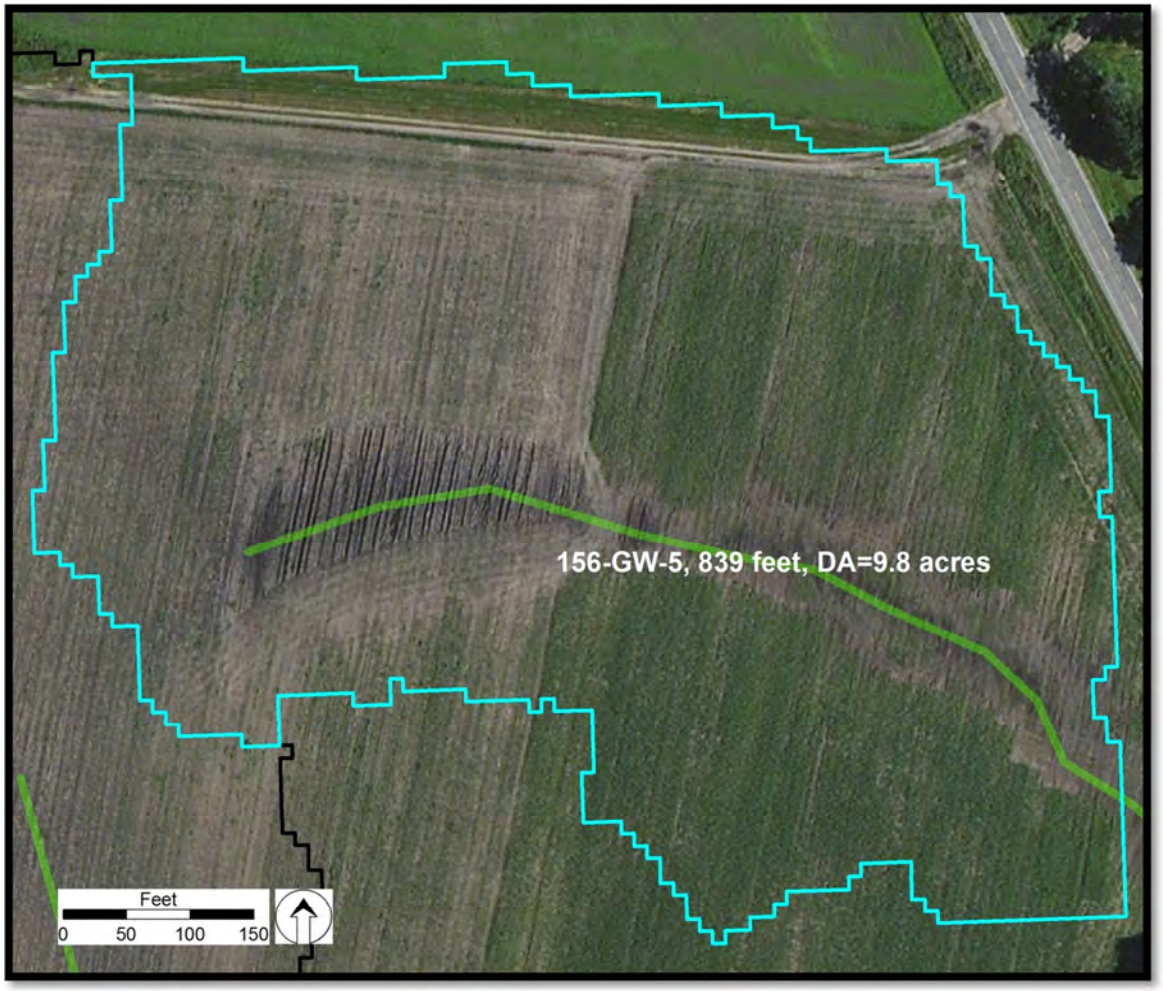
Total Phosphorus (TP) Reduction to Two Rivers Lake	1.53 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	748 lbs	Represents the annual reduction to the lake
Project Installation Cost	$4,406	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$144	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.29	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 156-GW-5

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.00 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	488 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,265	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$113	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.23	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

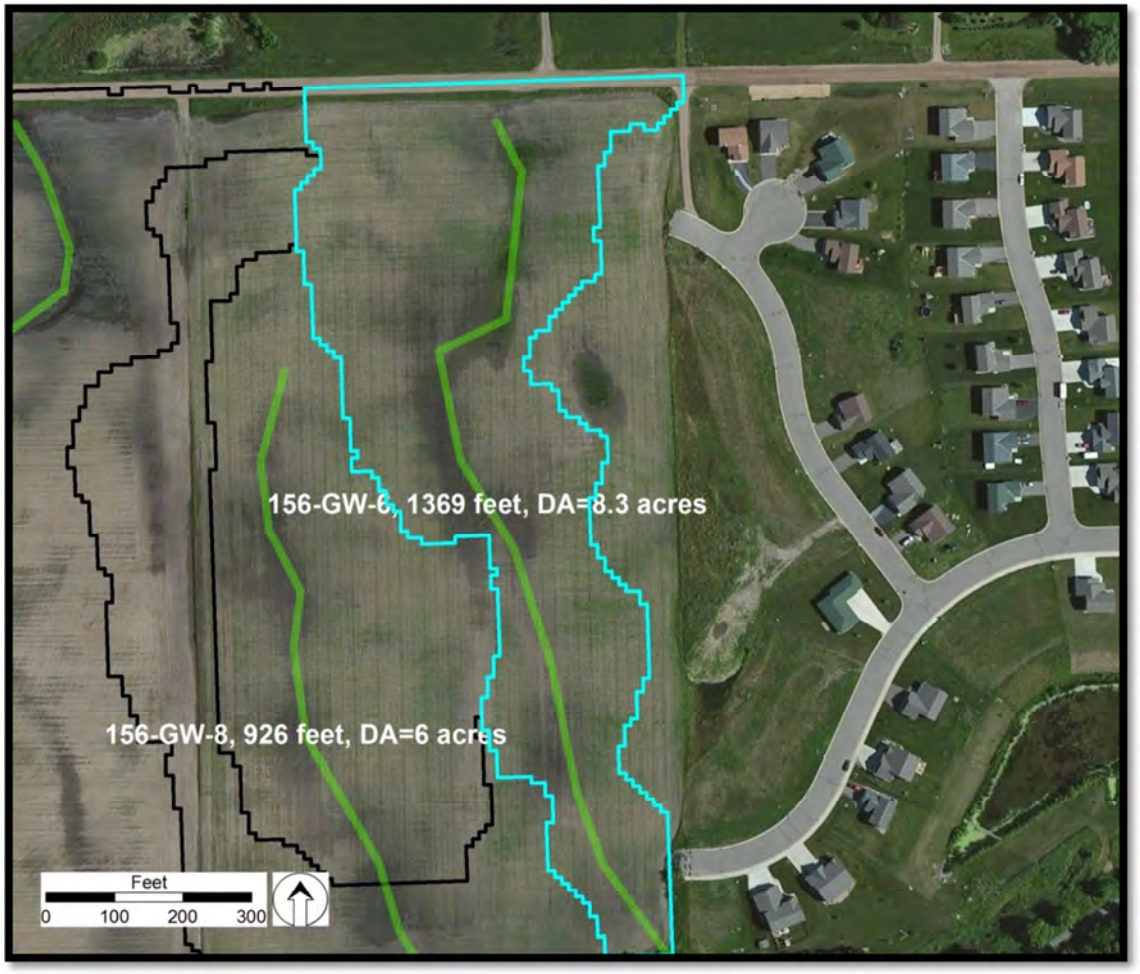


Potential Project 156-GW-6

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, Land Management Change (See 156-LMC-1), or Wetland Expansion (See 156-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.85 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	414 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,696	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$219	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.45	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

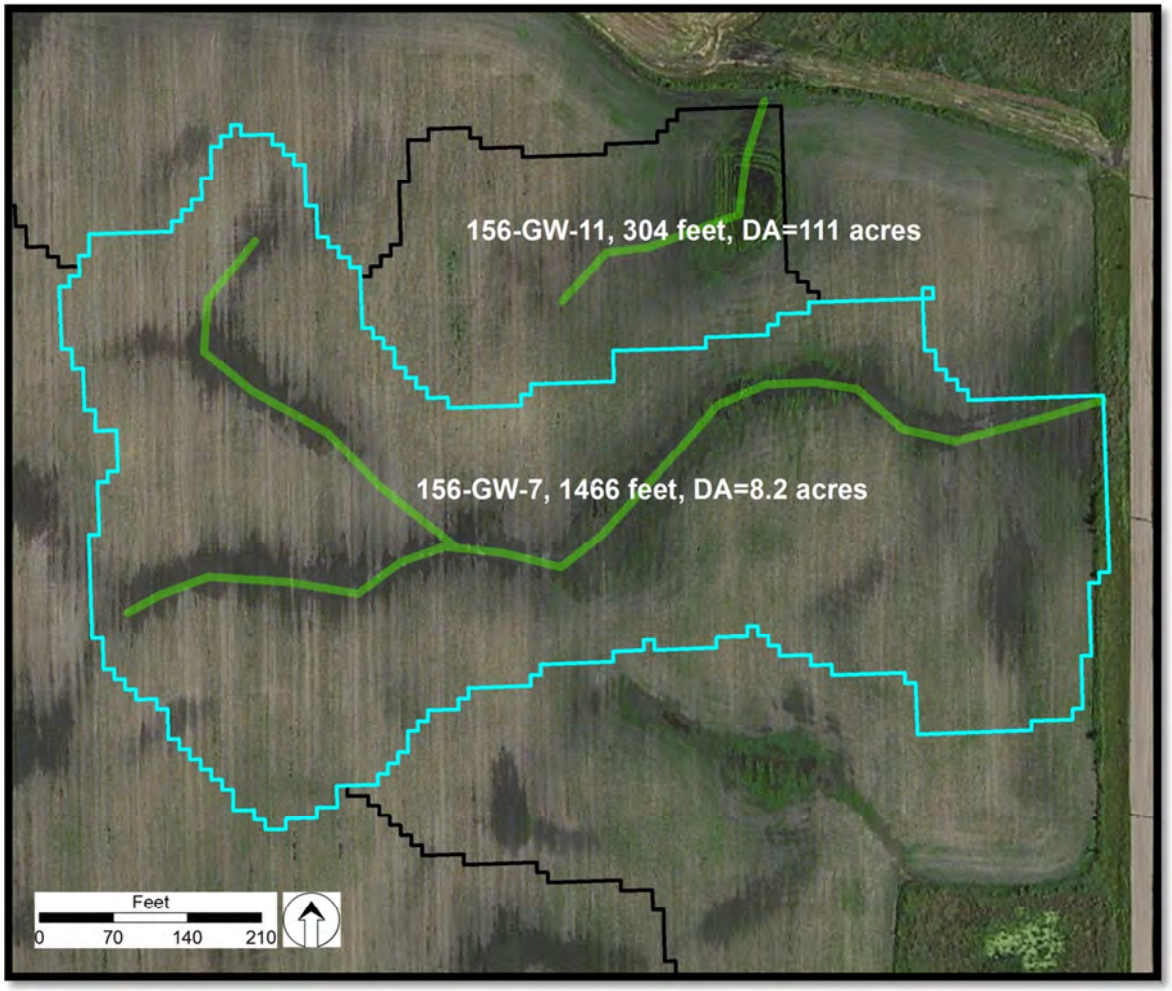


Potential Project 156-GW-7

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 156-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.84 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	409 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,958	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$237	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.48	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

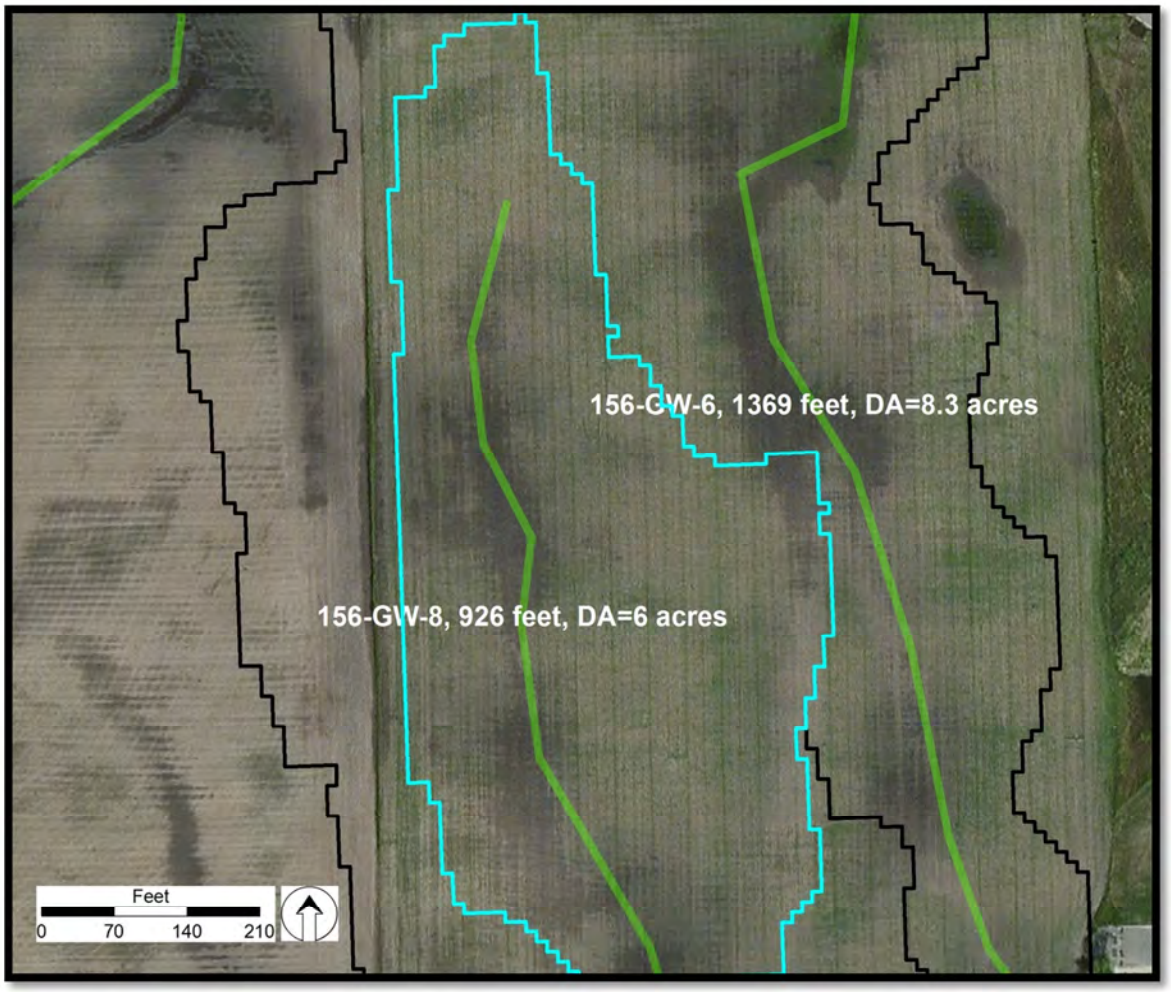


Potential Project 156-GW-8

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, Land Management Change (See 156-LMC-1), or Wetland Expansion (See 156-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.61 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	299 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,500	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$204	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.42	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

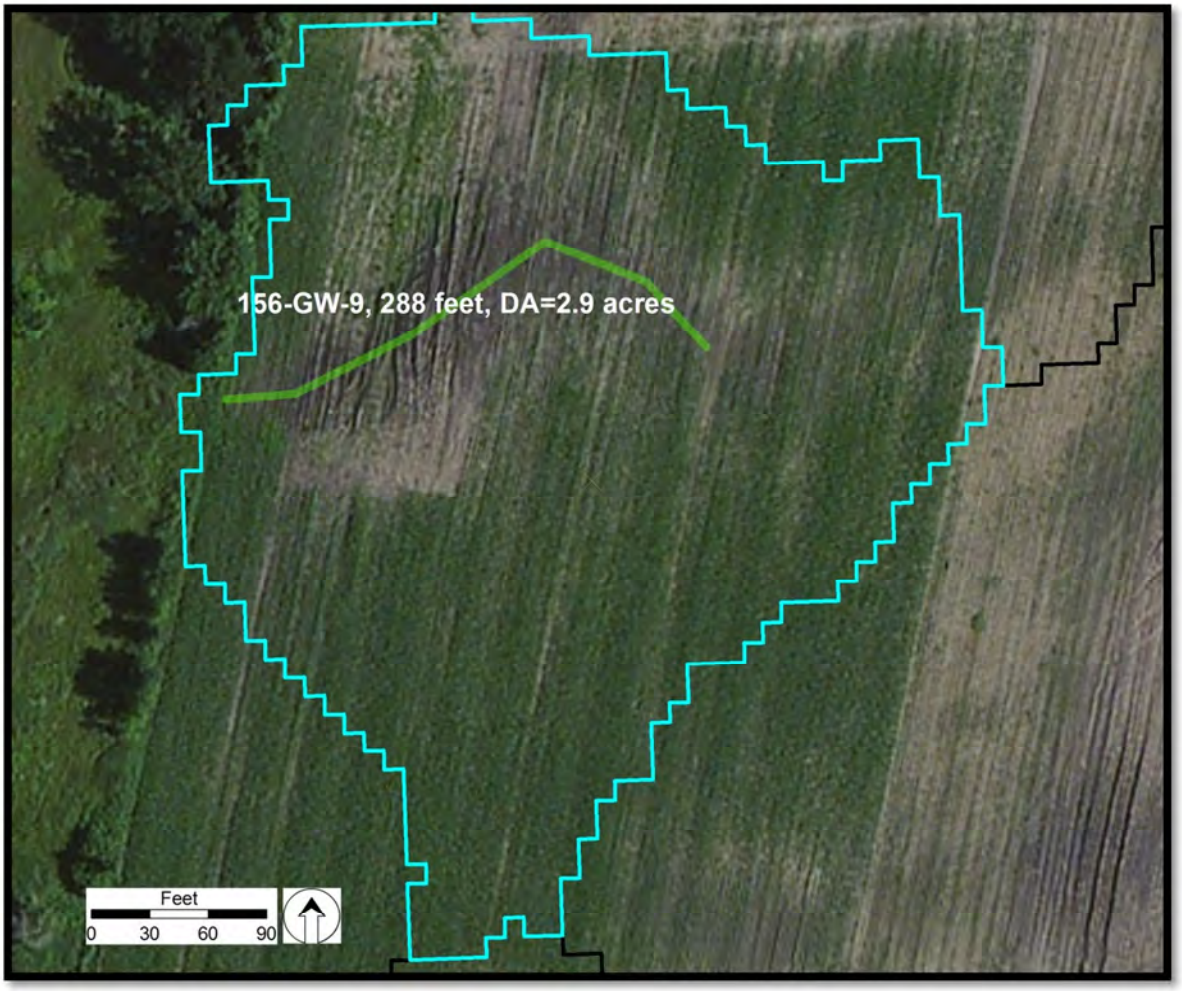


Potential Project 156-GW-9

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.30 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	145 lbs	Represents the annual reduction to the lake
Project Installation Cost	$778	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$132	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.27	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

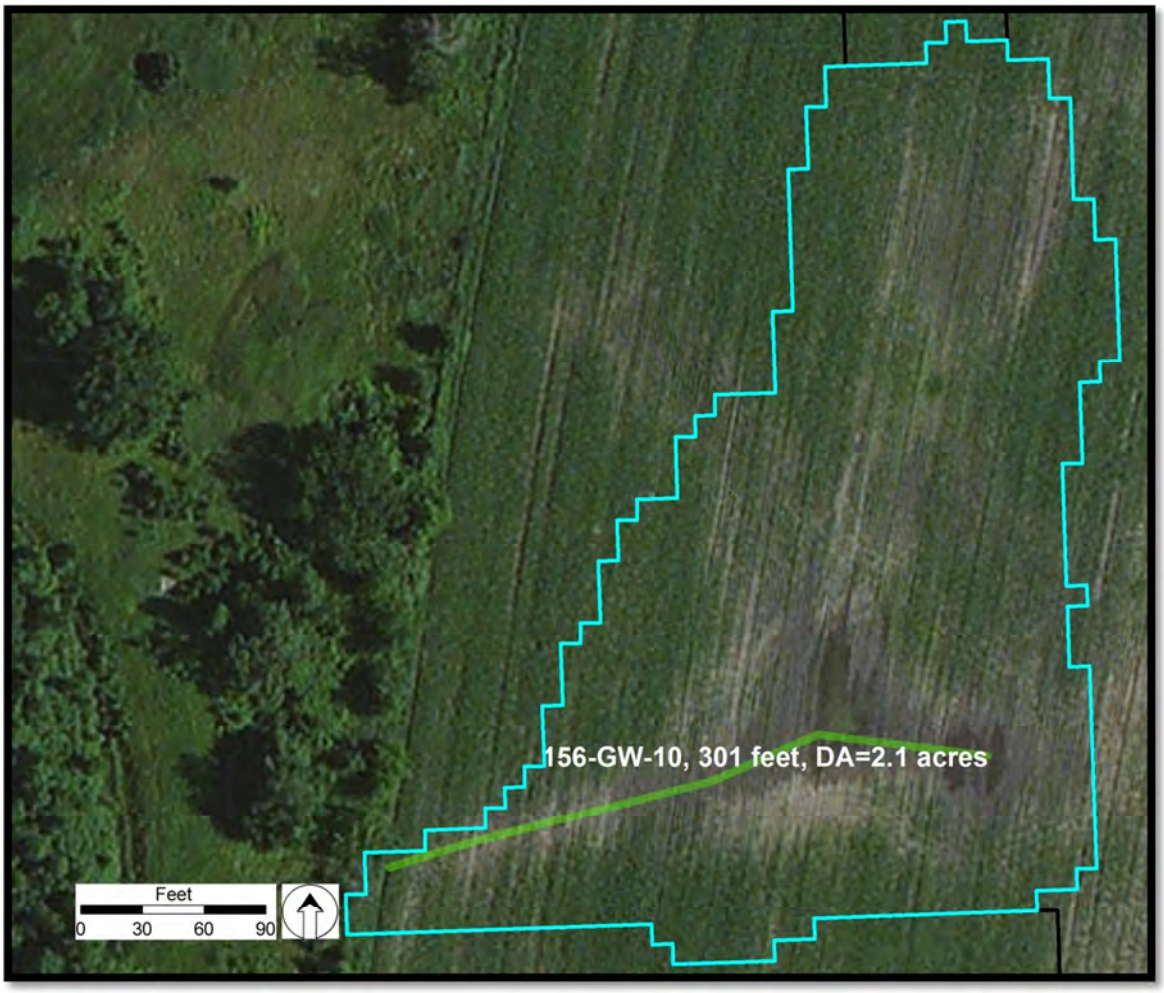


Potential Project 156-GW-10

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.21 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	105 lbs	Represents the annual reduction to the lake
Project Installation Cost	$813	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$190	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.39	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

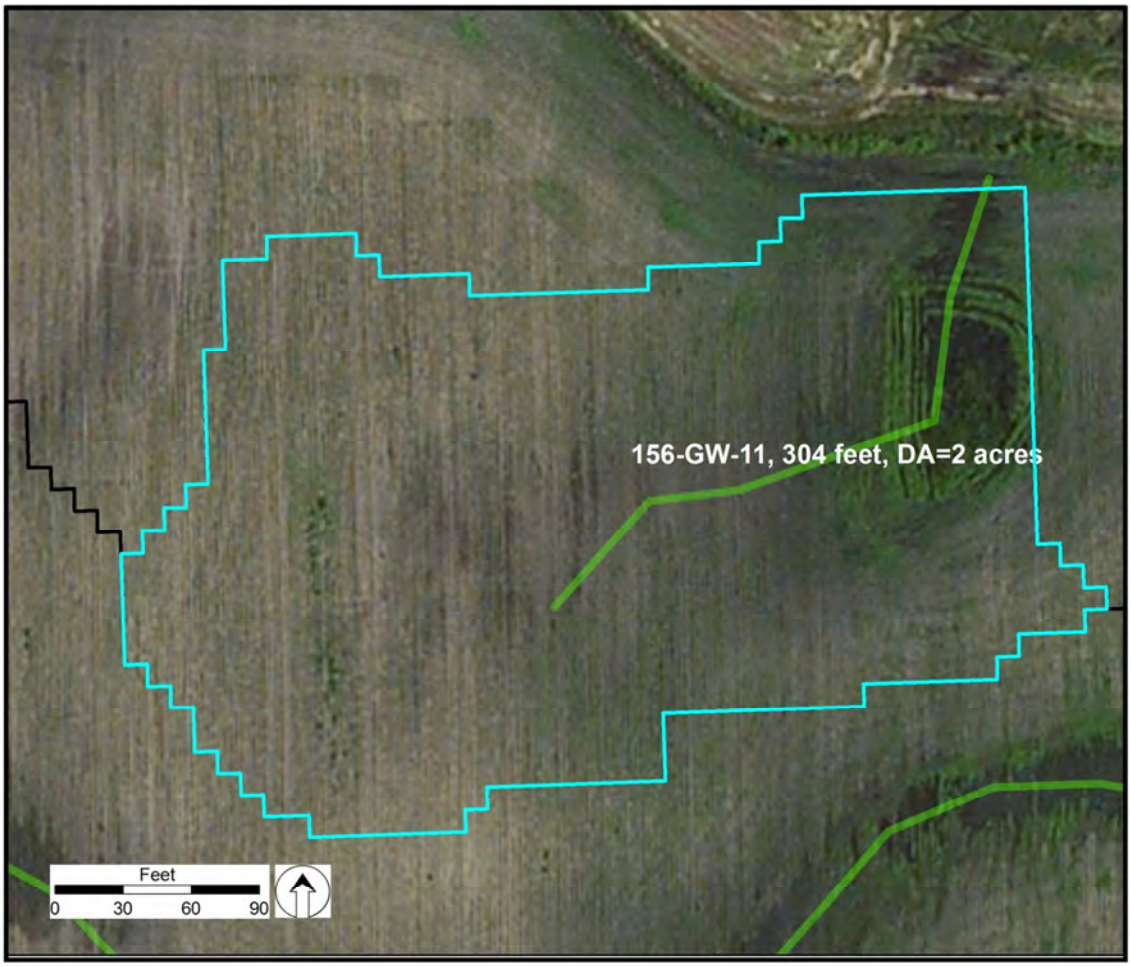


Potential Project 156-GW-11

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 156-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	11.31 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	5532 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,137	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$216	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.43	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

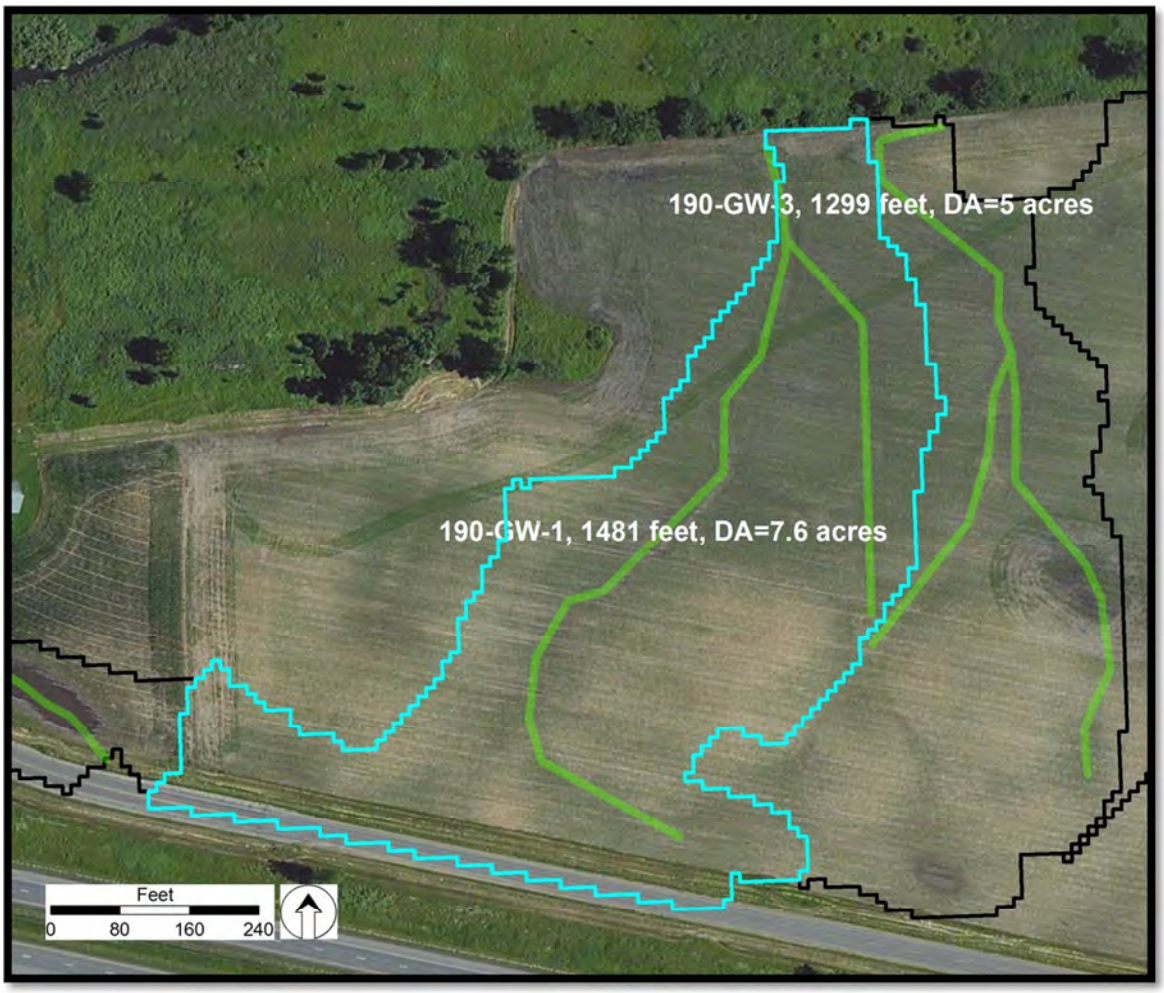


Potential Project 190-GW-1

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.58 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	222 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,999	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$343	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.90	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

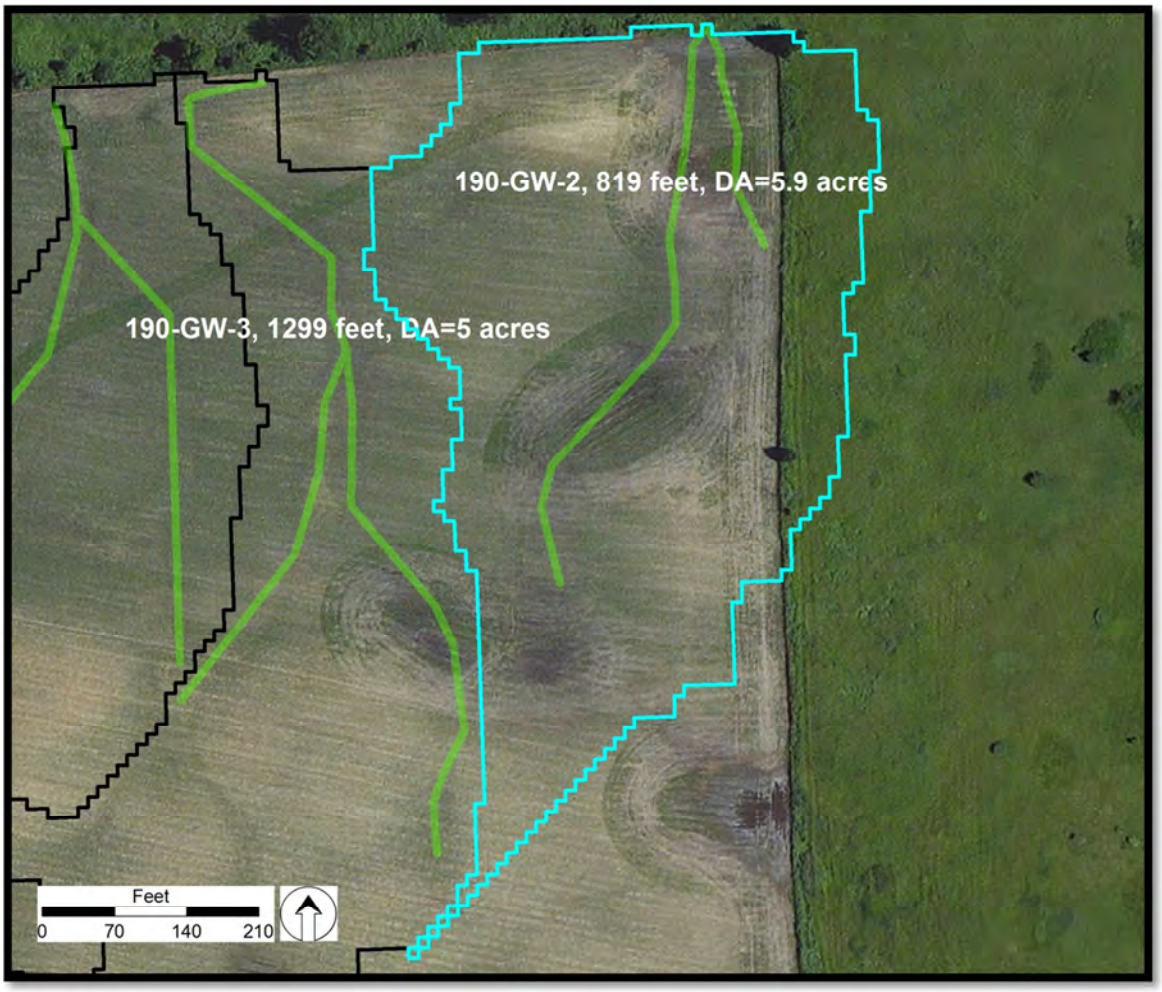


Potential Project 190-GW-2

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.45 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	172 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,211	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$244	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.64	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

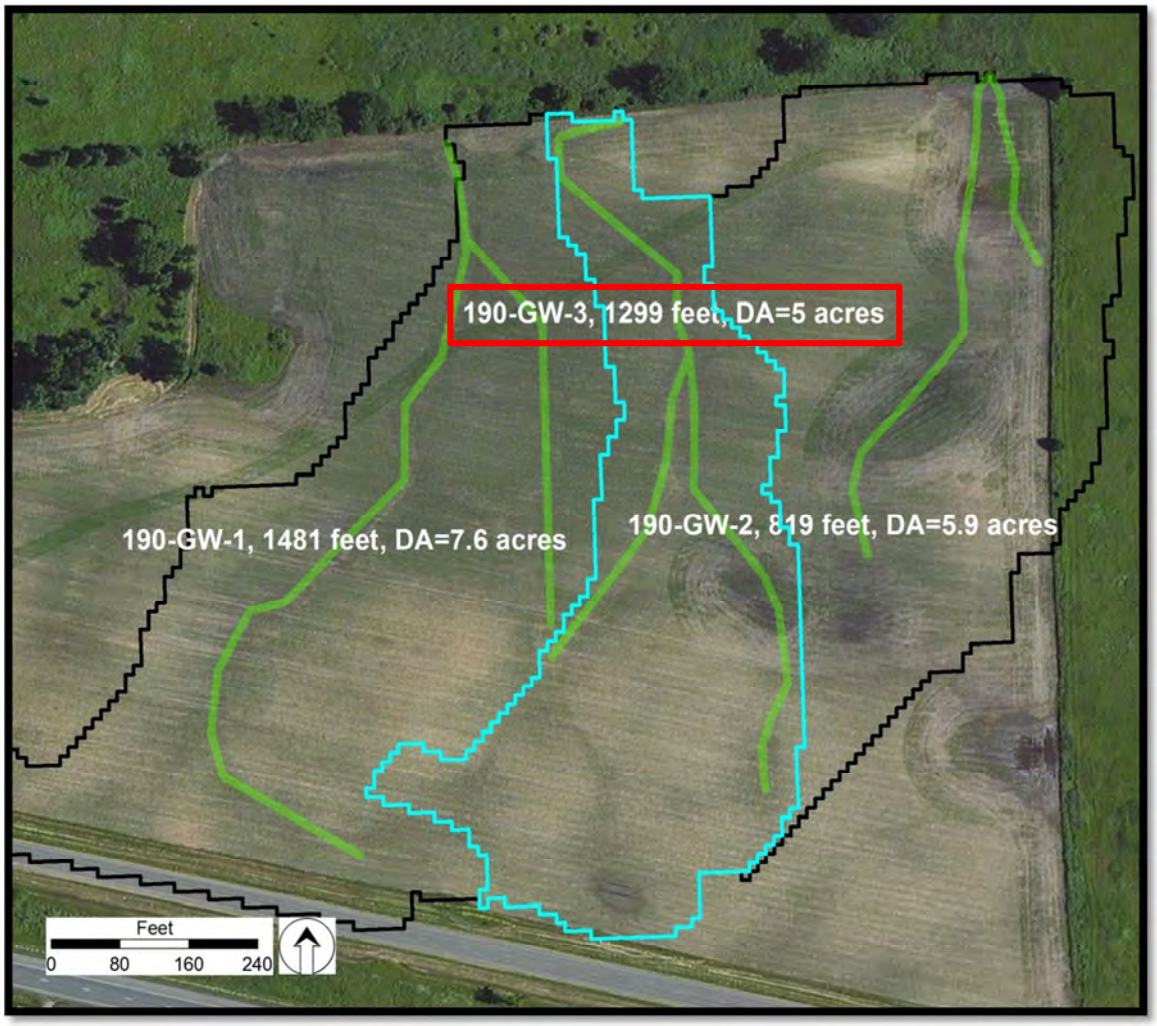


Potential Project 190-GW-3

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.38 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	146 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,507	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$458	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.20	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

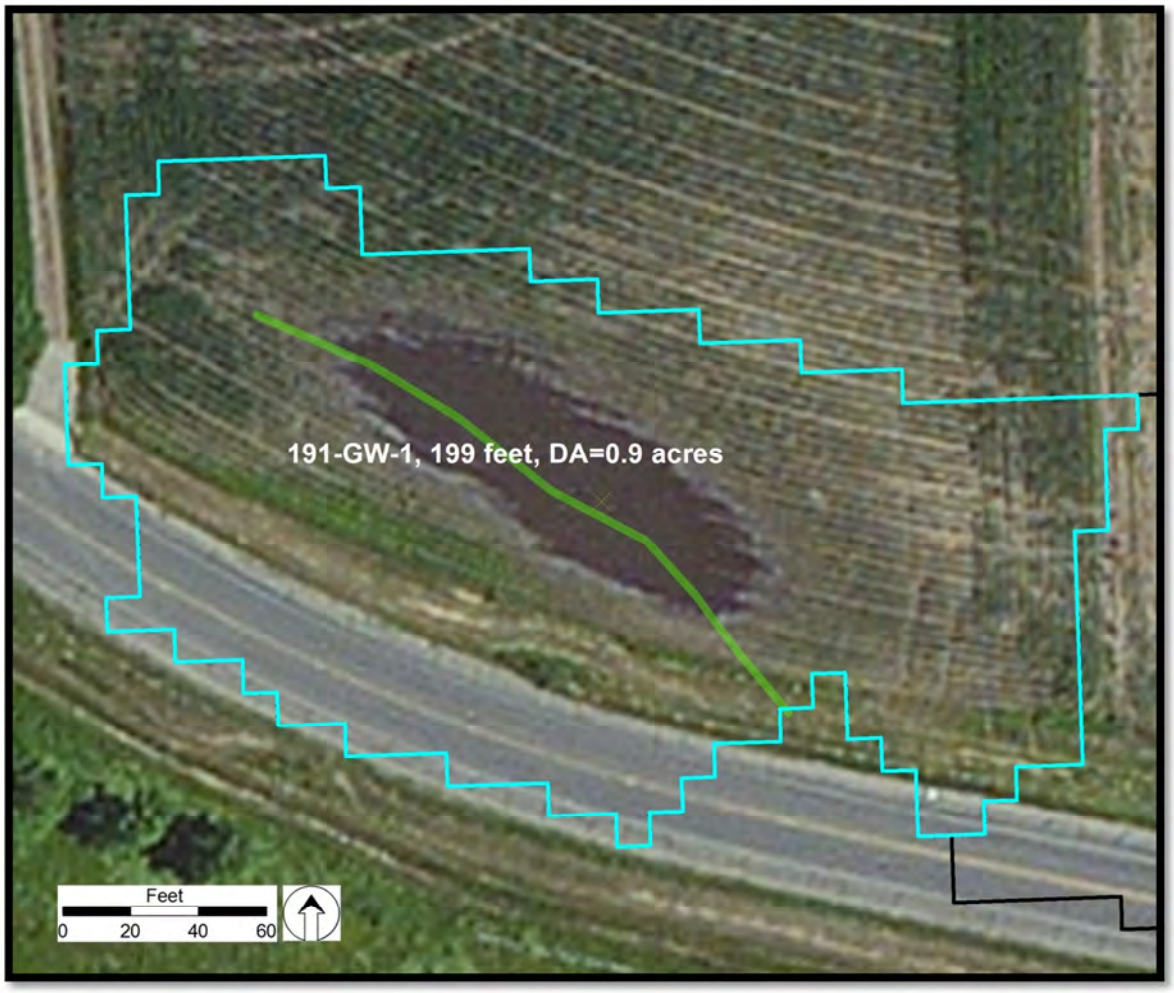


Potential Project 191-GW-1

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.06 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	24 lbs	Represents the annual reduction to the lake
Project Installation Cost	$537	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$439	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.13	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

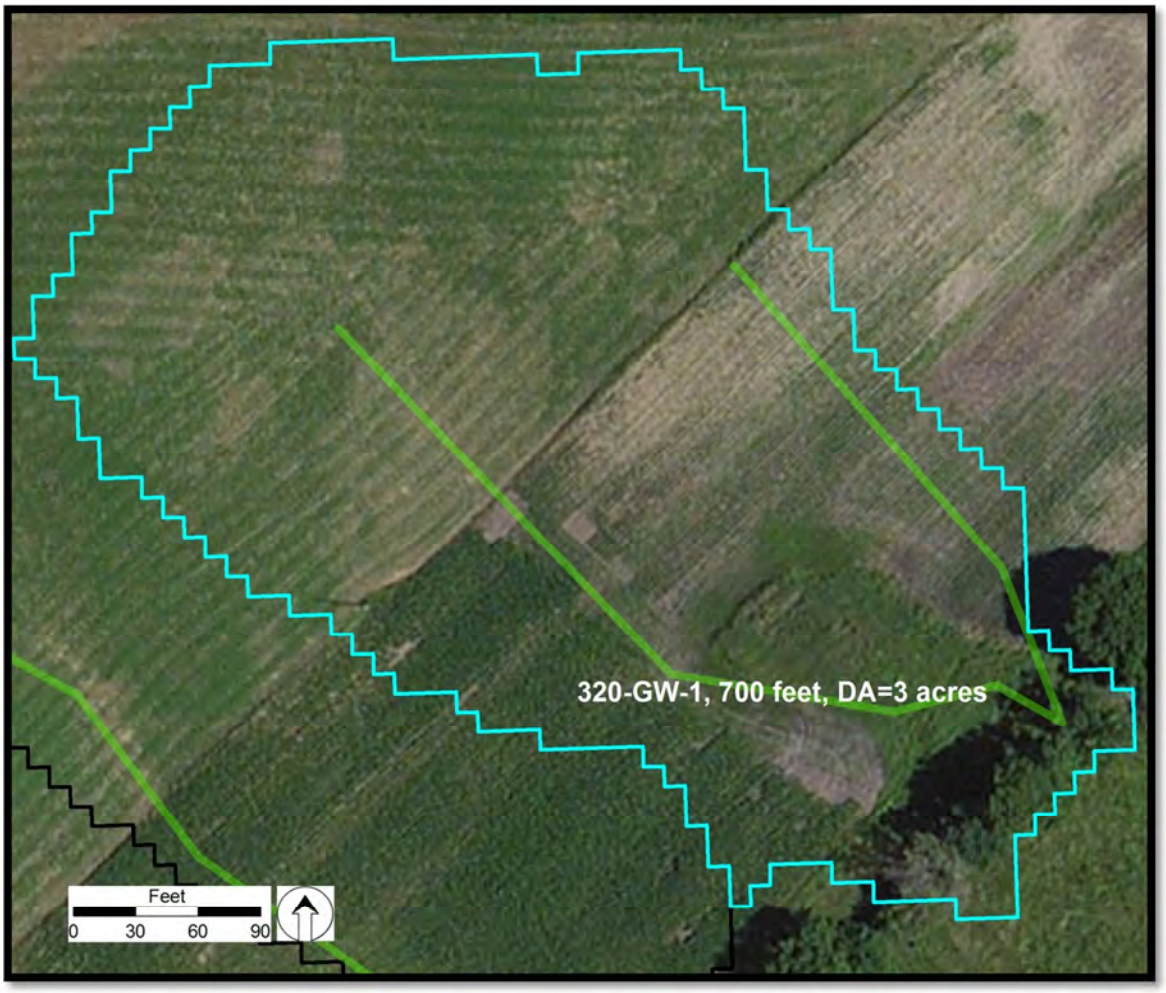


Potential Project 320-GW-1

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.17 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	18 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,890	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$567	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$5.30	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

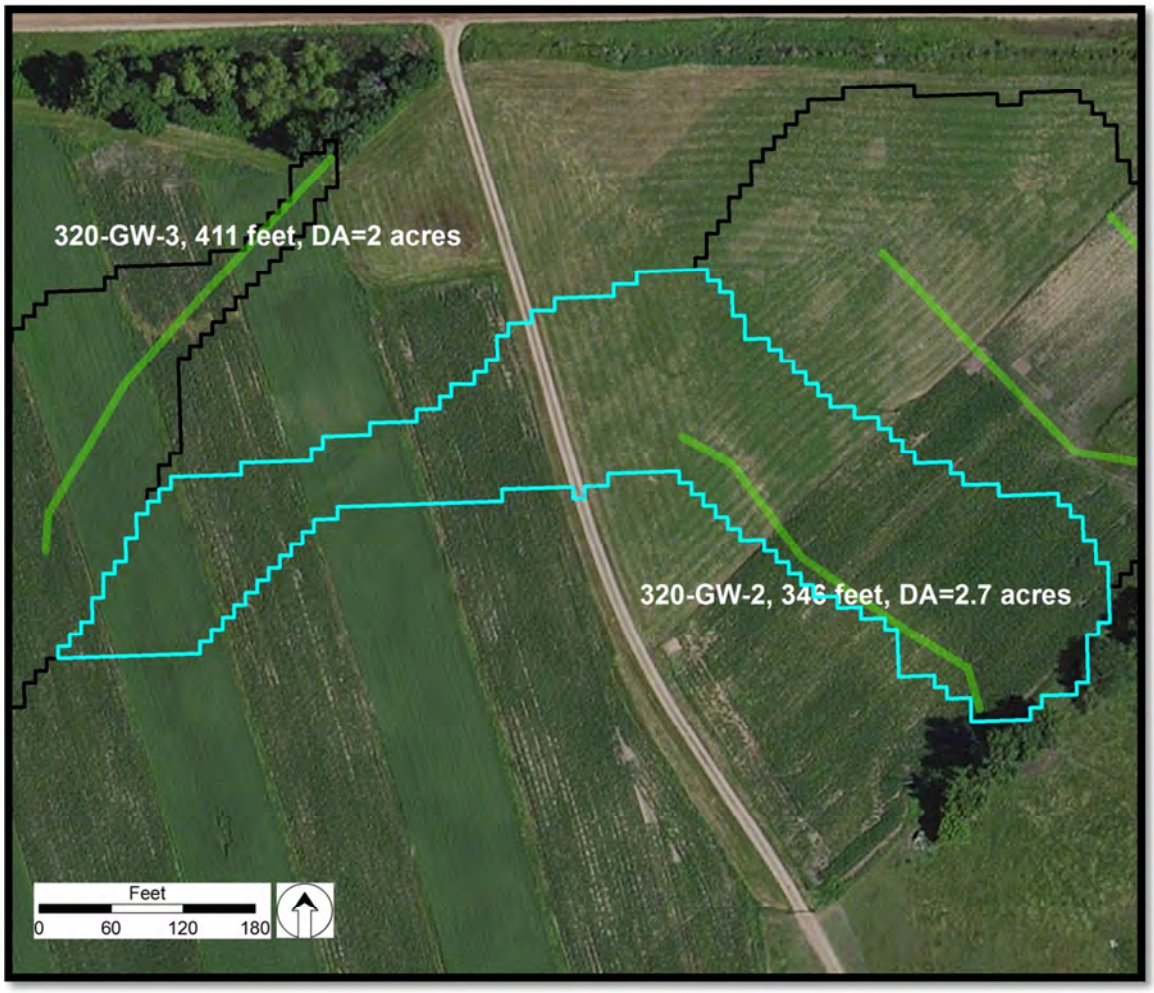


Potential Project 320-GW-2

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.15 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	16 lbs	Represents the annual reduction to the lake
Project Installation Cost	$934	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$311	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.91	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

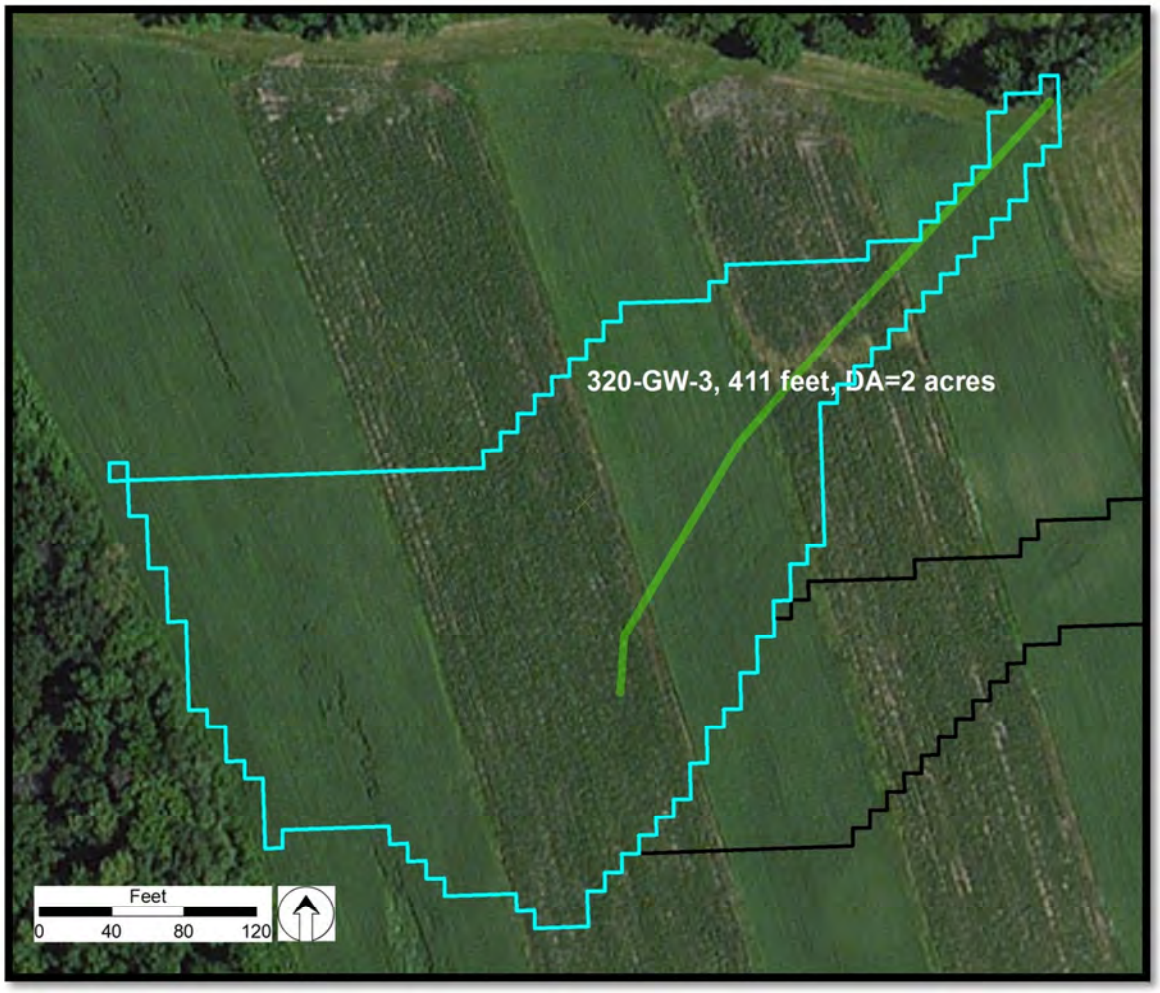


Potential Project 320-GW-3

Problem Description:	High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.11 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	12 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,110	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$499	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$4.67	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

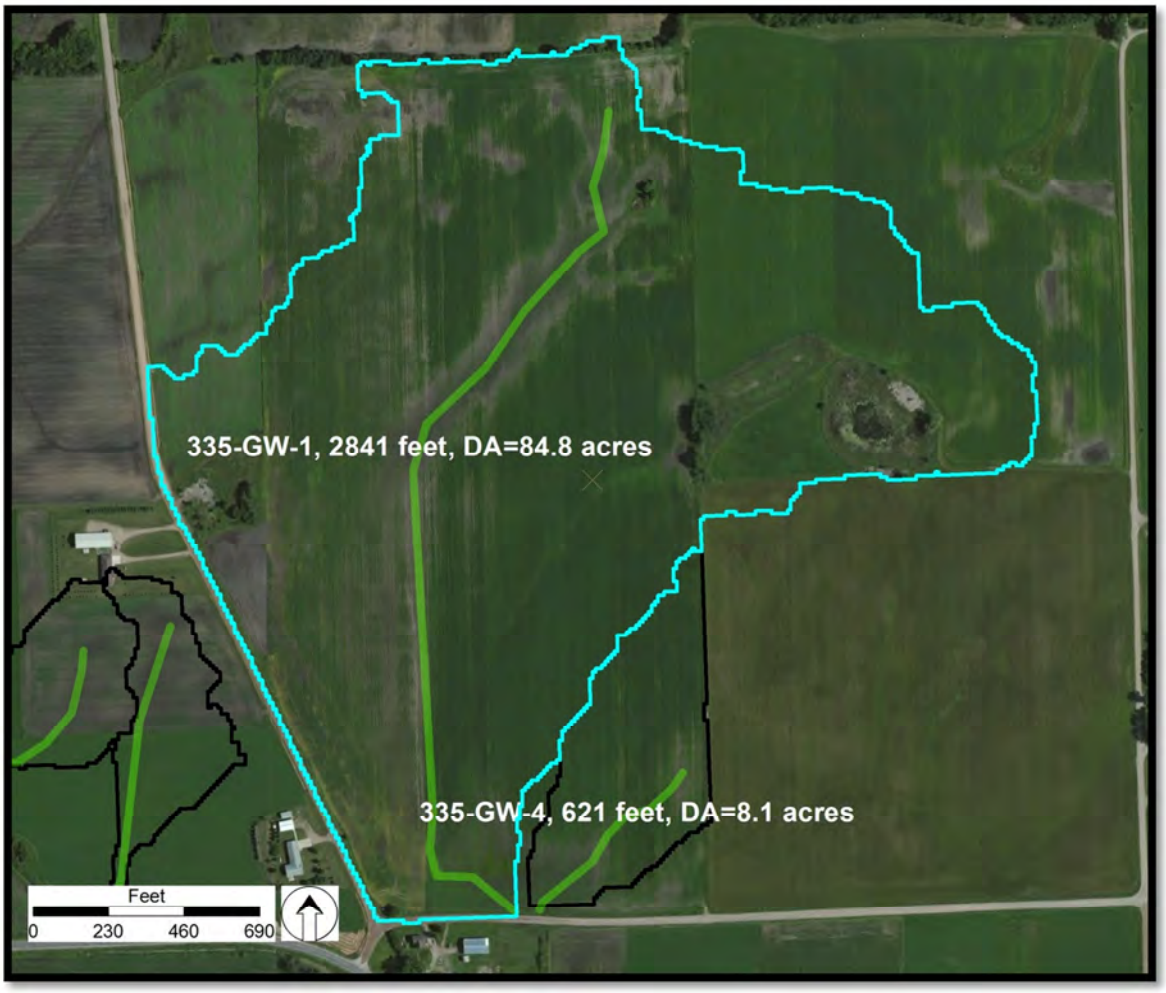


Potential Project 335-GW-1

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	5.94 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1193 lbs	Represents the annual reduction to the lake
Project Installation Cost	$7,671	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$65	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.32	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

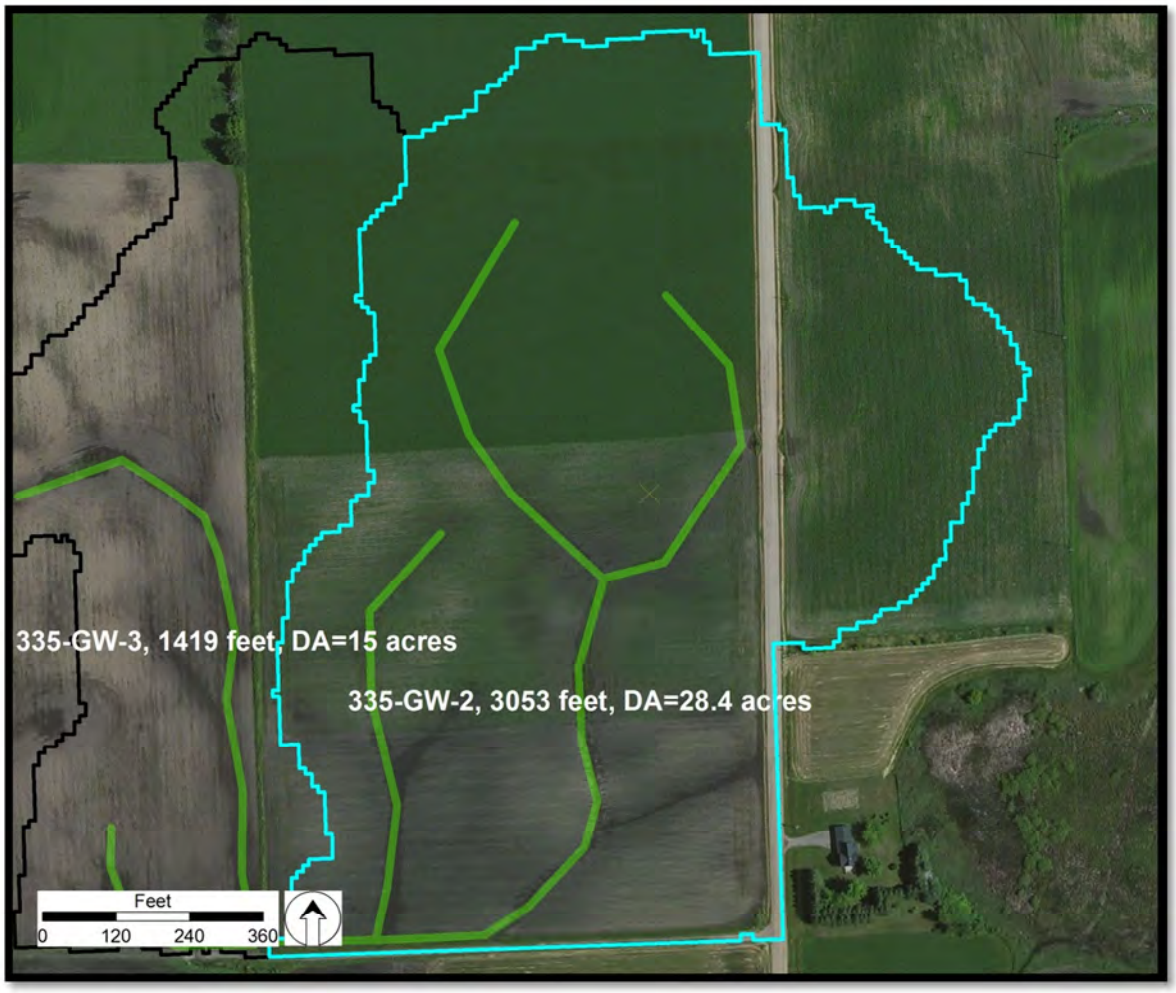


Potential Project 335-GW-2

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.99 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	399 lbs	Represents the annual reduction to the lake
Project Installation Cost	$8,243	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$207	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.03	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

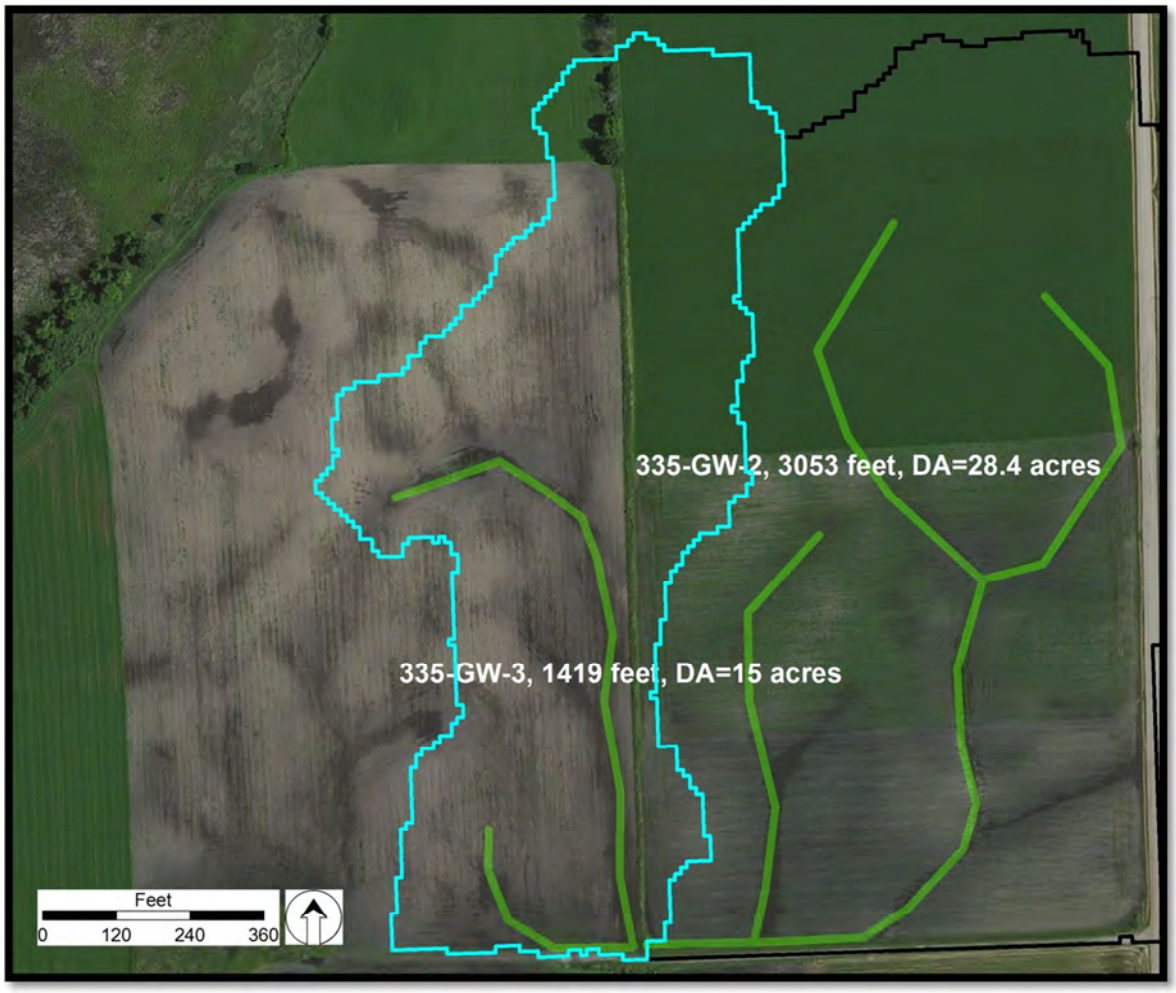


Potential Project 335-GW-3

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.05 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	211 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,831	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$182	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.91	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

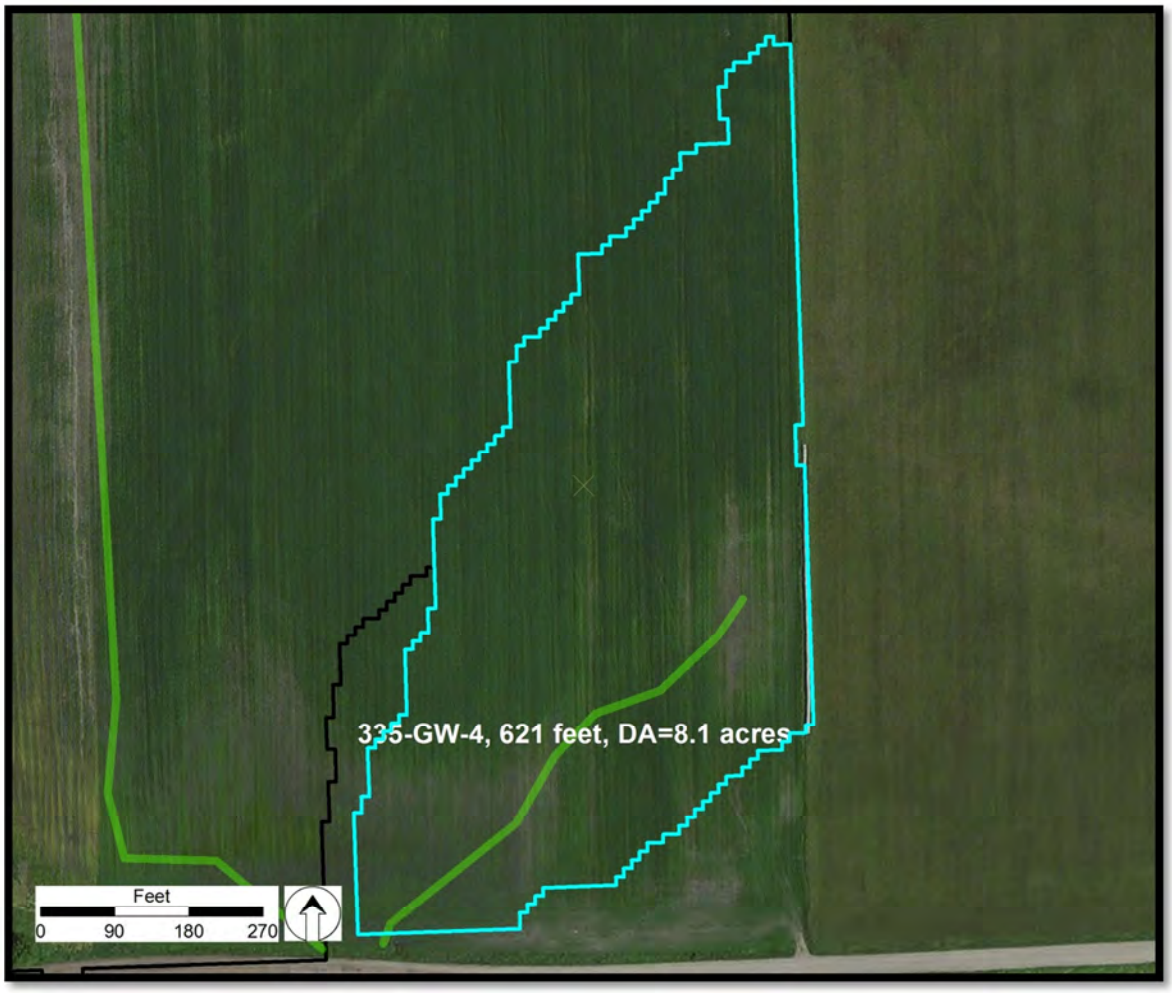


Potential Project 335-GW-4

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.57 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	114 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,677	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$148	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.74	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

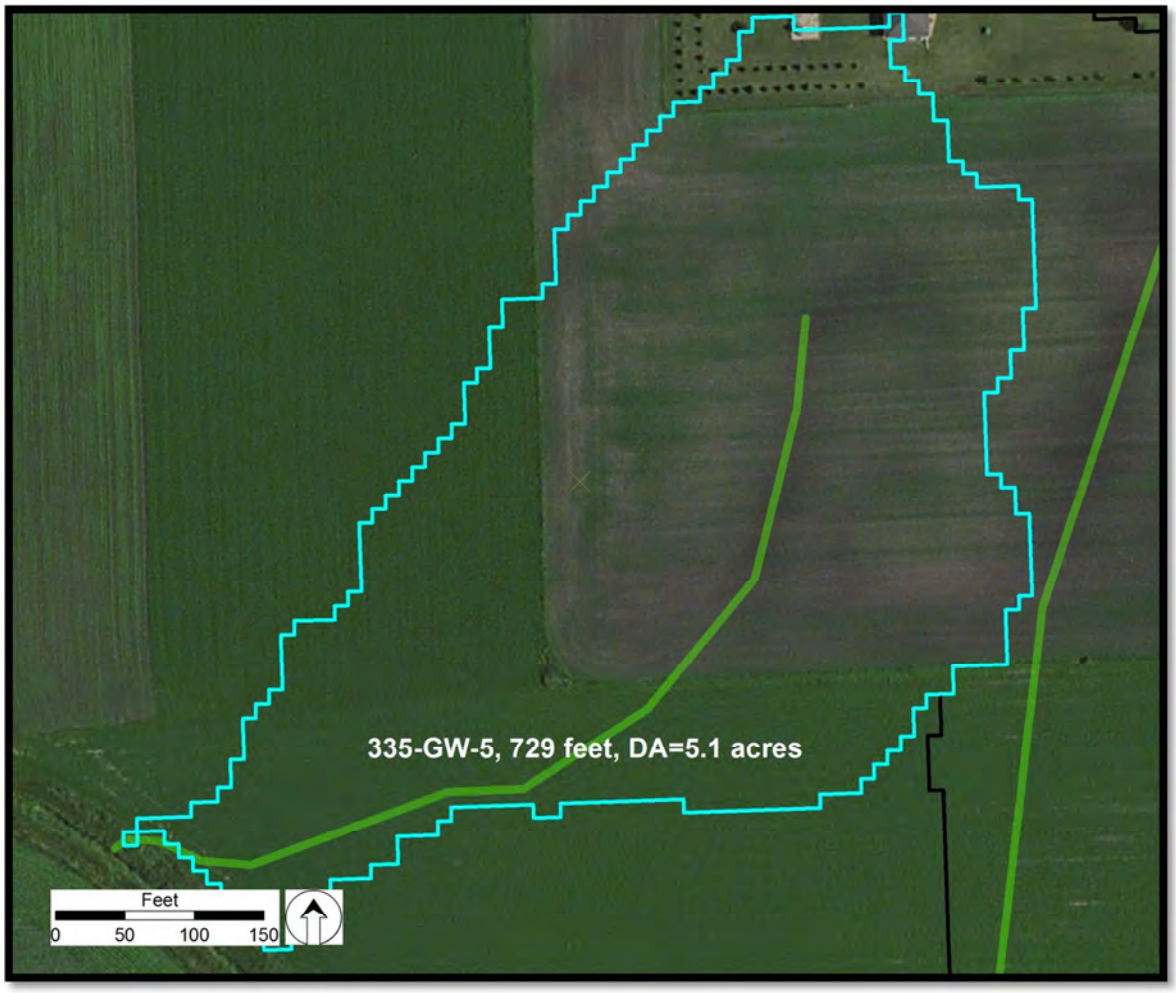


Potential Project 335-GW-5

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.36 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	72 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,968	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$276	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.37	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

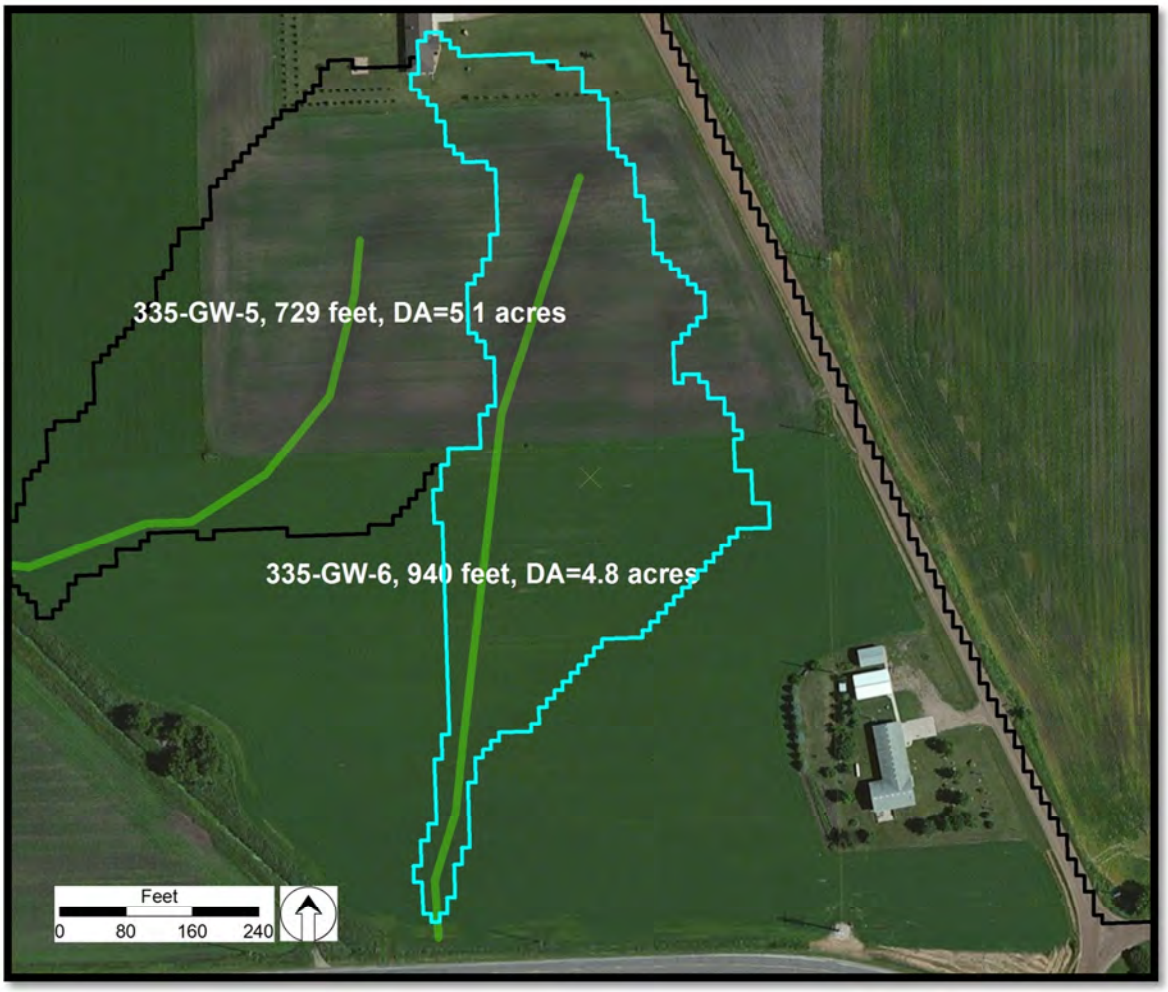


Potential Project 335-GW-6

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.34 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	68 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,538	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$378	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.88	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

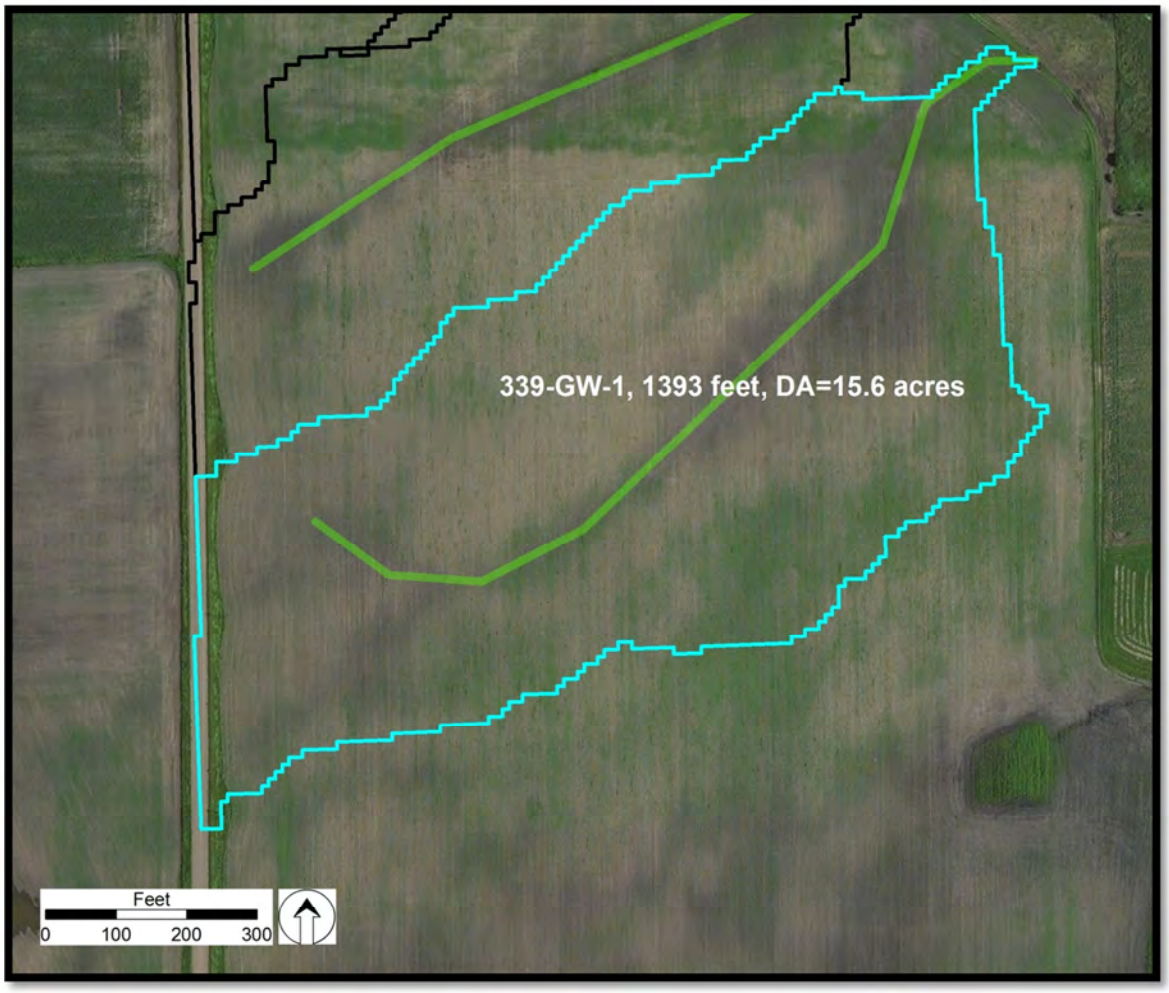


Potential Project 339-GW-1

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.99 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	128 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,761	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$189	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.47	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

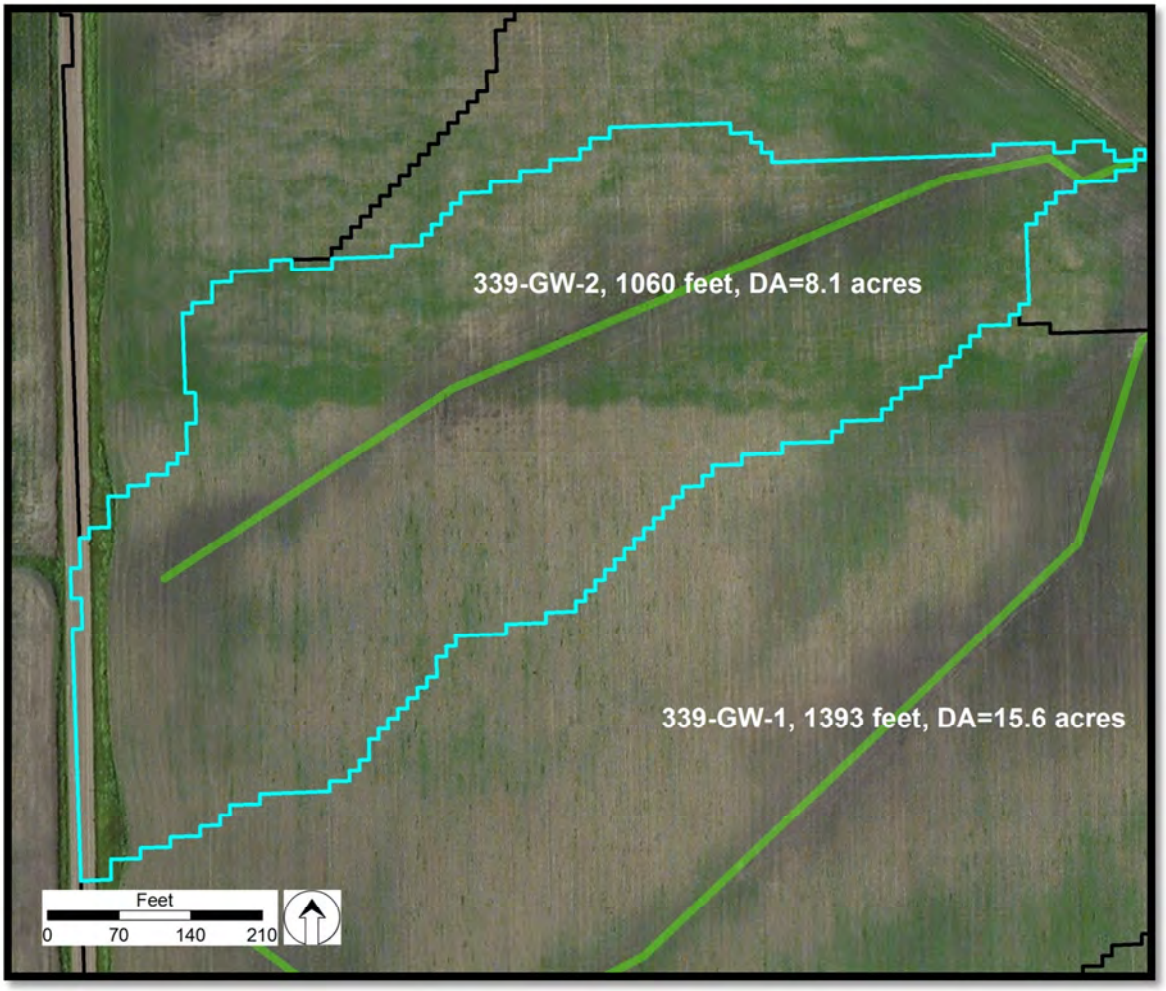


Potential Project 339-GW-2

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.52 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	67 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,862	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$277	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.15	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

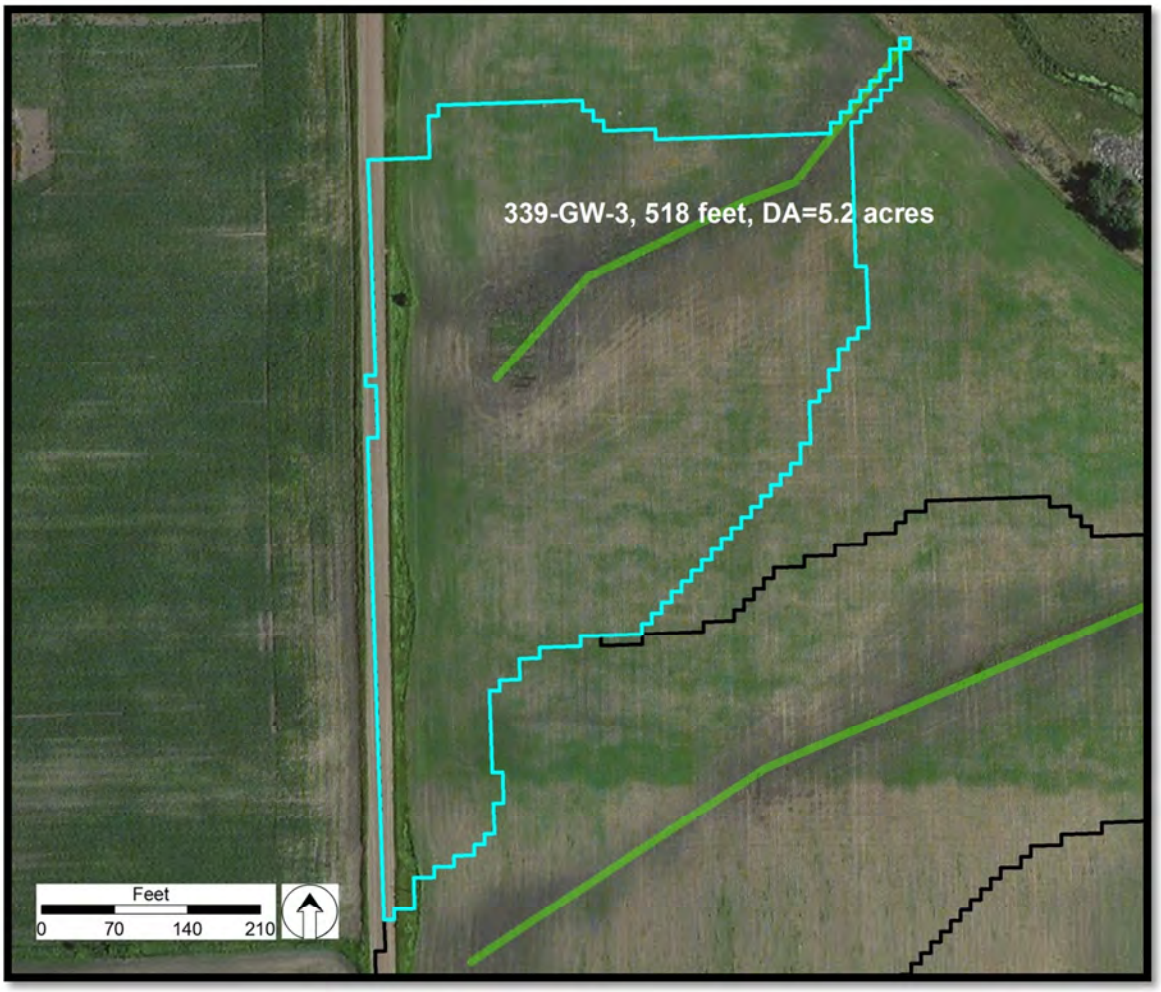


Potential Project 339-GW-3

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.33 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	43 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,399	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$211	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.64	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

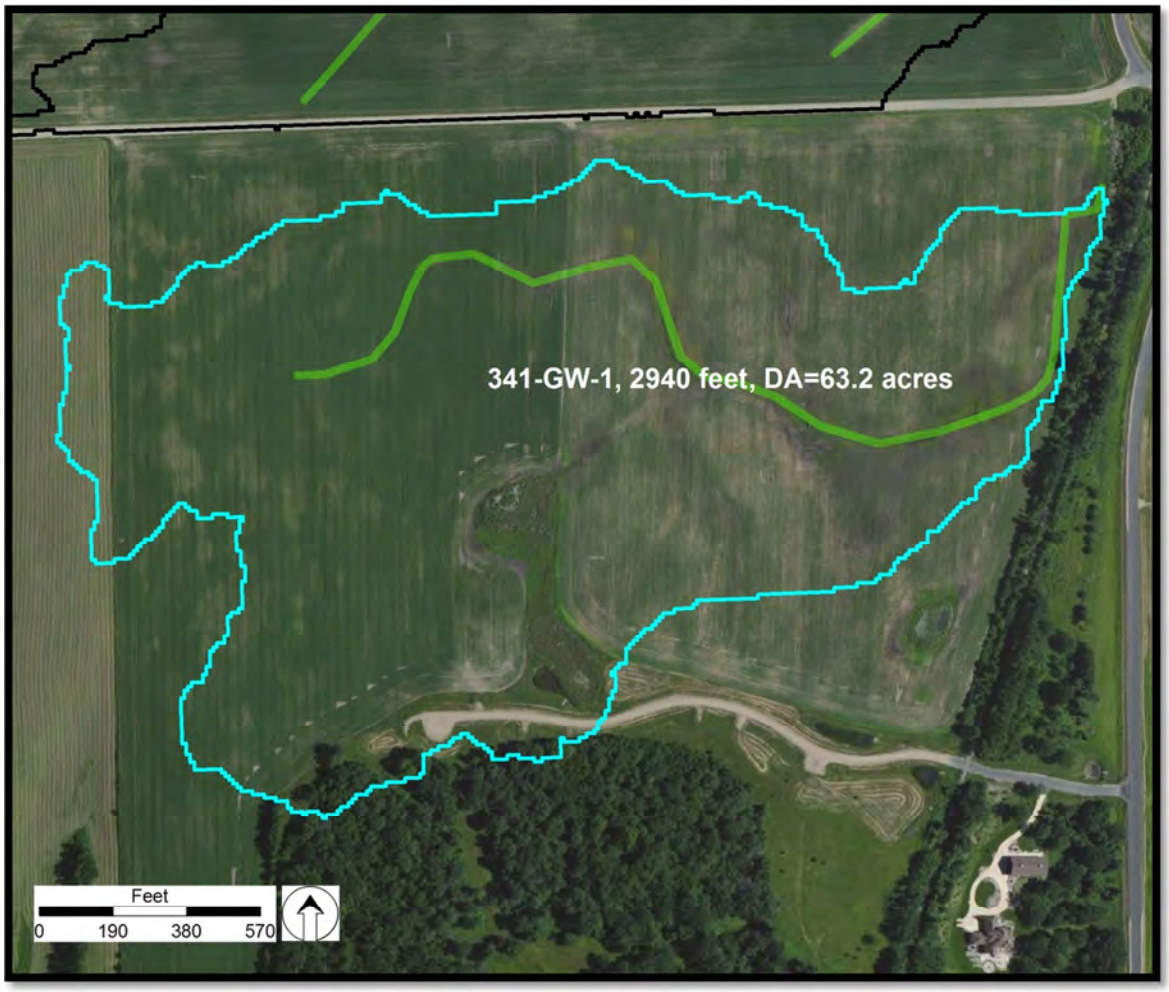


Potential Project 341-GW-1

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Replant Existing Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	3.89 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	619 lbs	Represents the annual reduction to the lake
Project Installation Cost	$7,938	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$102	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.64	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

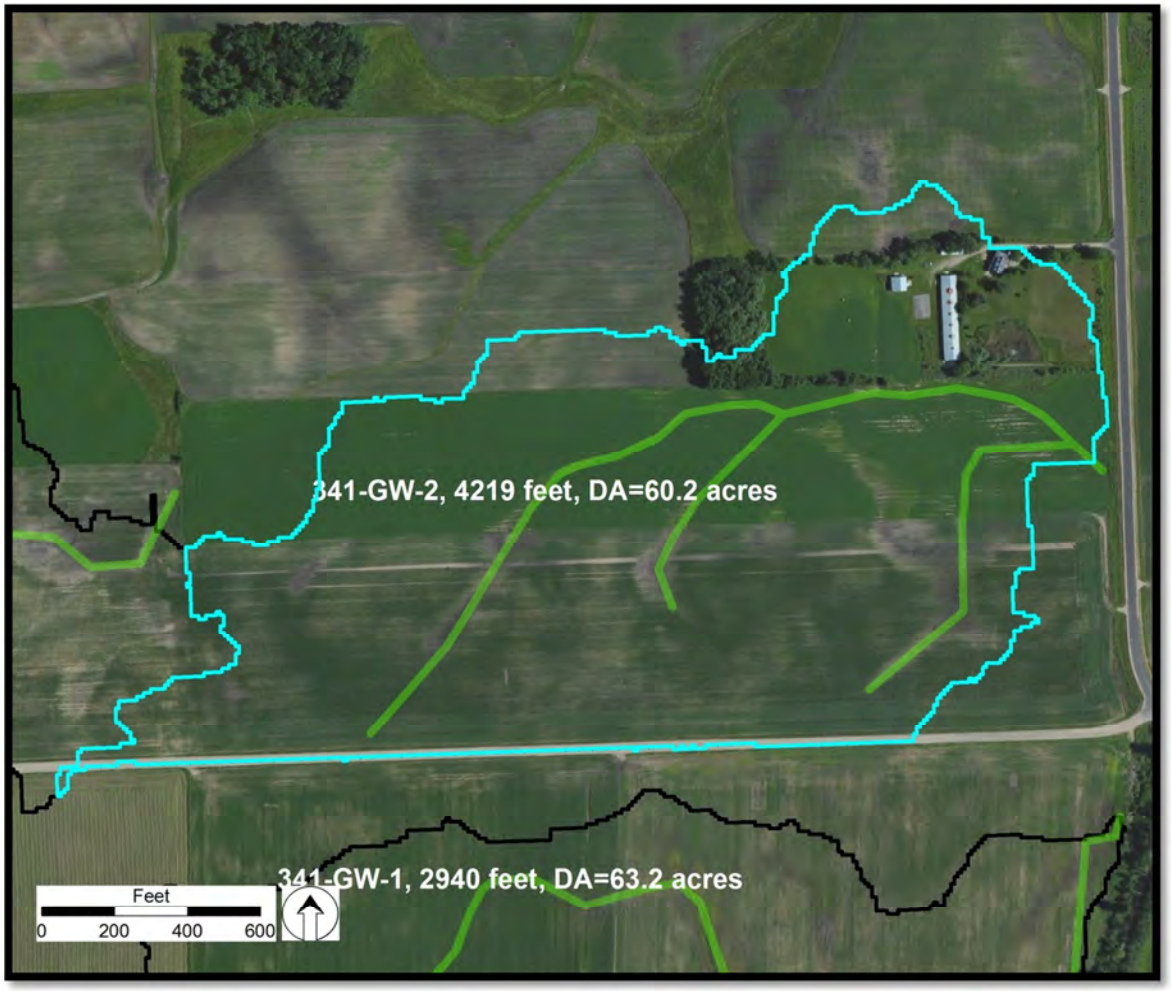


Potential Project 341-GW-2

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	3.70 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	589 lbs	Represents the annual reduction to the lake
Project Installation Cost	$11,391	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$154	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.97	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

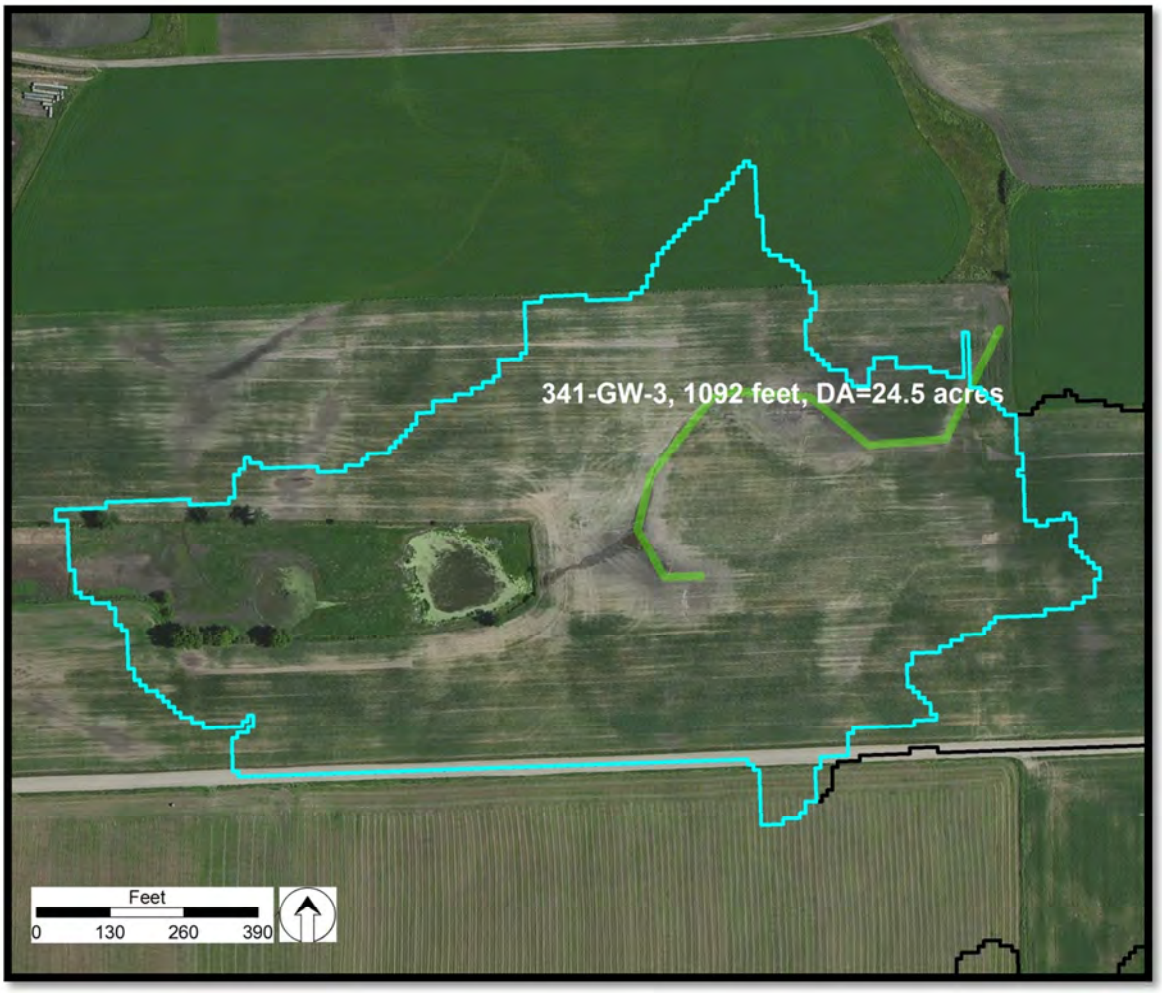


Potential Project 341-GW-3

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.51 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	240 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,948	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$98	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.61	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

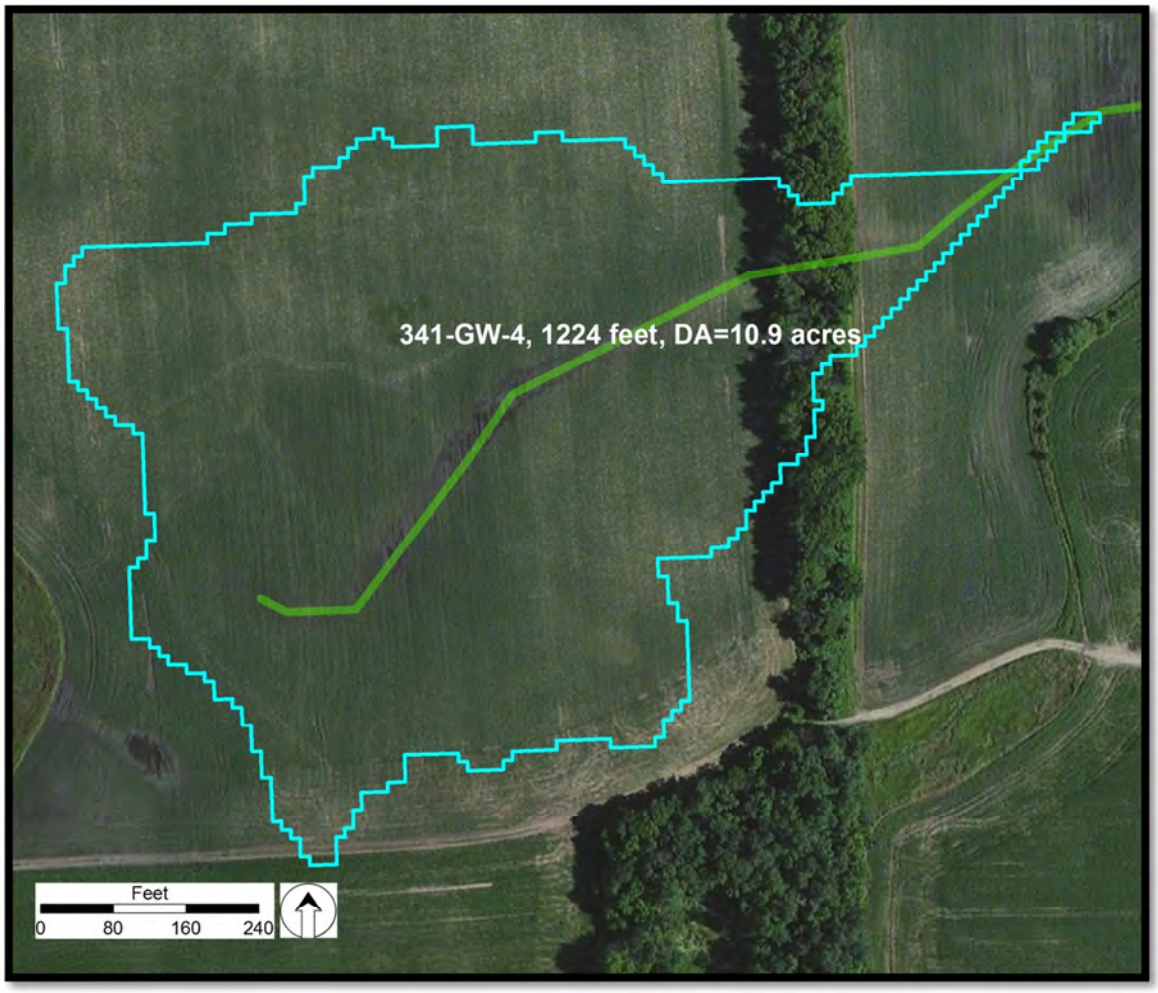


Potential Project 341-GW-4

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.67 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	107 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,305	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$246	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.55	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

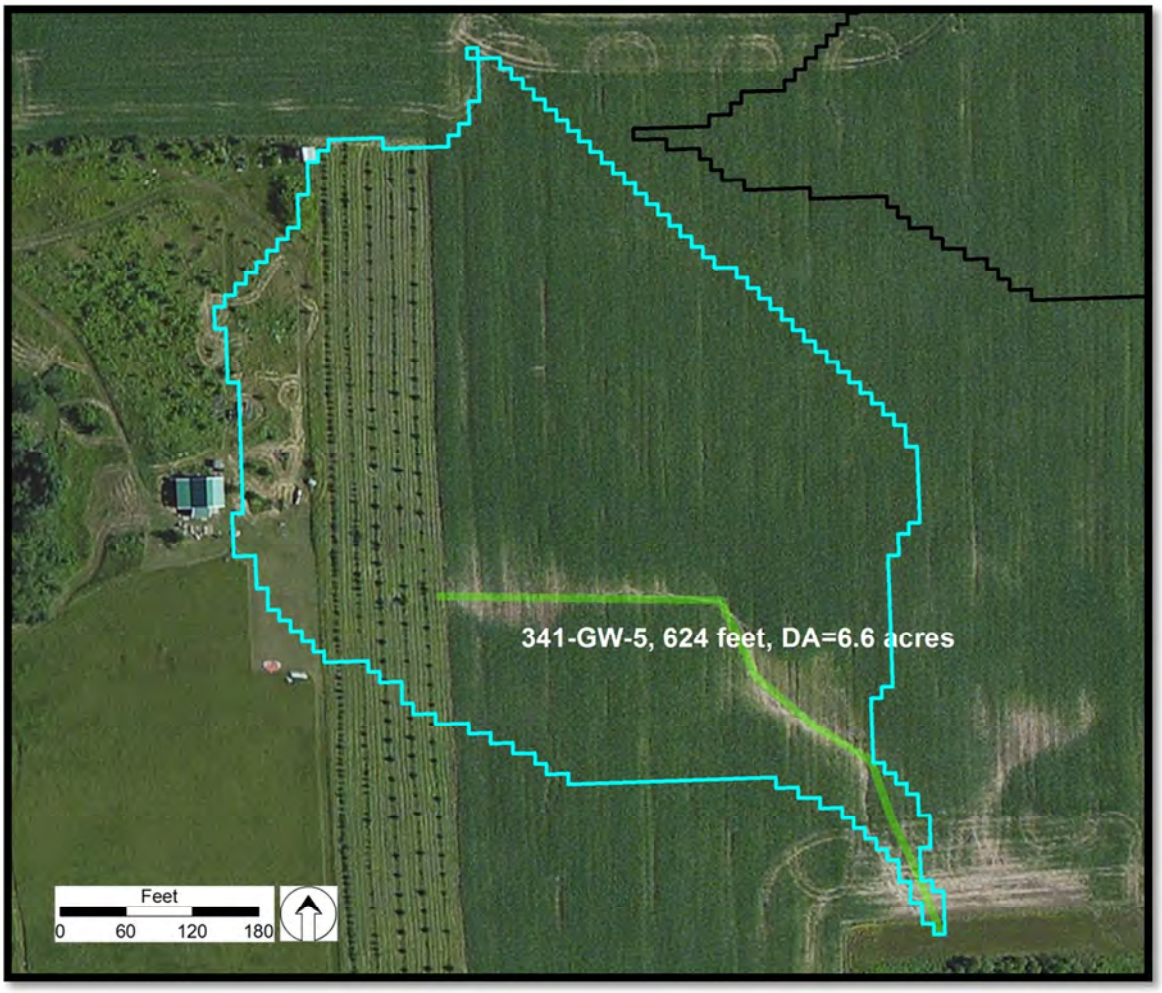


Potential Project 341-GW-5

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.41 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	65 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,685	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$208	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.30	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

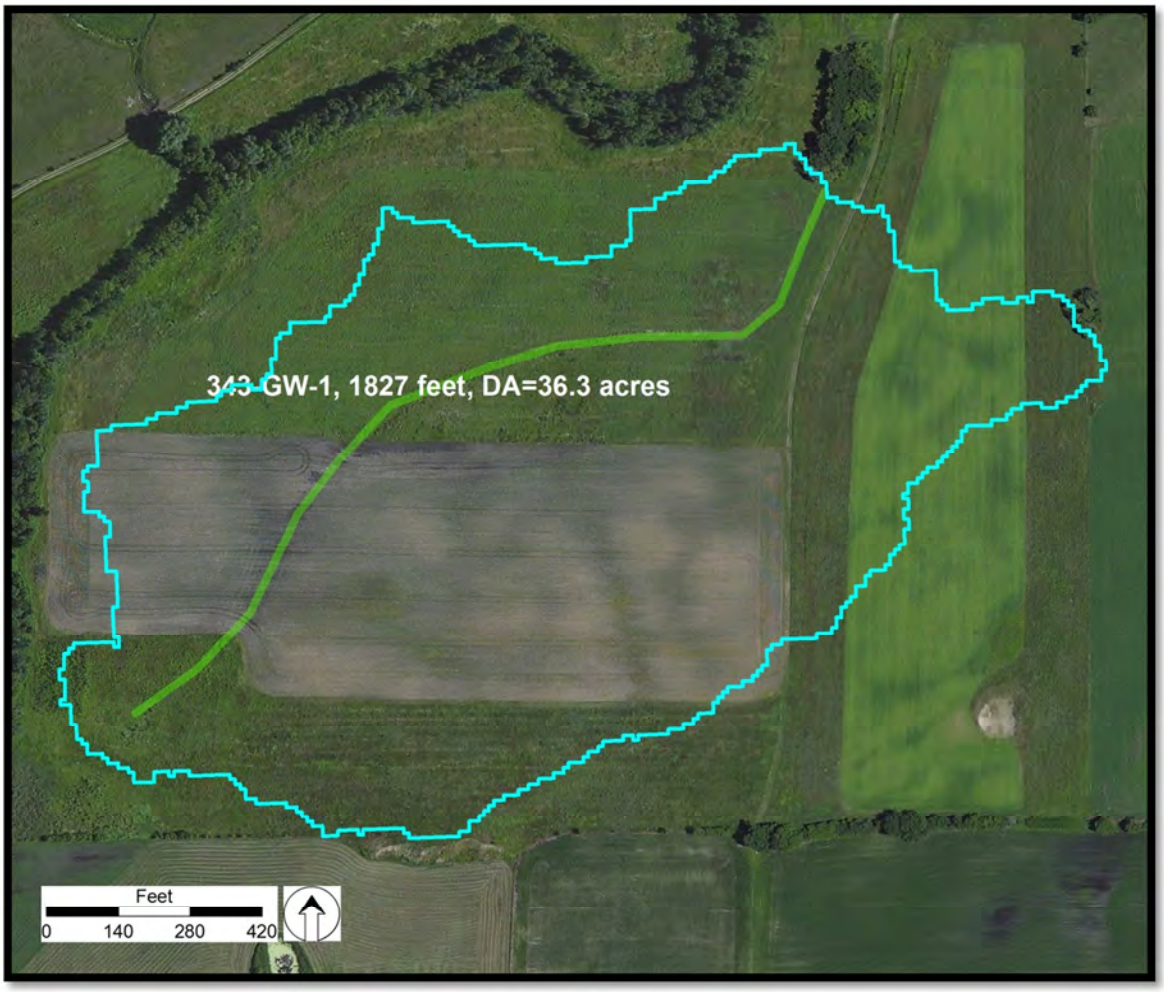


Potential Project 343-GW-1

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	2.36 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	232 lbs	Represents the annual reduction to the lake
Project Installation Cost	$4,933	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$105	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.06	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

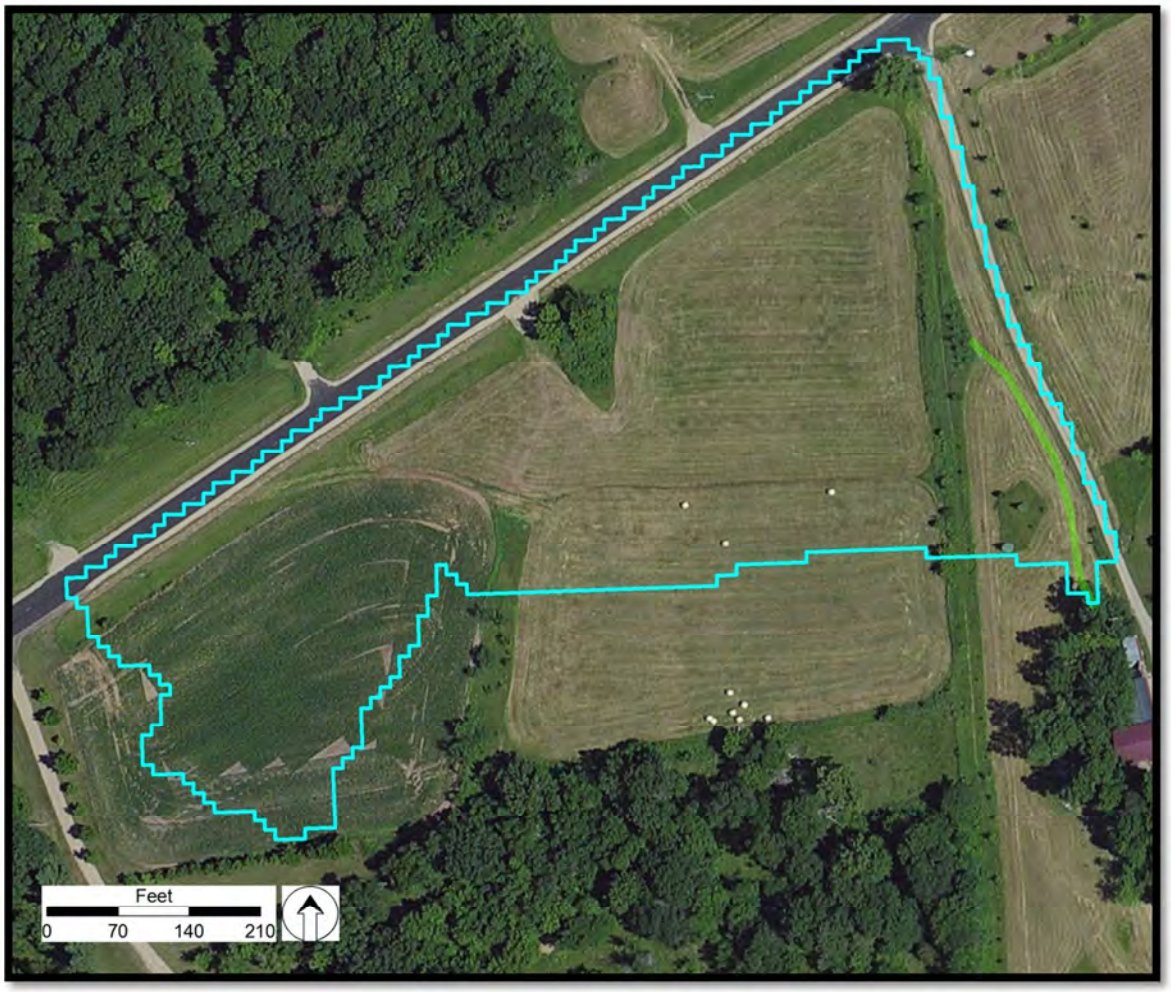


Potential Project 347-GW-1

Problem Description:	High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.45 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	49 lbs	Represents the annual reduction to the lake
Project Installation Cost	$783	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$87	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.79	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

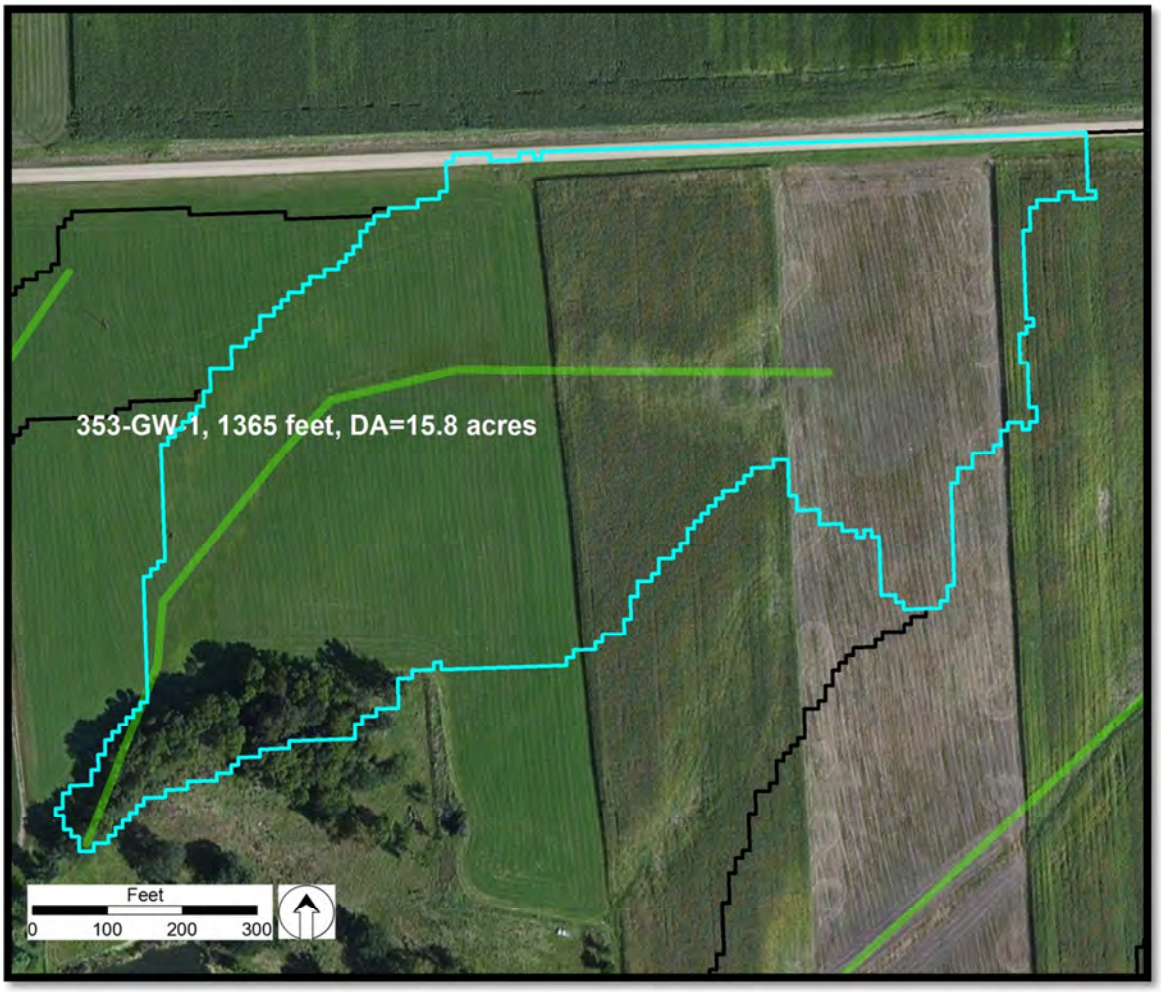


Potential Project 353-GW-1

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.86 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	109 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,686	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$215	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.69	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

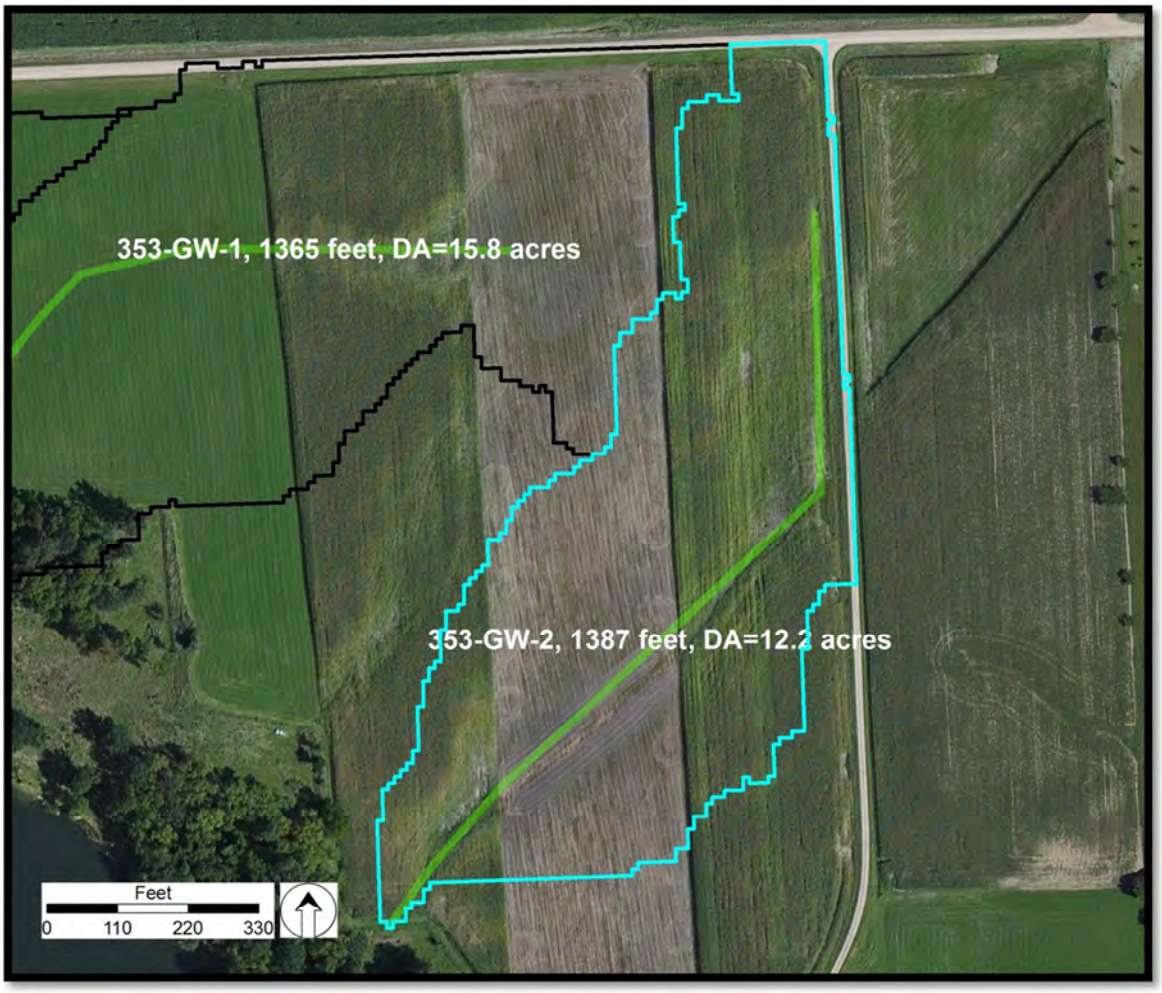


Potential Project 353-GW-2

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Replant Existing Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.66 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	84 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,745	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$283	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.23	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

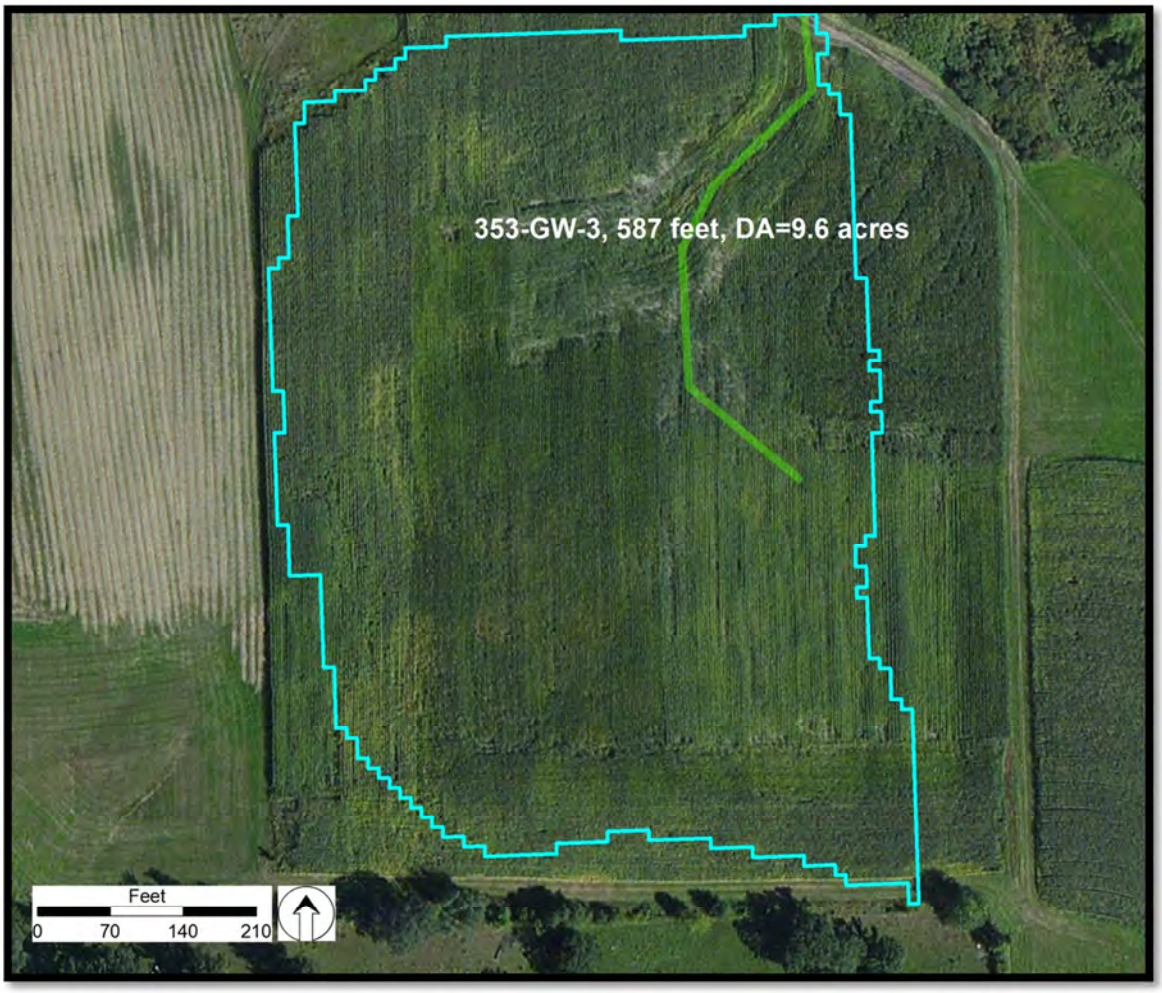


Potential Project 353-GW-3

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Replant Existing Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.52 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	66 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,585	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$152	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.20	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 353-GW-4

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

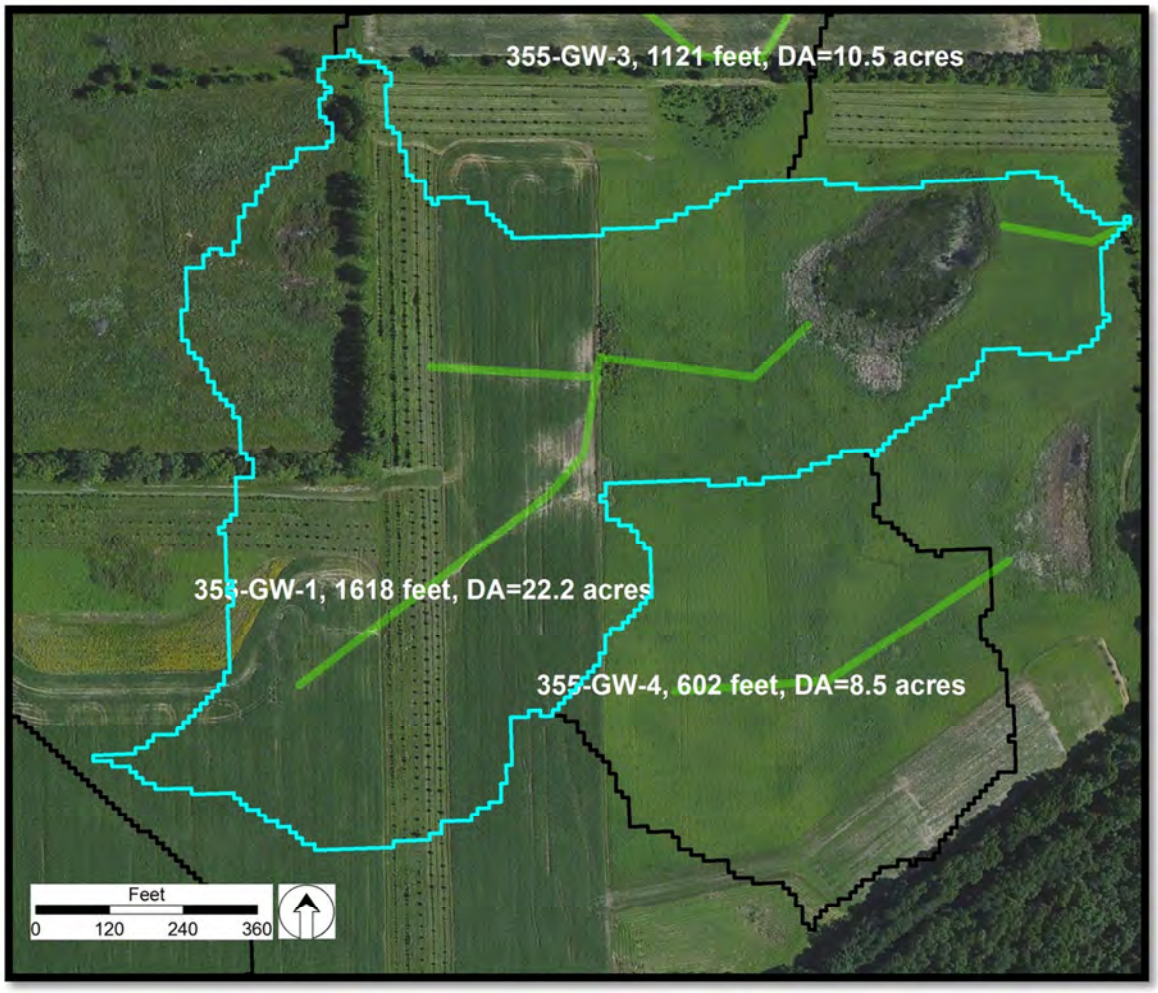
Total Phosphorus (TP) Reduction to Two Rivers Lake	0.30 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	39 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,754	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$454	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.57	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 355-GW-1

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, Land Management Change and/or Wetland Restoration (See 355-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.37 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	177 lbs	Represents the annual reduction to the lake
Project Installation Cost	$4,369	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$159	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.23	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

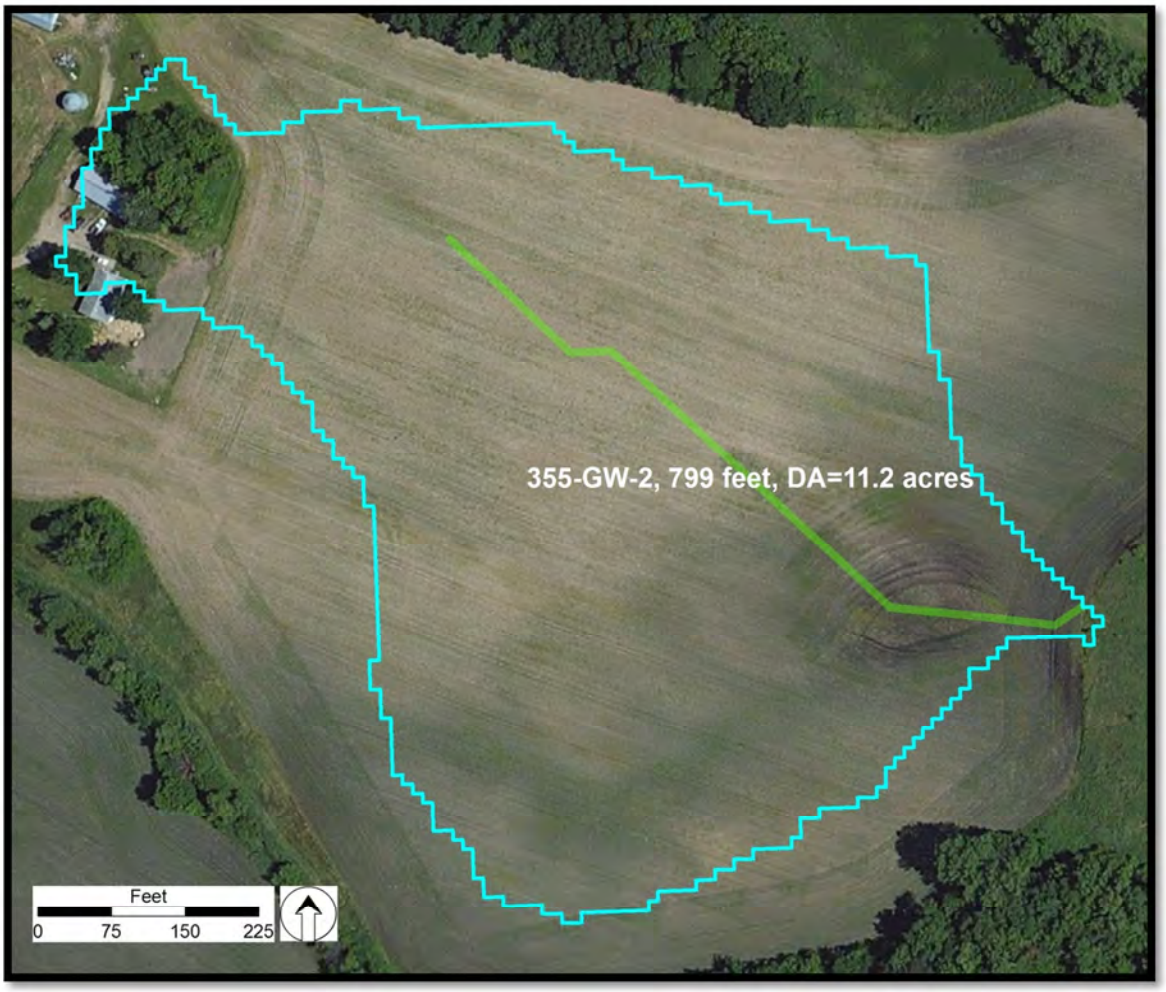


Potential Project 355-GW-2

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.69 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	89 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,157	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$156	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.21	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

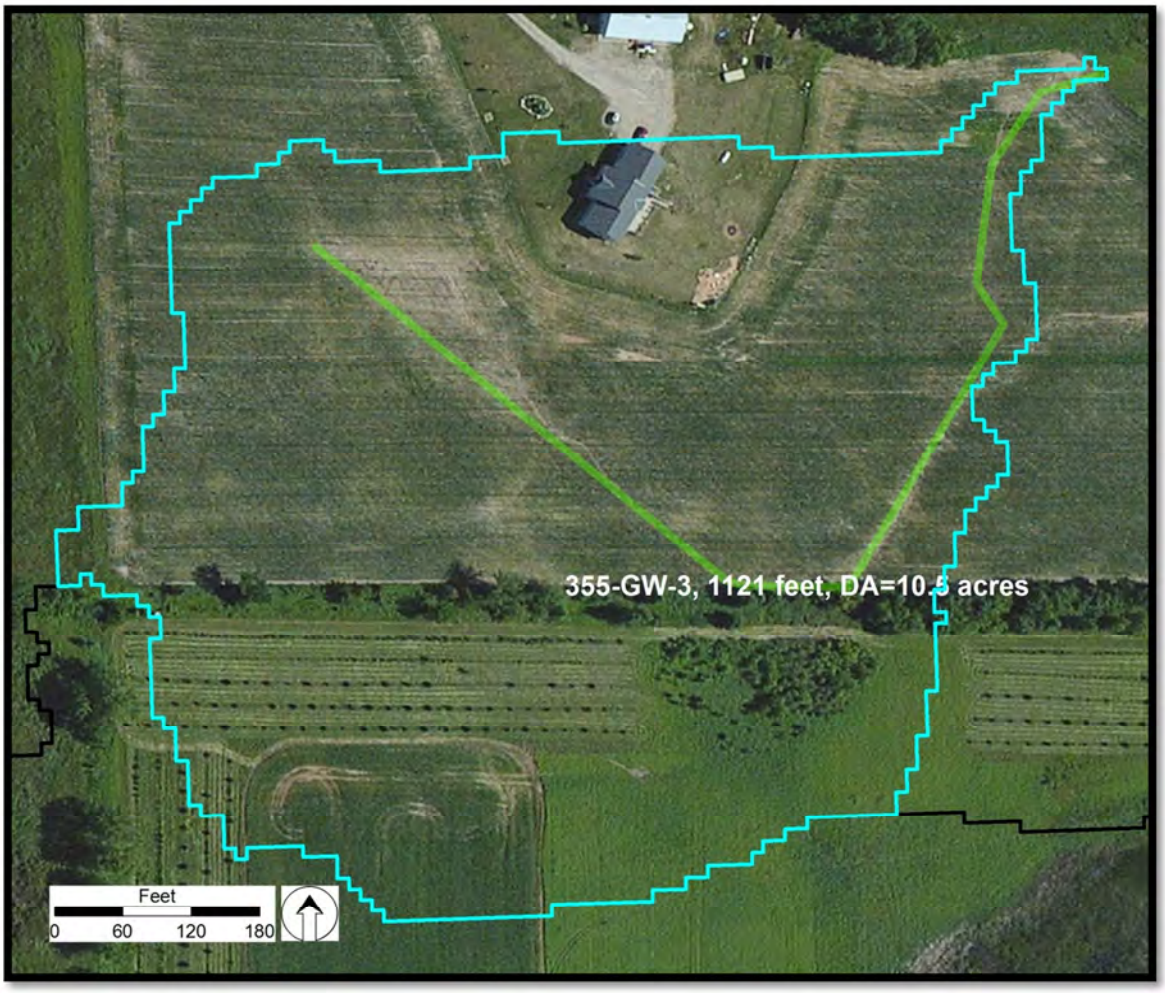


Potential Project 355-GW-3

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.65 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	84 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,027	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$233	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.81	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

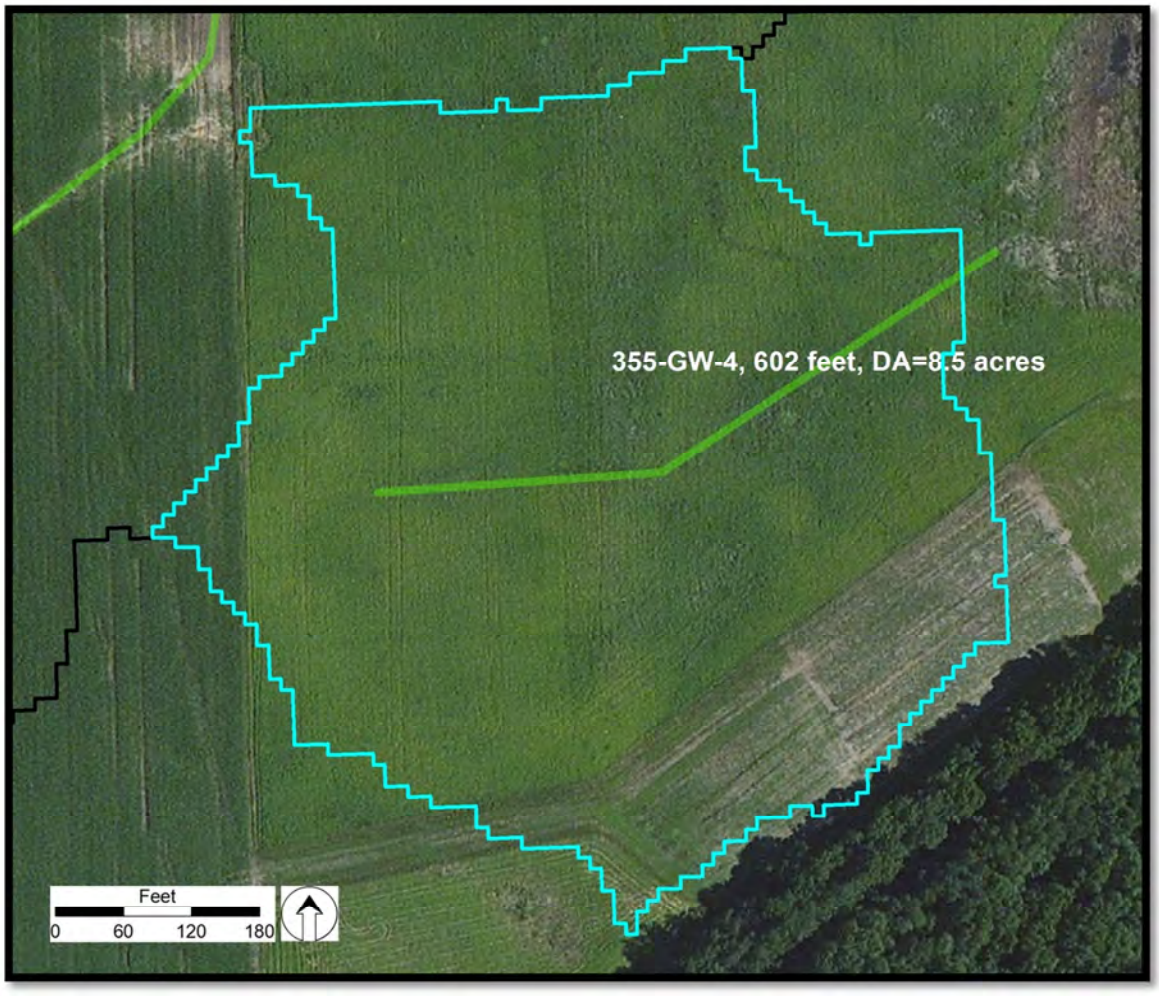


Potential Project 355-GW-4

Problem Description:	High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.53 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	68 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,625	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$155	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.20	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

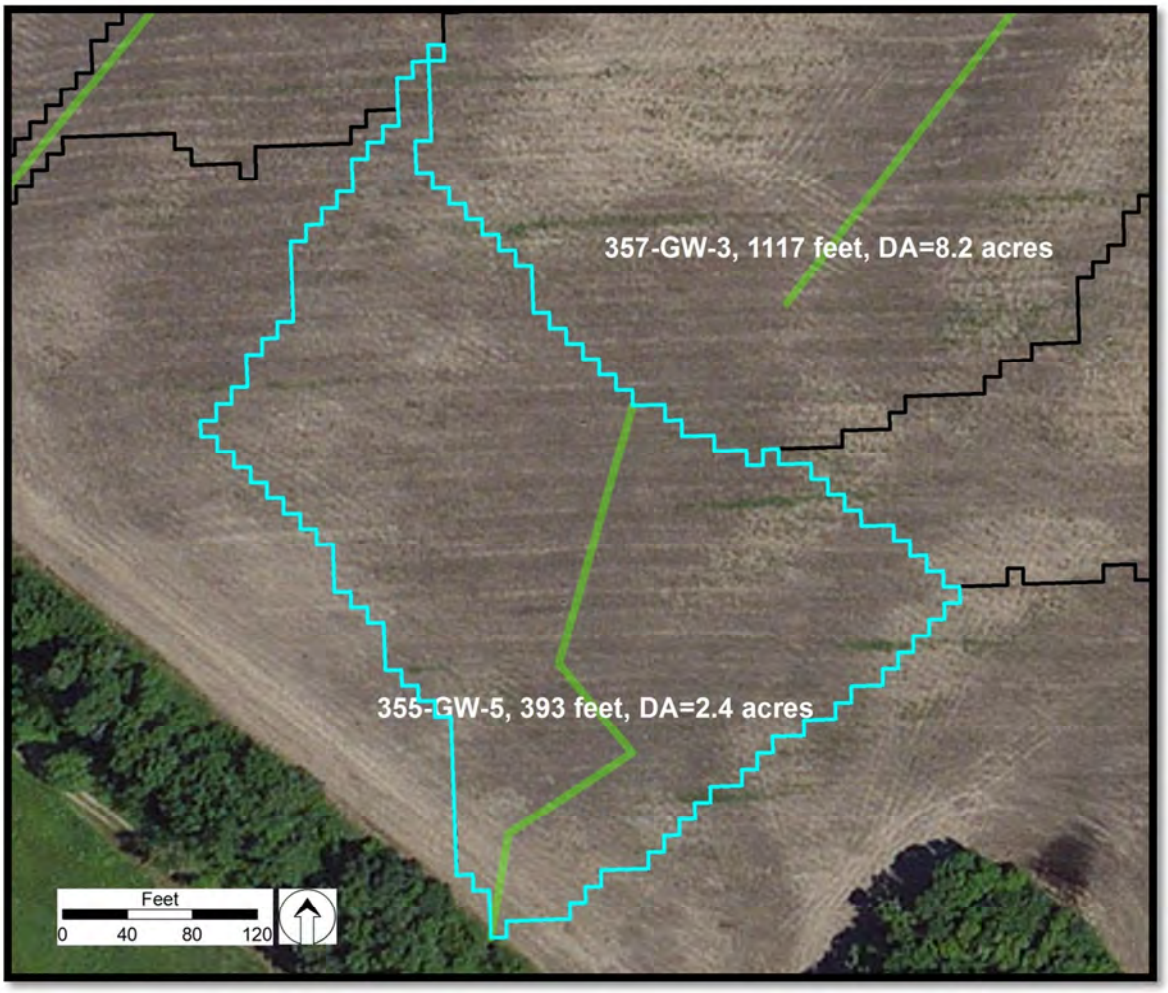


Potential Project 355-GW-5

Problem Description:	Medium-High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.15 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	19 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,061	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$358	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.77	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

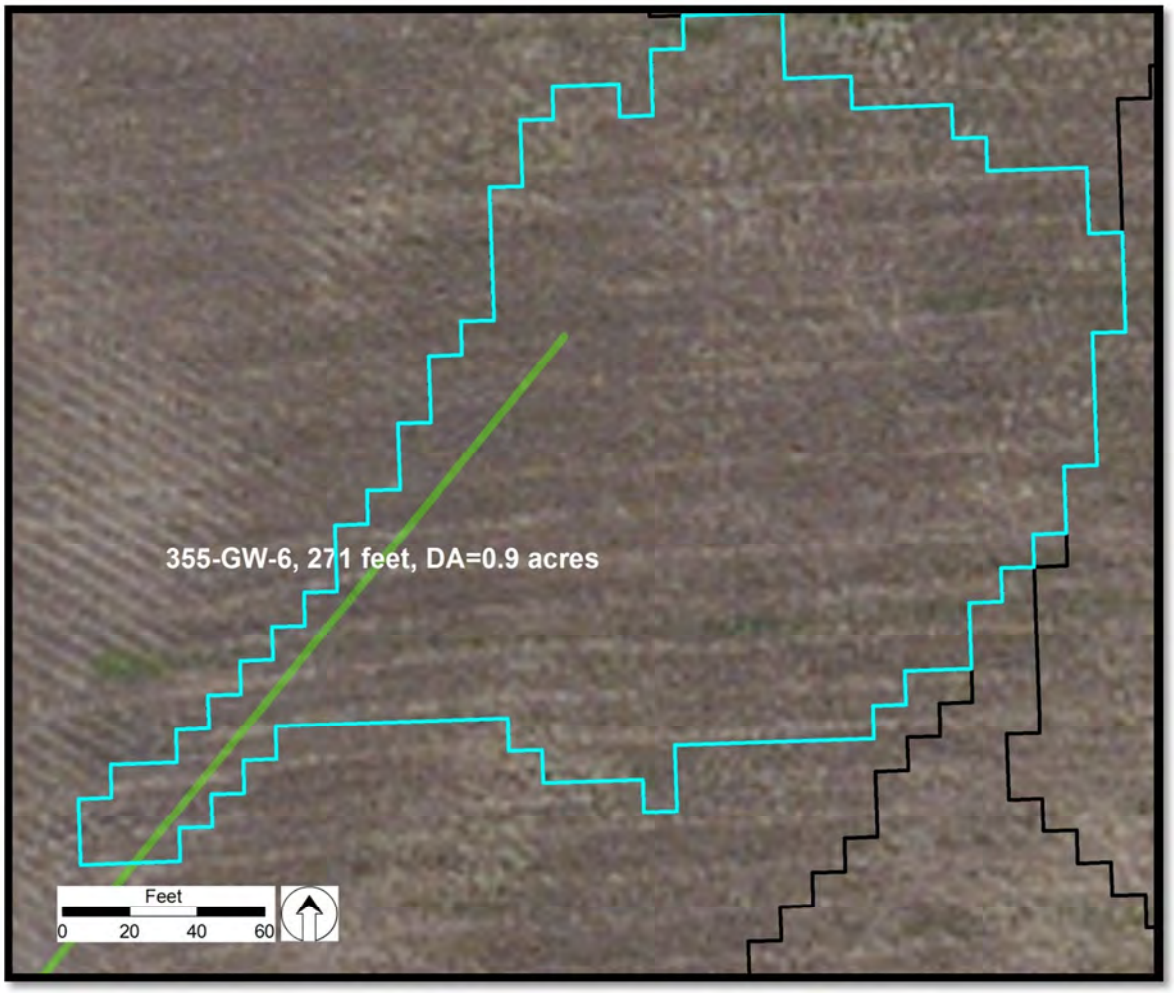


Potential Project 355-GW-6

Problem Description:	Medium-High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.06 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	7 lbs	Represents the annual reduction to the lake
Project Installation Cost	$732	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$658	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$5.10	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

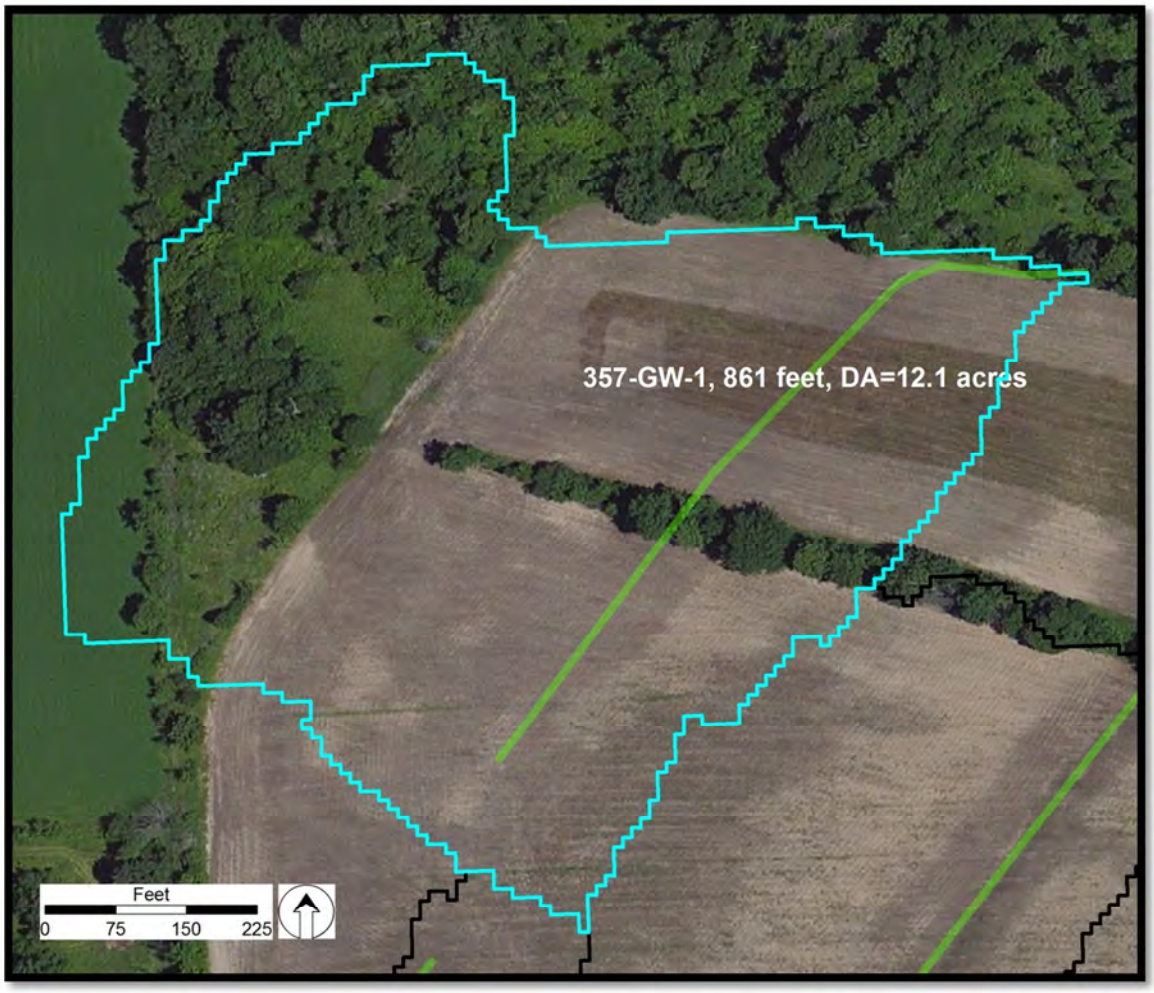


Potential Project 357-GW-1

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.68 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	93 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,325	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$170	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.24	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

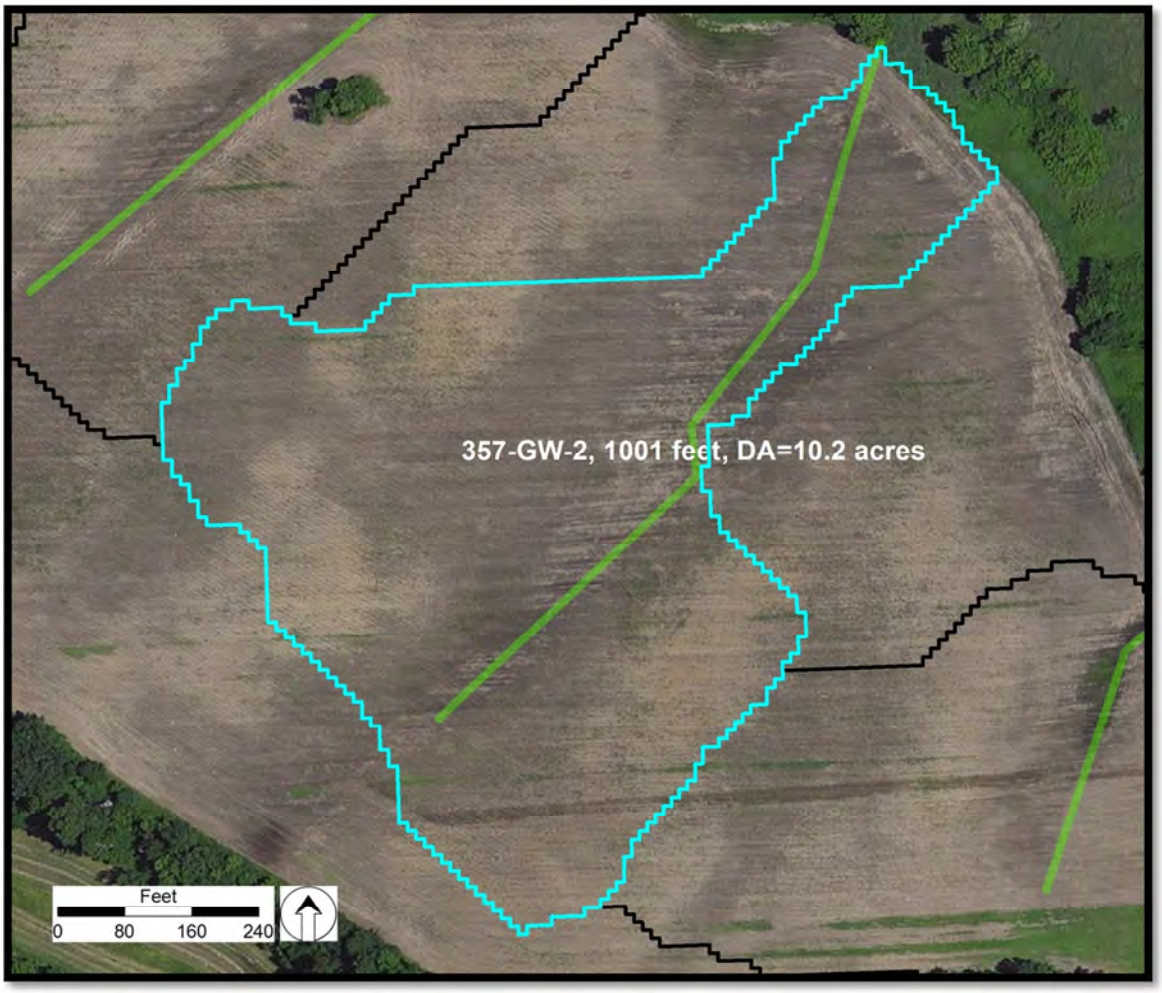


Potential Project 357-GW-2

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.57 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	79 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,703	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$235	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.72	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

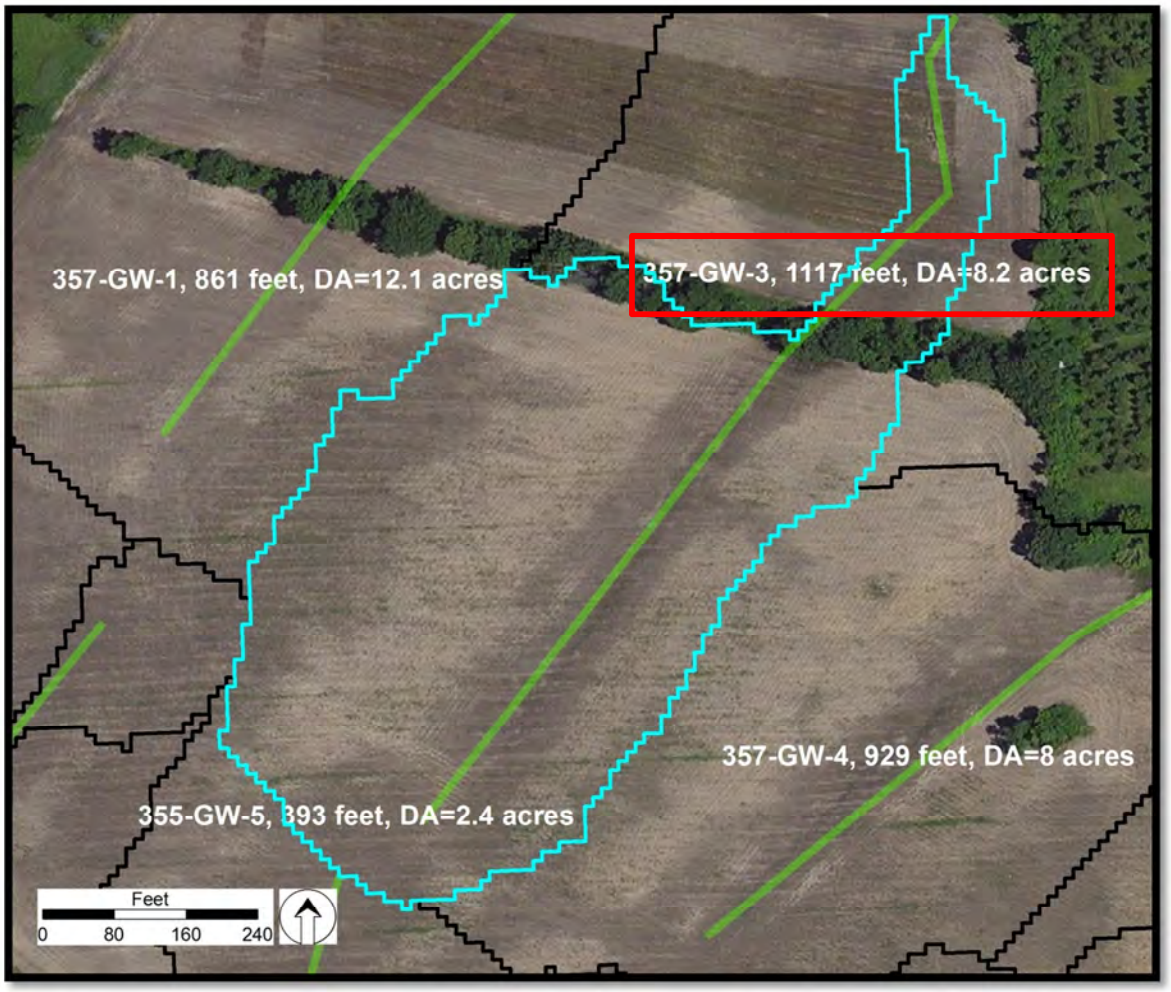


Potential Project 357-GW-3

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.46 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	63 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,016	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$326	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.38	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

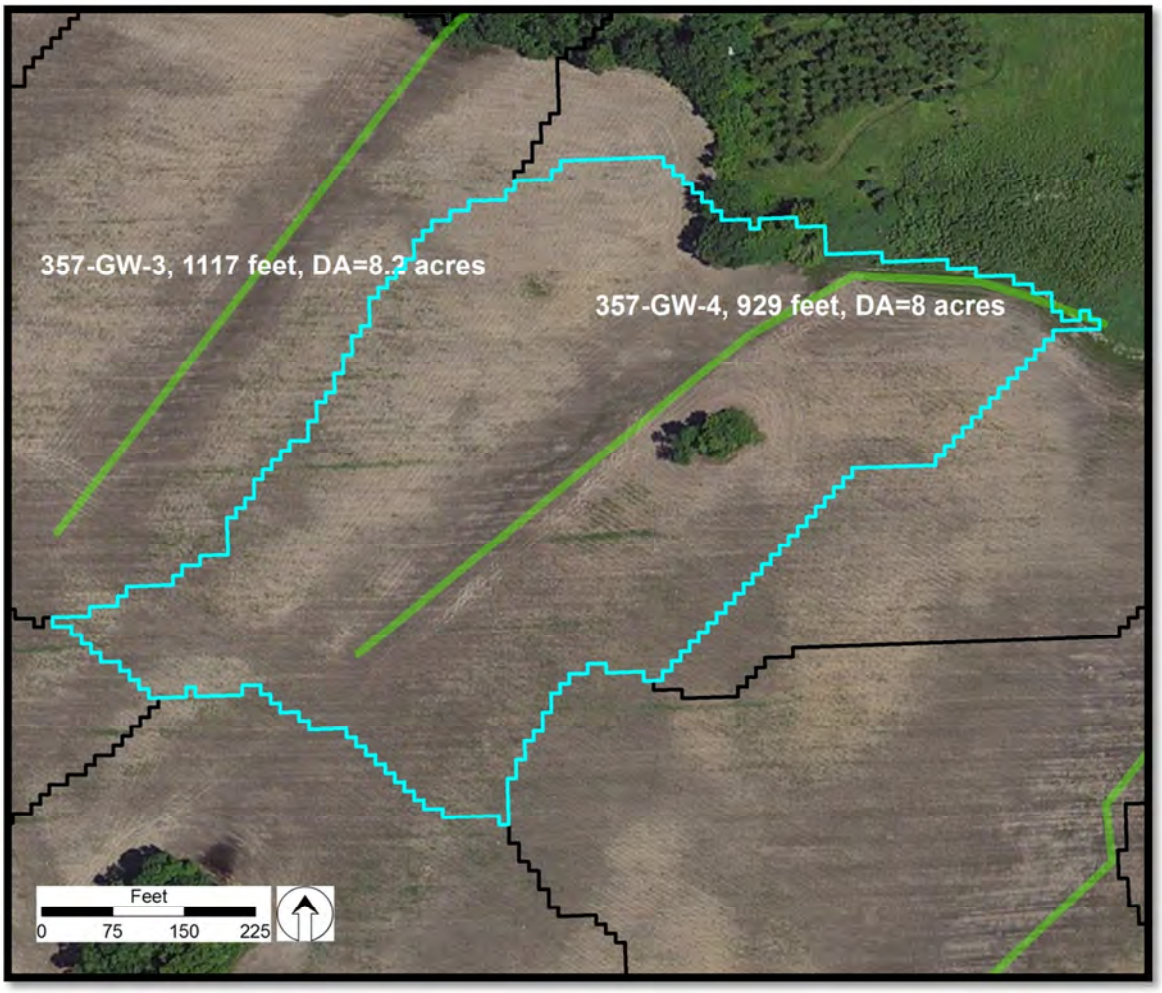


Potential Project 357-GW-4

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.45 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	62 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,508	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$278	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.03	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

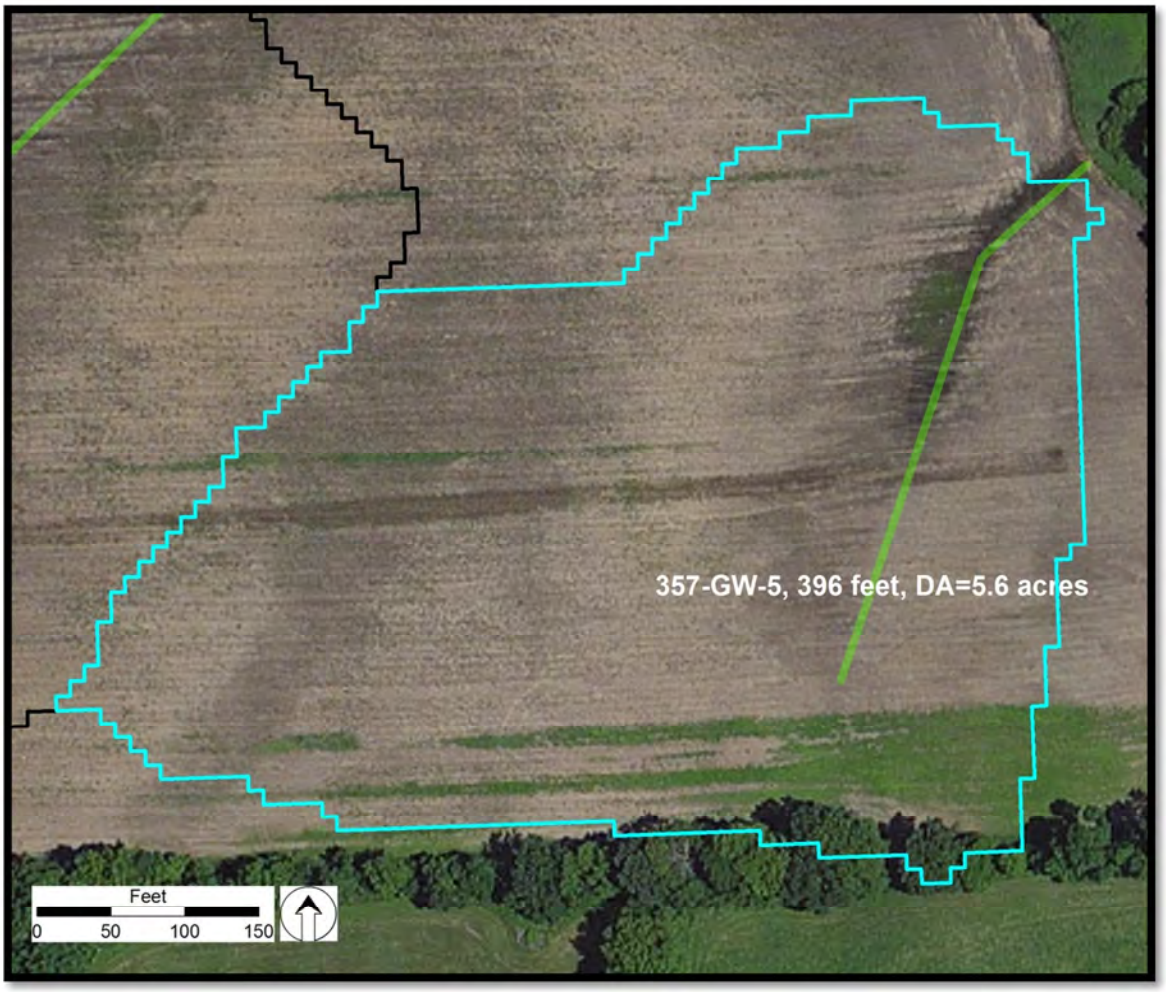


Potential Project 357-GW-5

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.32 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	43 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,069	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$169	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.24	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

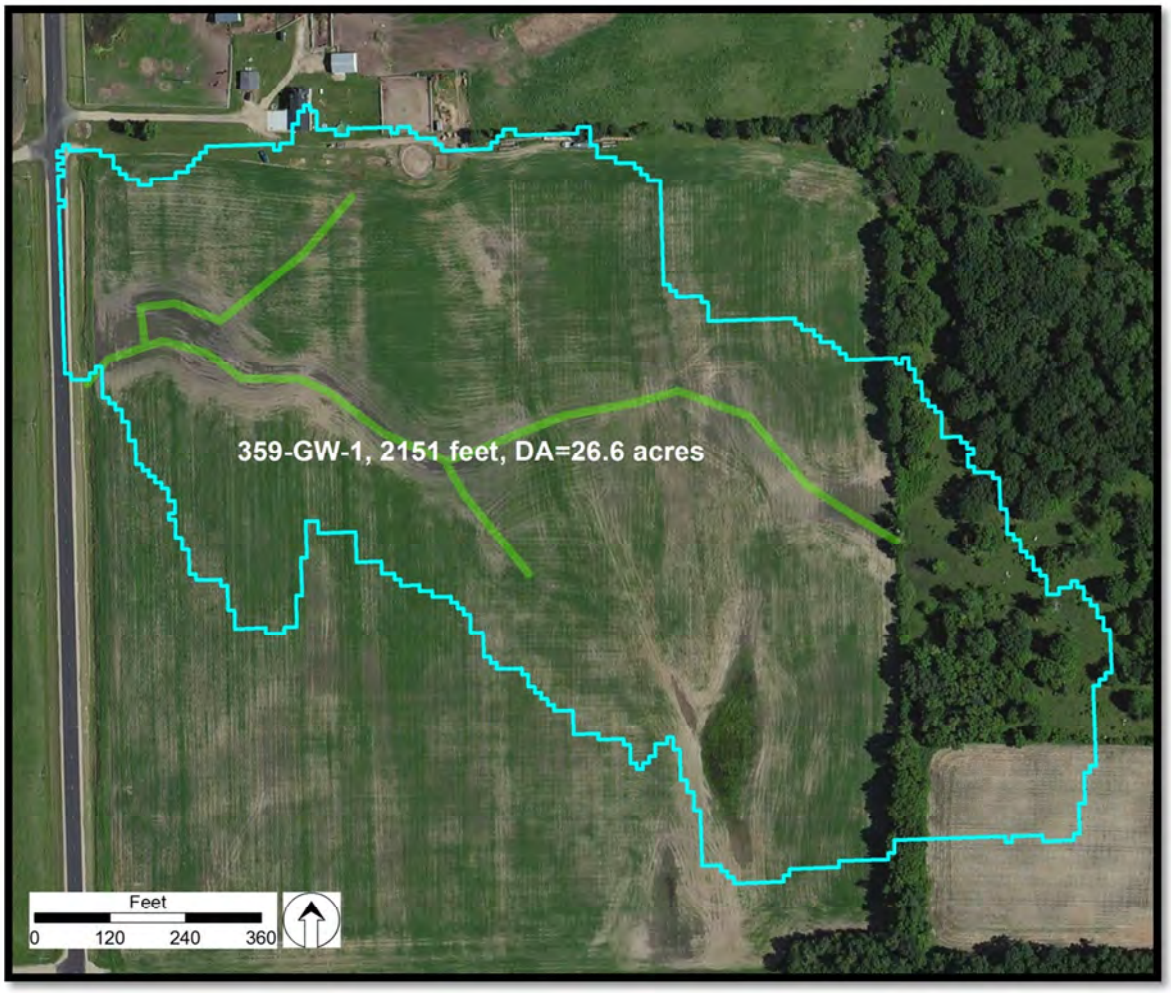


Potential Project 359-GW-1

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	2.19 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	367 lbs	Represents the annual reduction to the lake
Project Installation Cost	$5,808	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$133	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.79	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

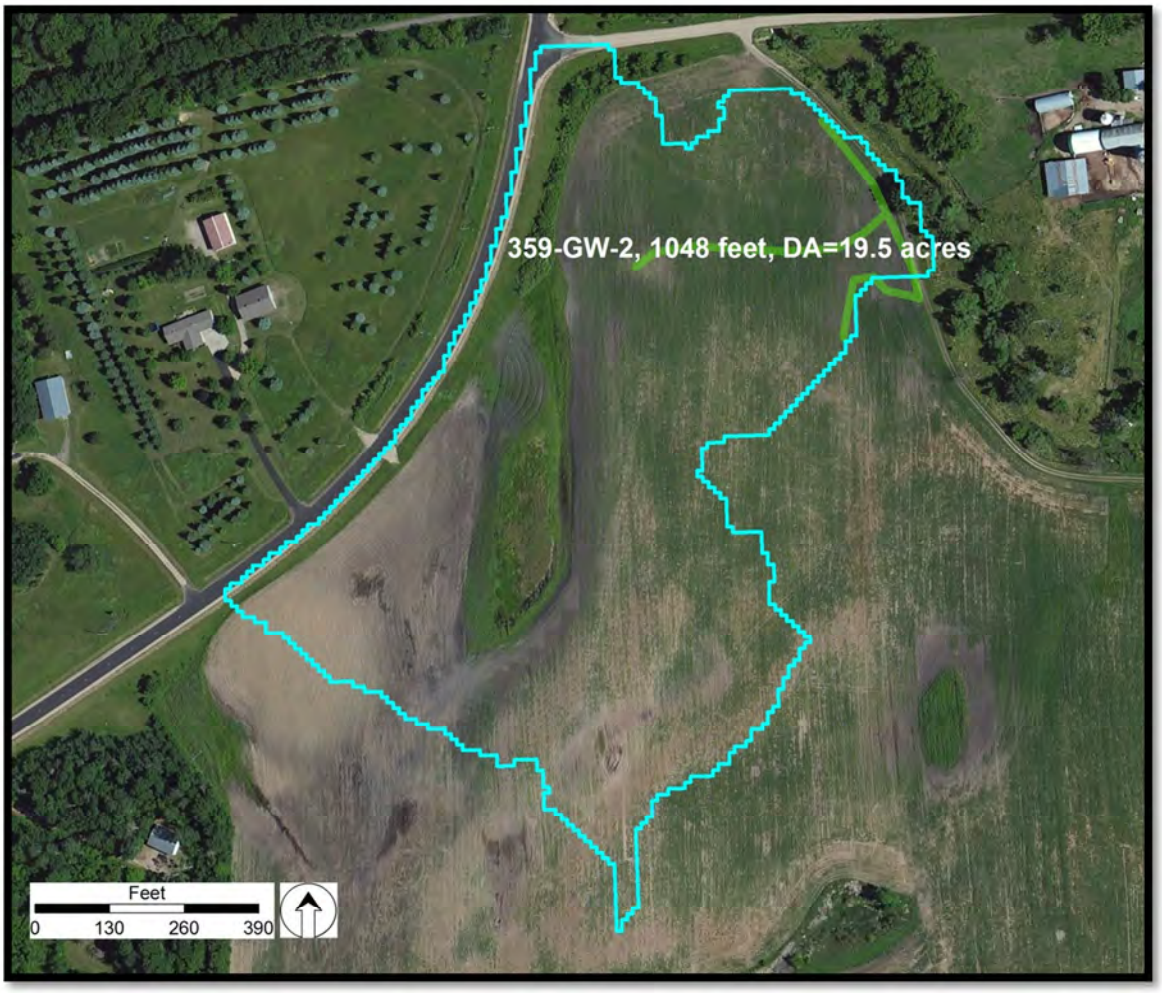


Potential Project 359-GW-2

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.60 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	269 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,830	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$88	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.53	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

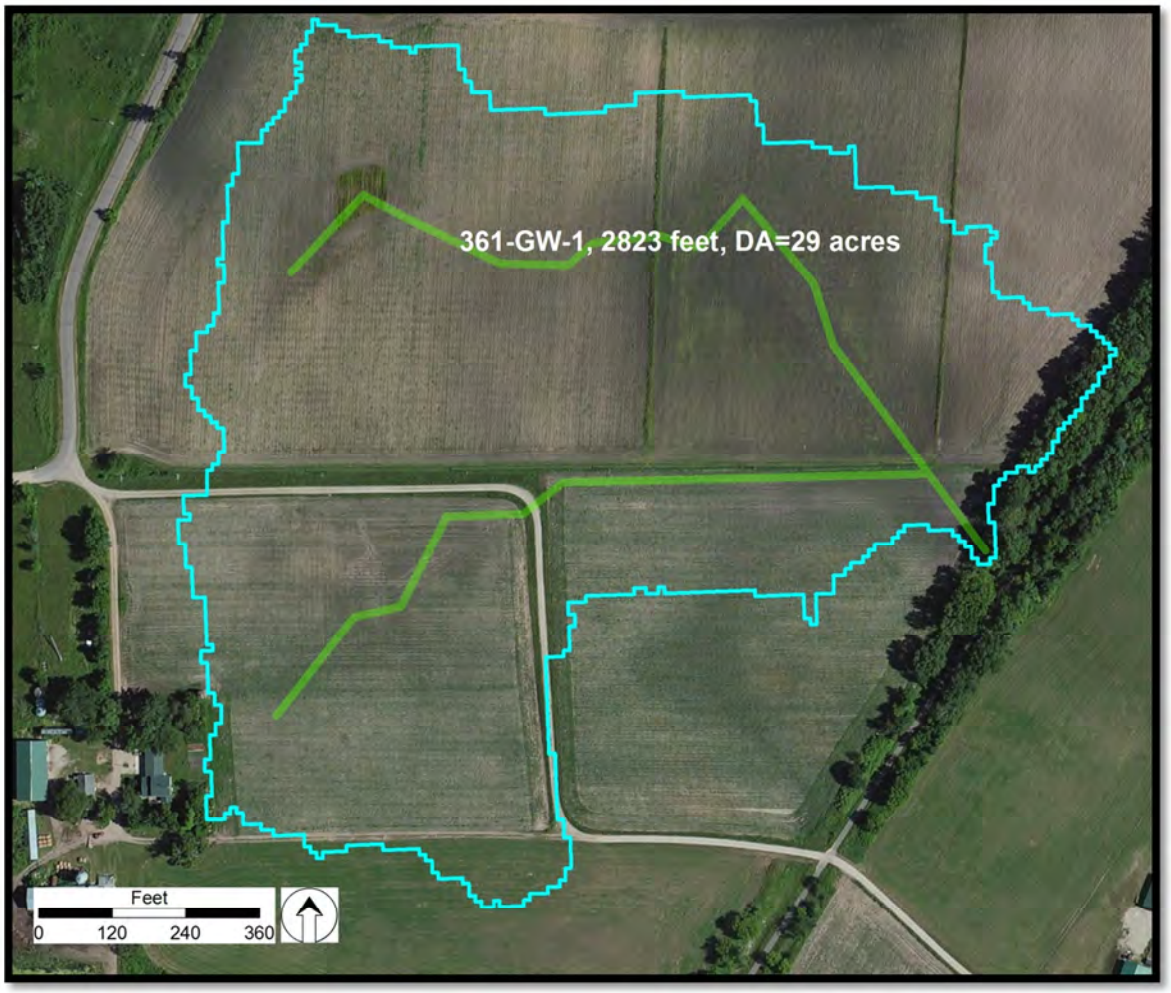


Potential Project 361-GW-1

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.84 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	216 lbs	Represents the annual reduction to the lake
Project Installation Cost	$7,622	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$207	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.76	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

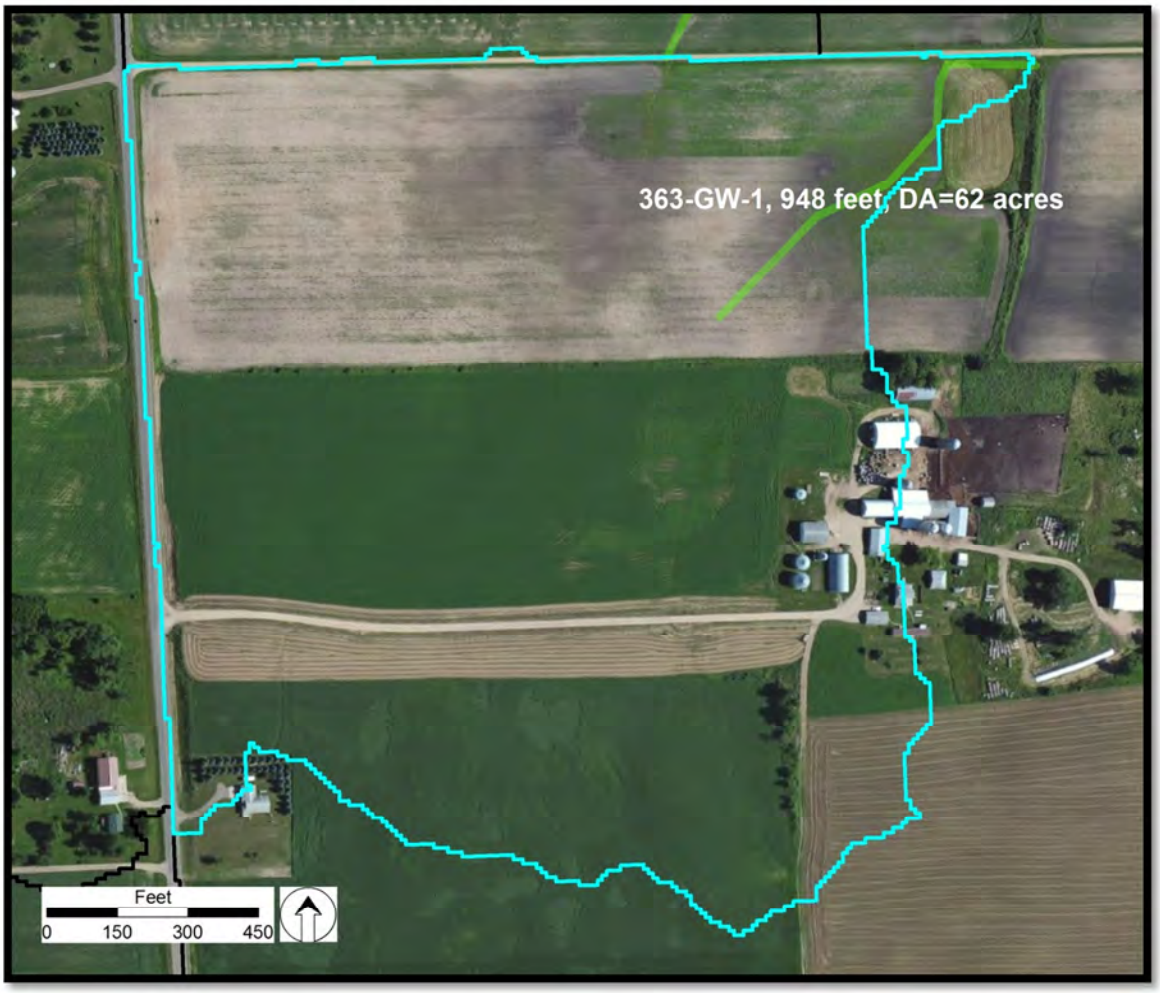


Potential Project 363-GW-1

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 363-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	4.24 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	386 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,560	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$30	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.33	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

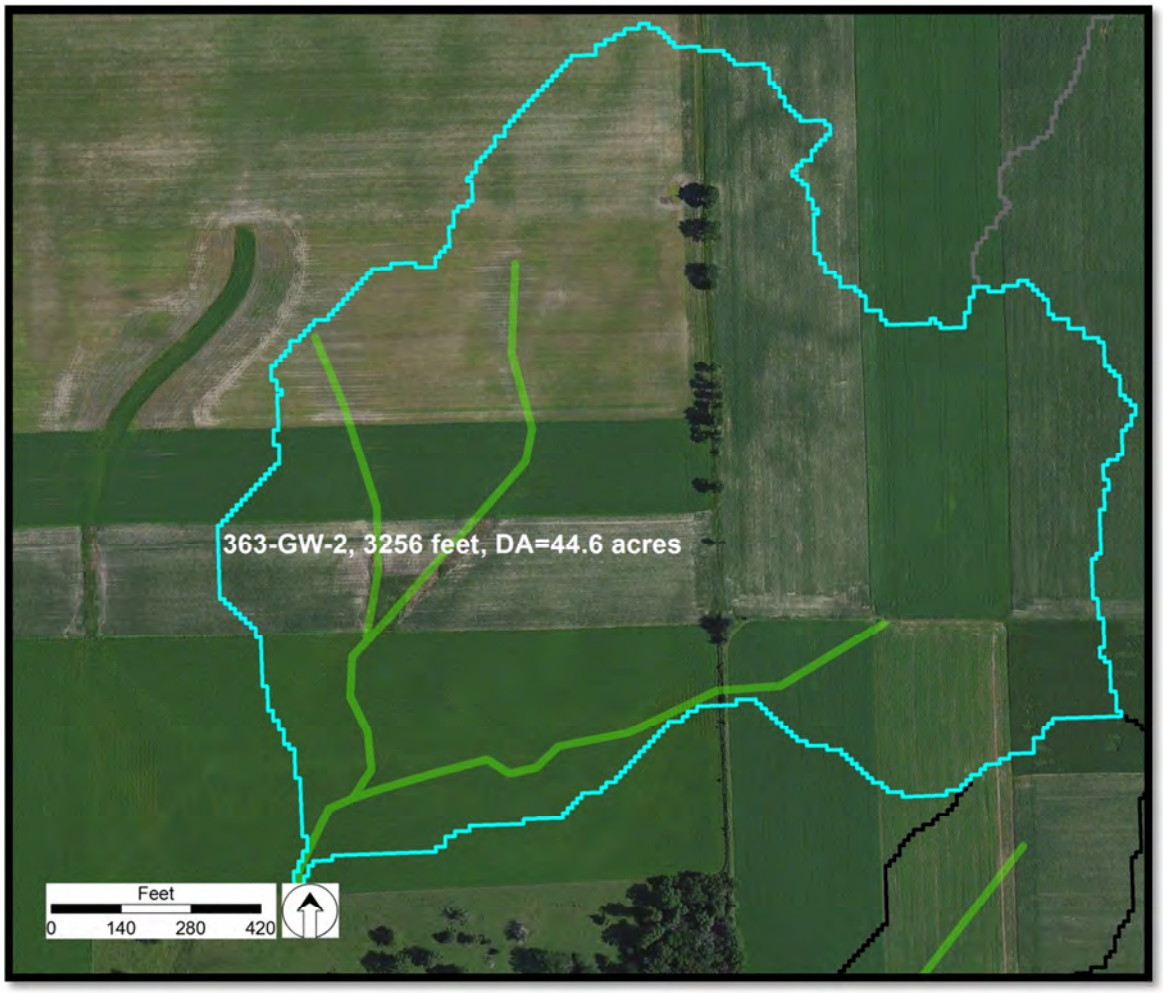


Potential Project 363-GW-2

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Replant Existing Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	3.05 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	277 lbs	Represents the annual reduction to the lake
Project Installation Cost	$8,791	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$144	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.58	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

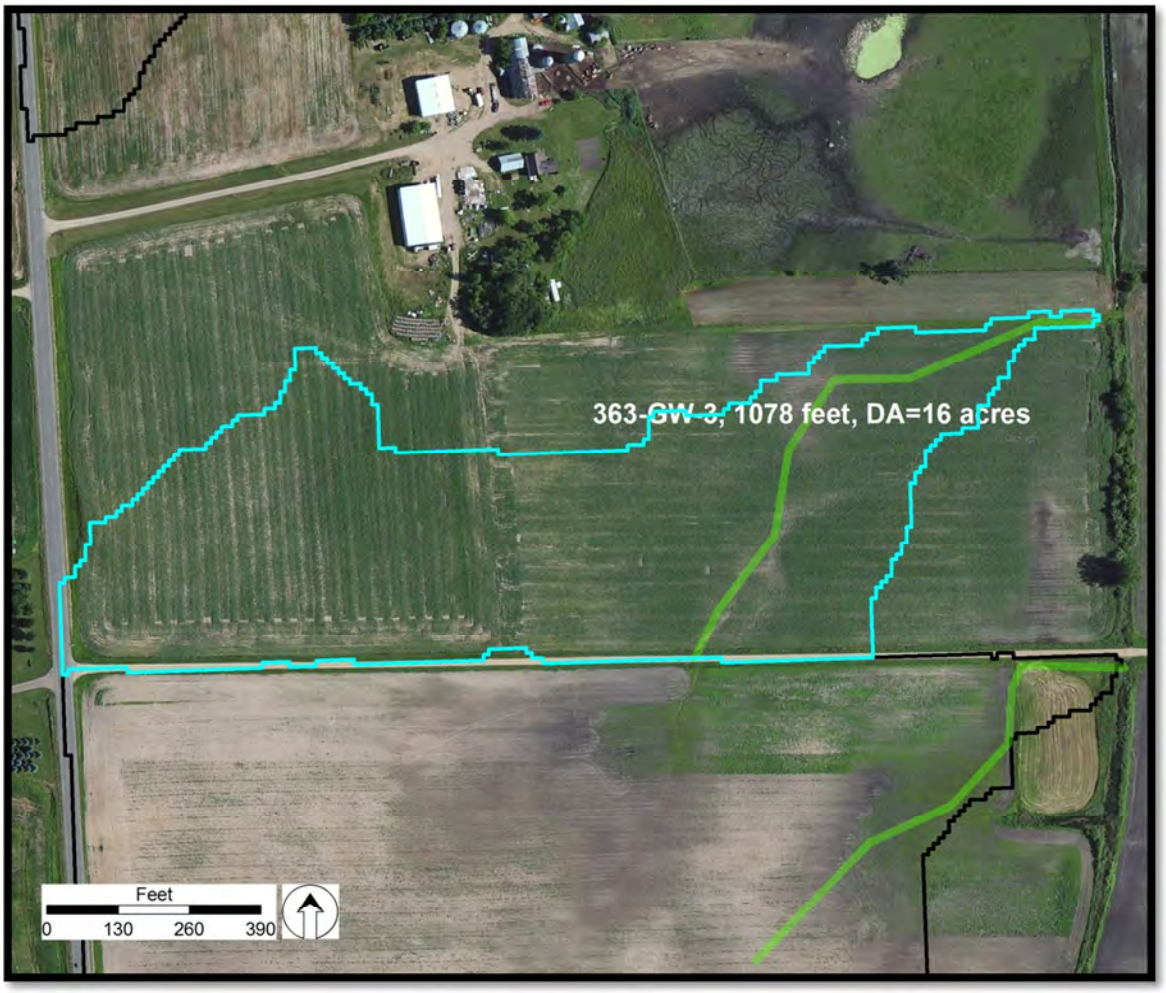


Potential Project 363-GW-3

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.09 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	99 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,911	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$133	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.46	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

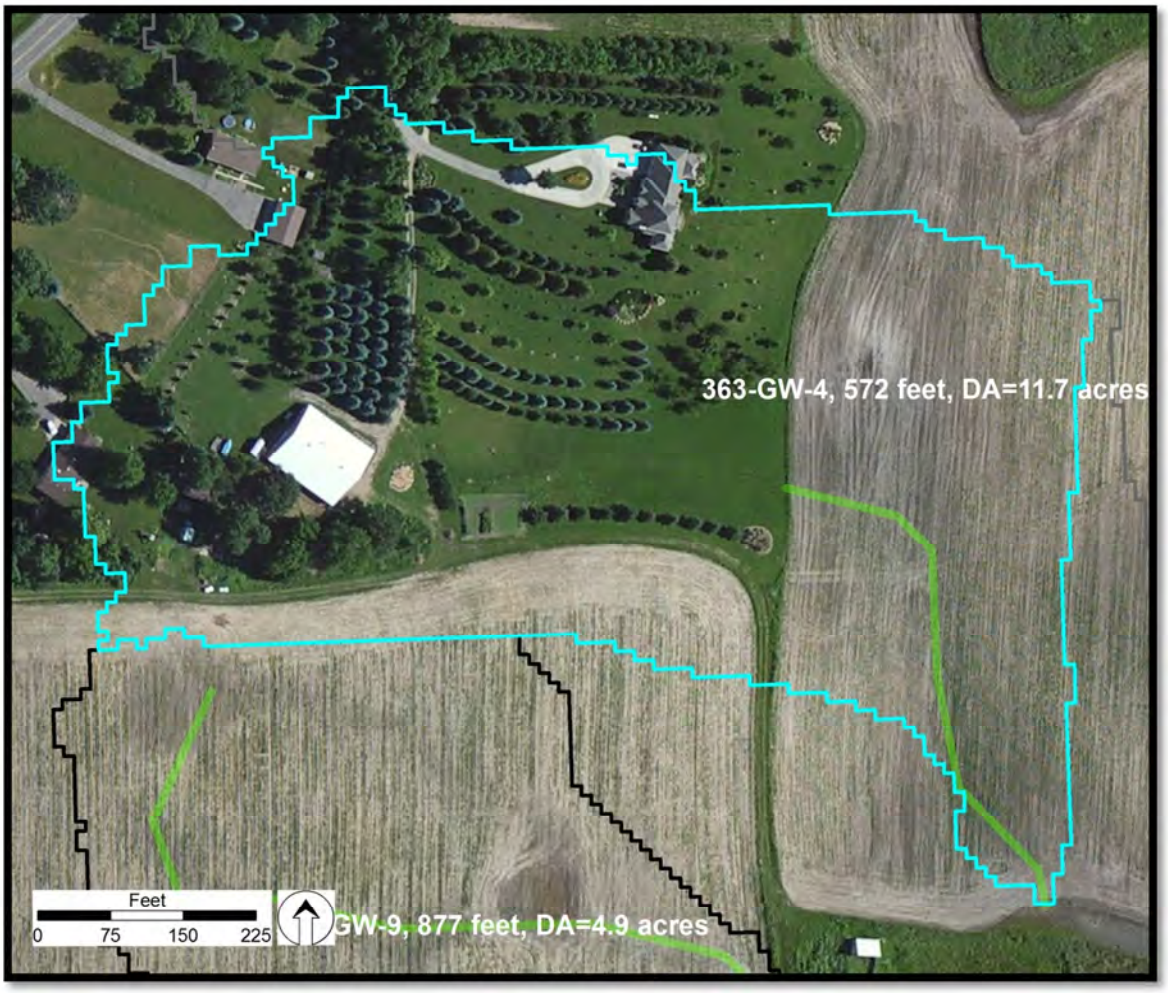


Potential Project 363-GW-4

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.80 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	73 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,544	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$96	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.06	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

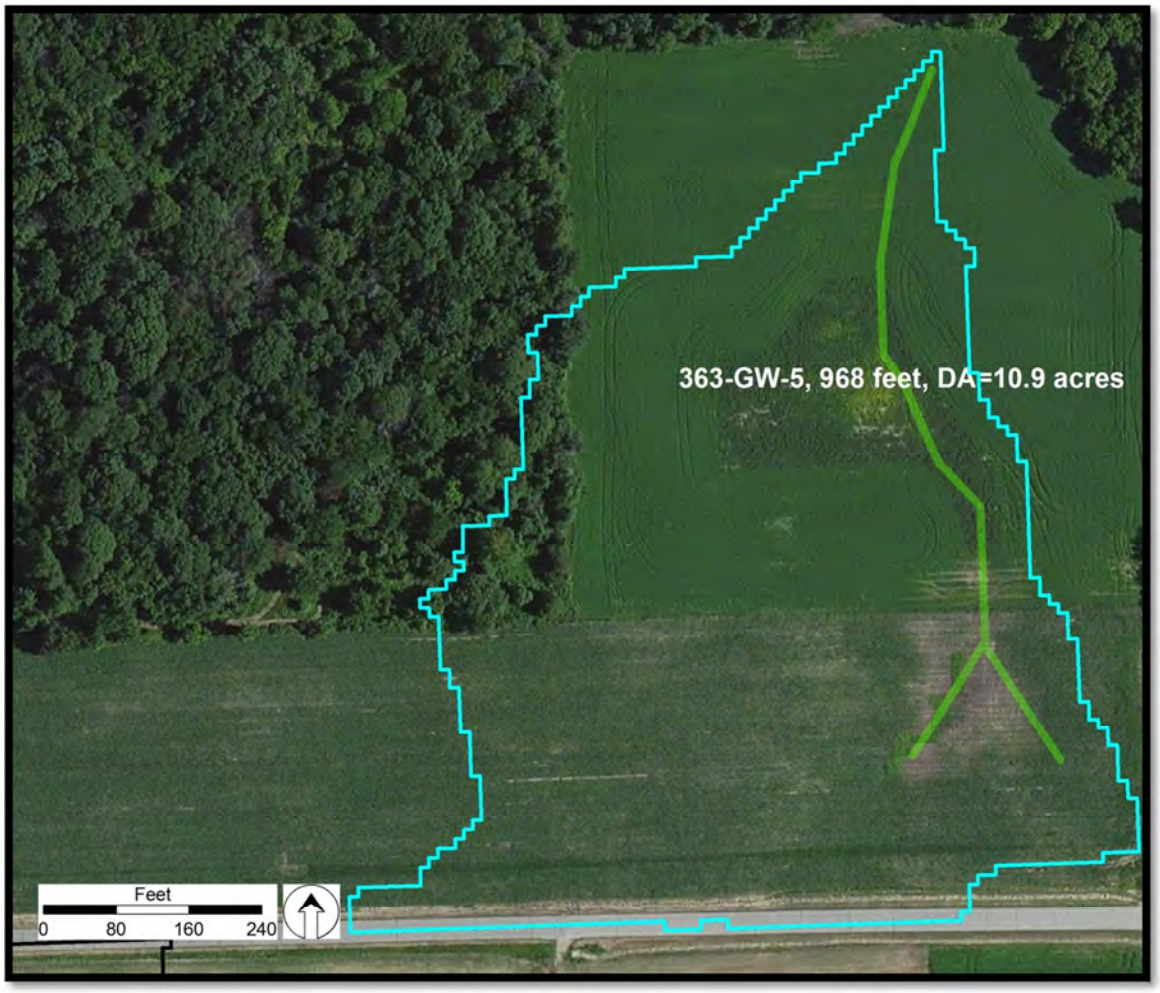


Potential Project 363-GW-5

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.75 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	68 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,614	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$175	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.93	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

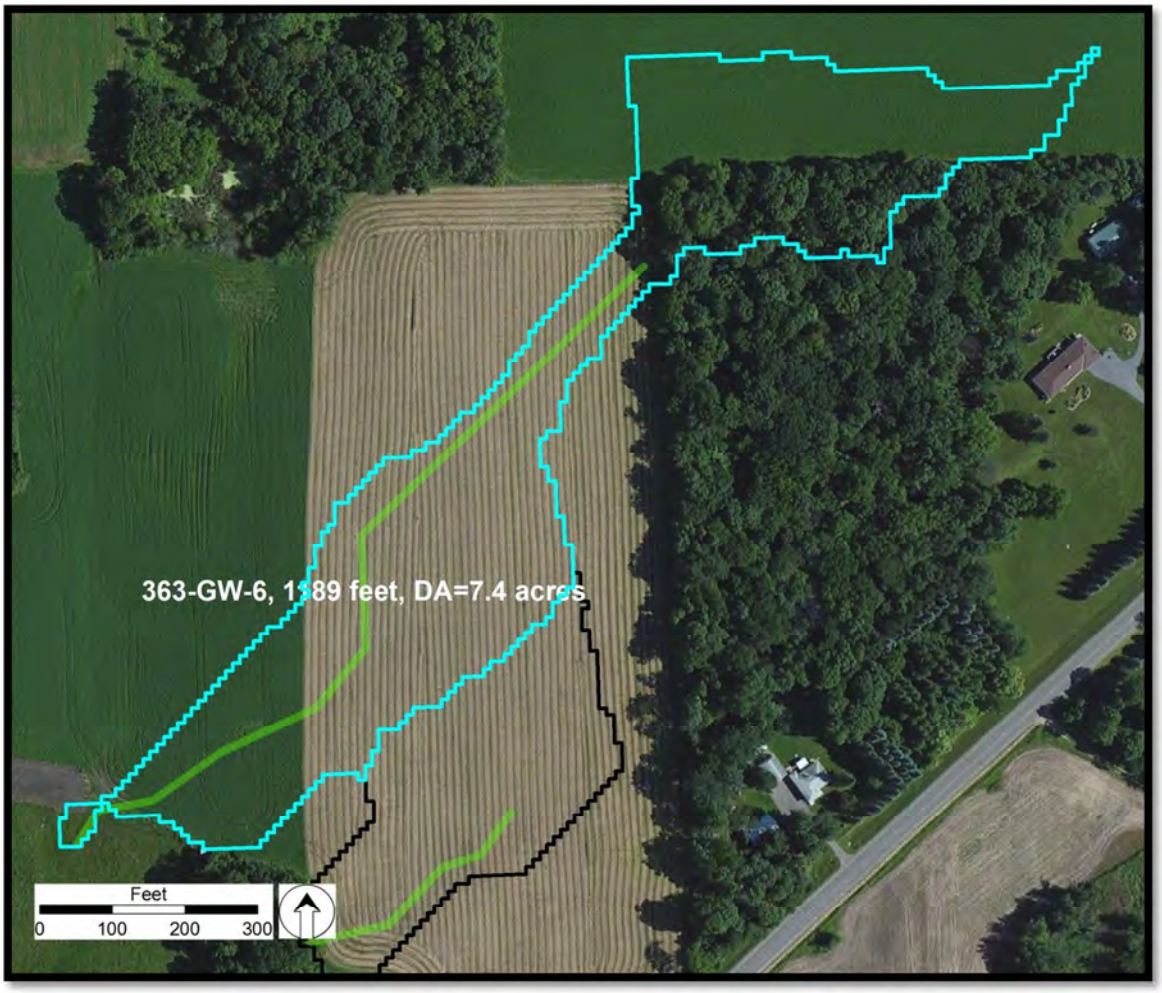


Potential Project 363-GW-6

Problem Description:	High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.51 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	46 lbs	Represents the annual reduction to the lake
Project Installation Cost	$3,210	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$317	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.49	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

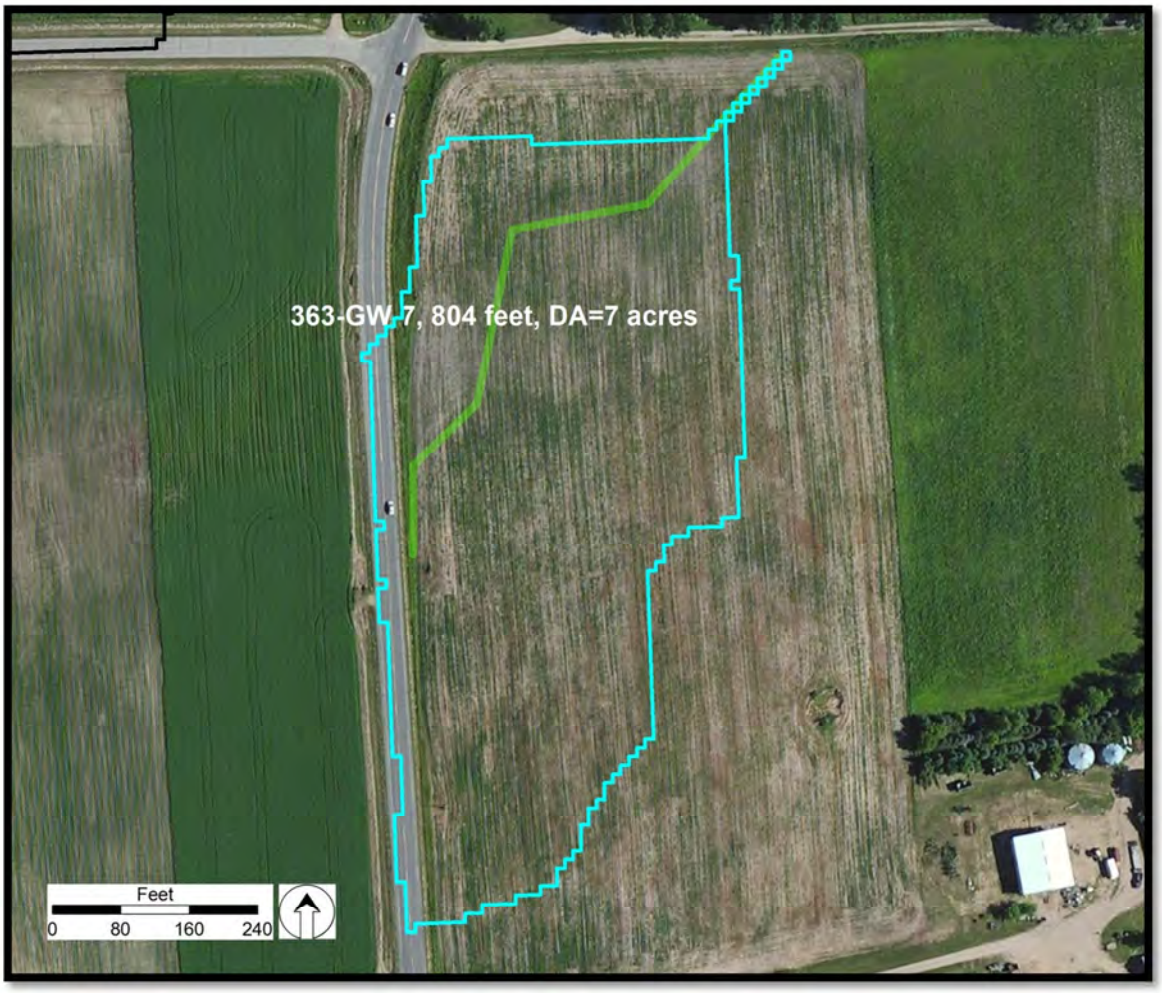


Potential Project 363-GW-7

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.48 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	44 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,171	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$227	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.49	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 363-GW-8

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

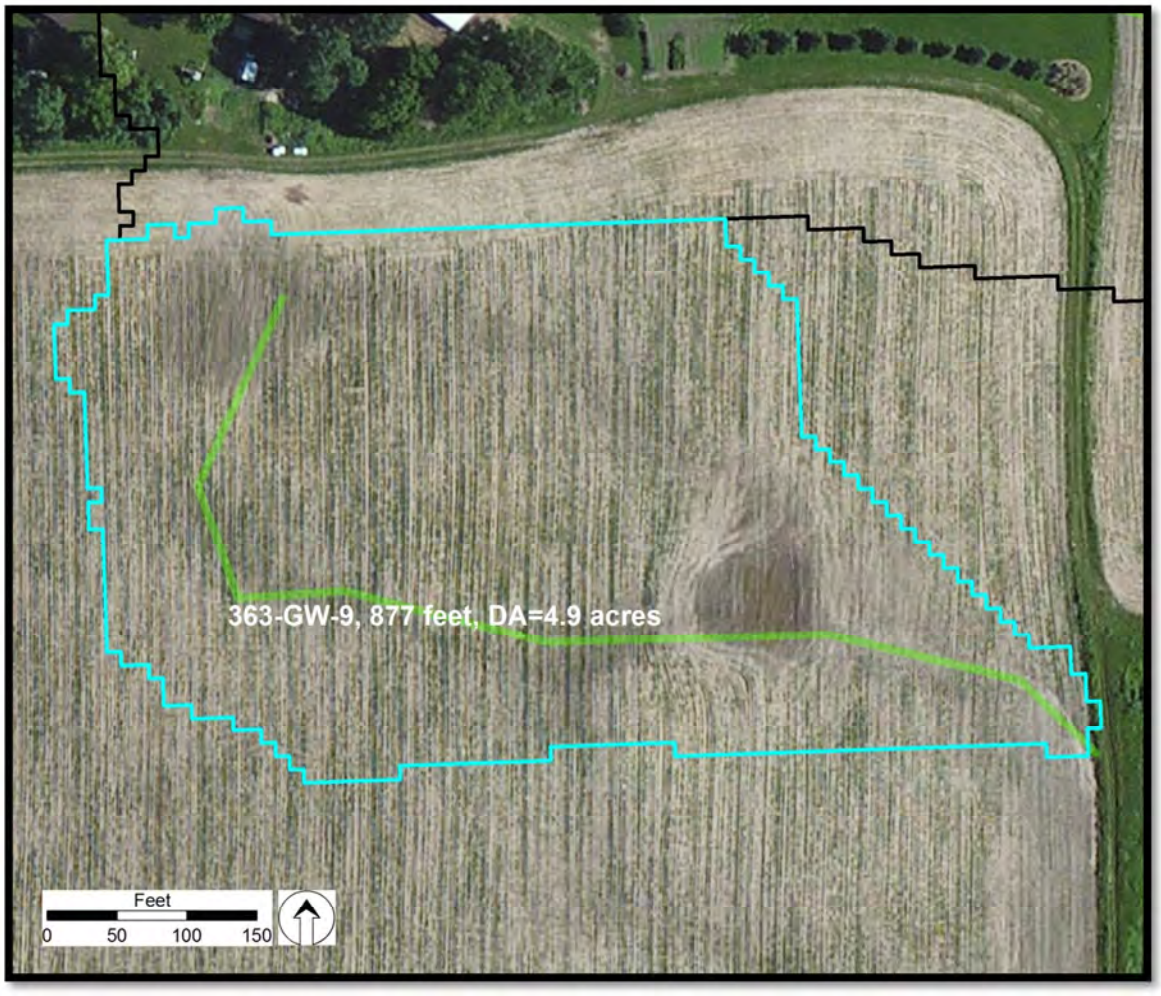
Total Phosphorus (TP) Reduction to Two Rivers Lake	0.48 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	44 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,055	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$215	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.36	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 363-GW-9

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.34 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	30 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,368	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$353	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.89	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

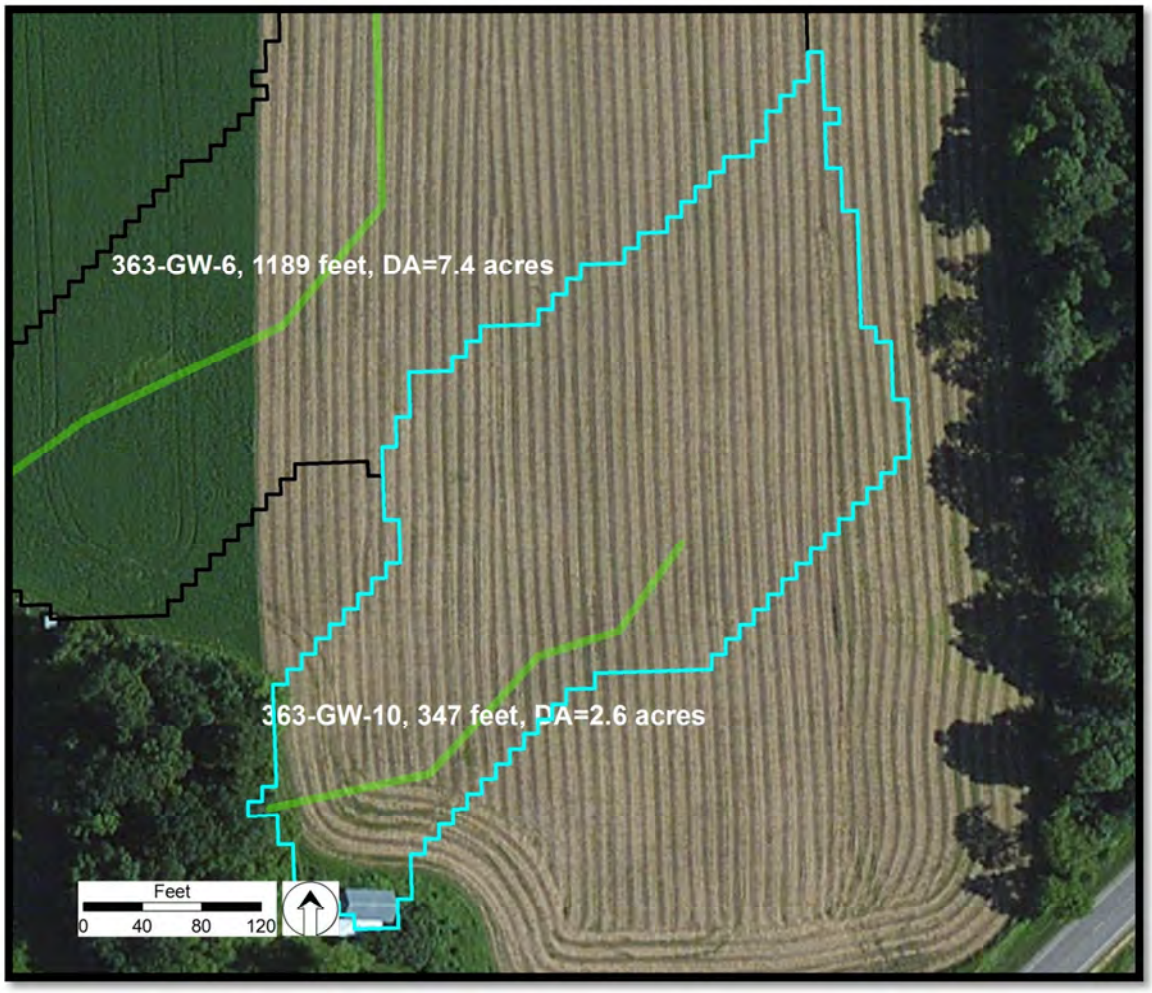


Potential Project 363-GW-10

Problem Description:	High Stream Power Index (SPI) (Little Visible Erosion)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.18 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	16 lbs	Represents the annual reduction to the lake
Project Installation Cost	$937	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$263	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$2.90	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 365-GW-1

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

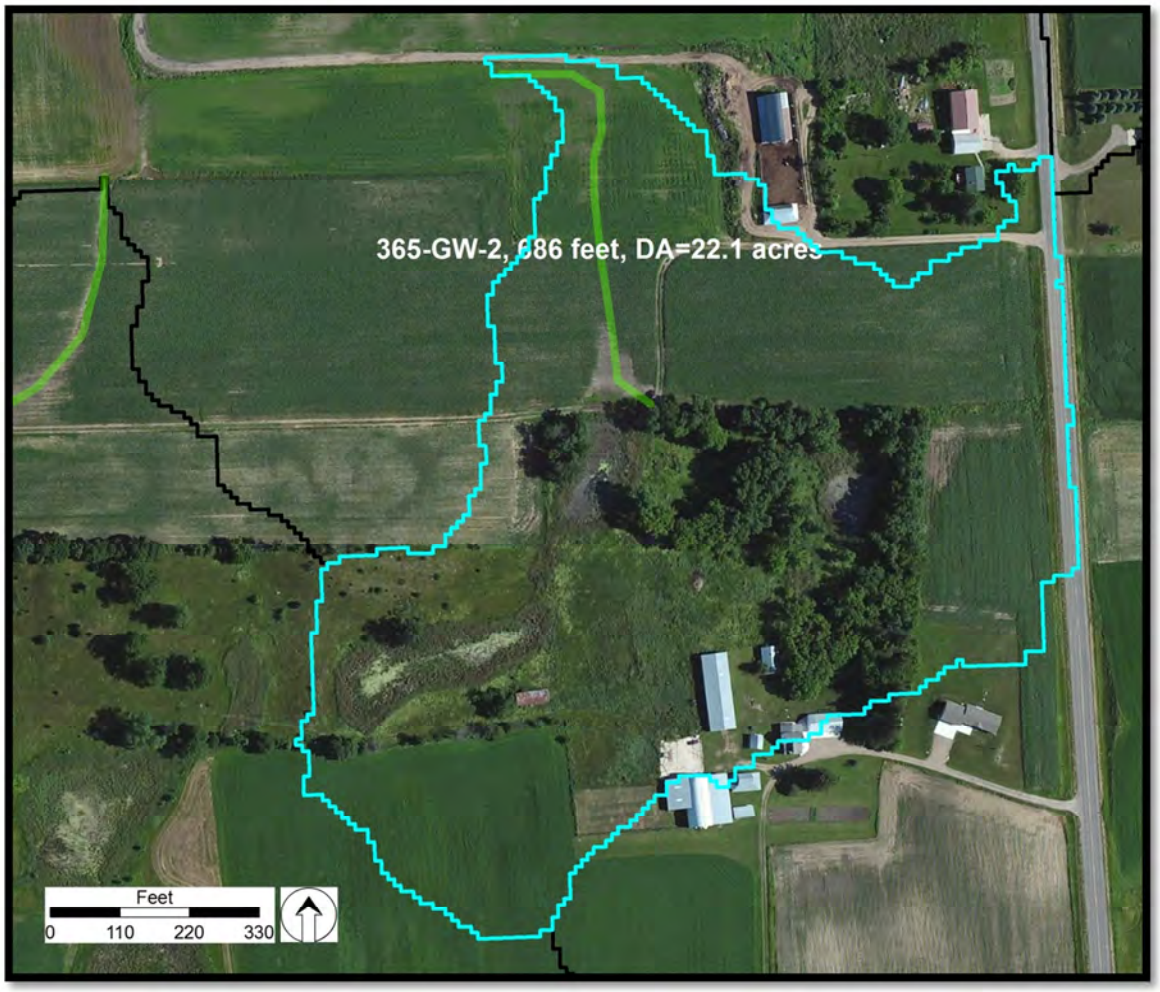
Total Phosphorus (TP) Reduction to Two Rivers Lake	2.97 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	178 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,806	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$30	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$0.51	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 365-GW-2

Problem Description:	Some Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.49 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	89 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,852	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$62	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.04	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 365-GW-3

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Replant Existing Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

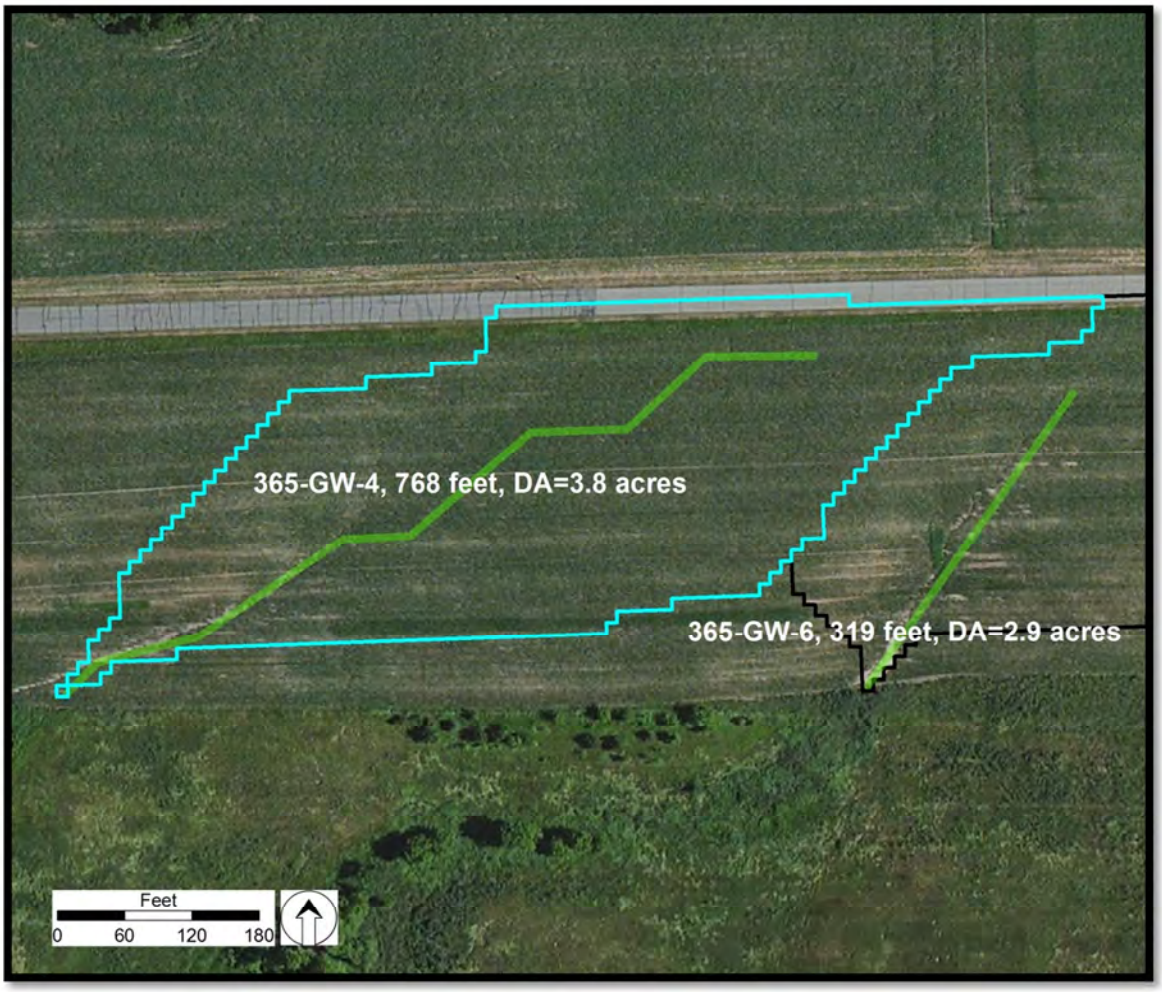
Total Phosphorus (TP) Reduction to Two Rivers Lake	0.26 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	16 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,210	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$230	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.83	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 365-GW-4

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.26 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	15 lbs	Represents the annual reduction to the lake
Project Installation Cost	$2,074	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$404	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$6.74	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

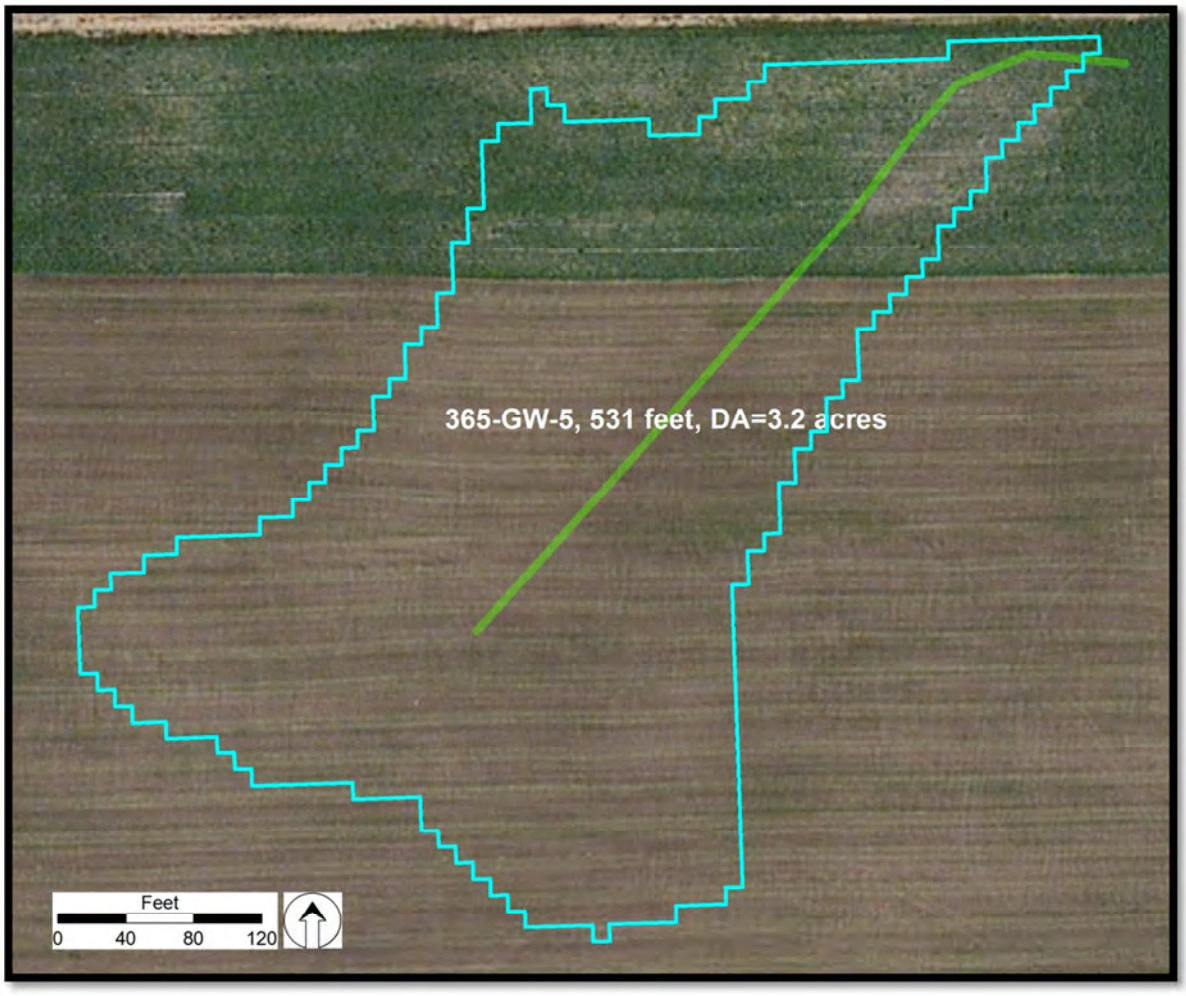


Potential Project 365-GW-5

Problem Description:	Some Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.22 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	13 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,434	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$332	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$5.53	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

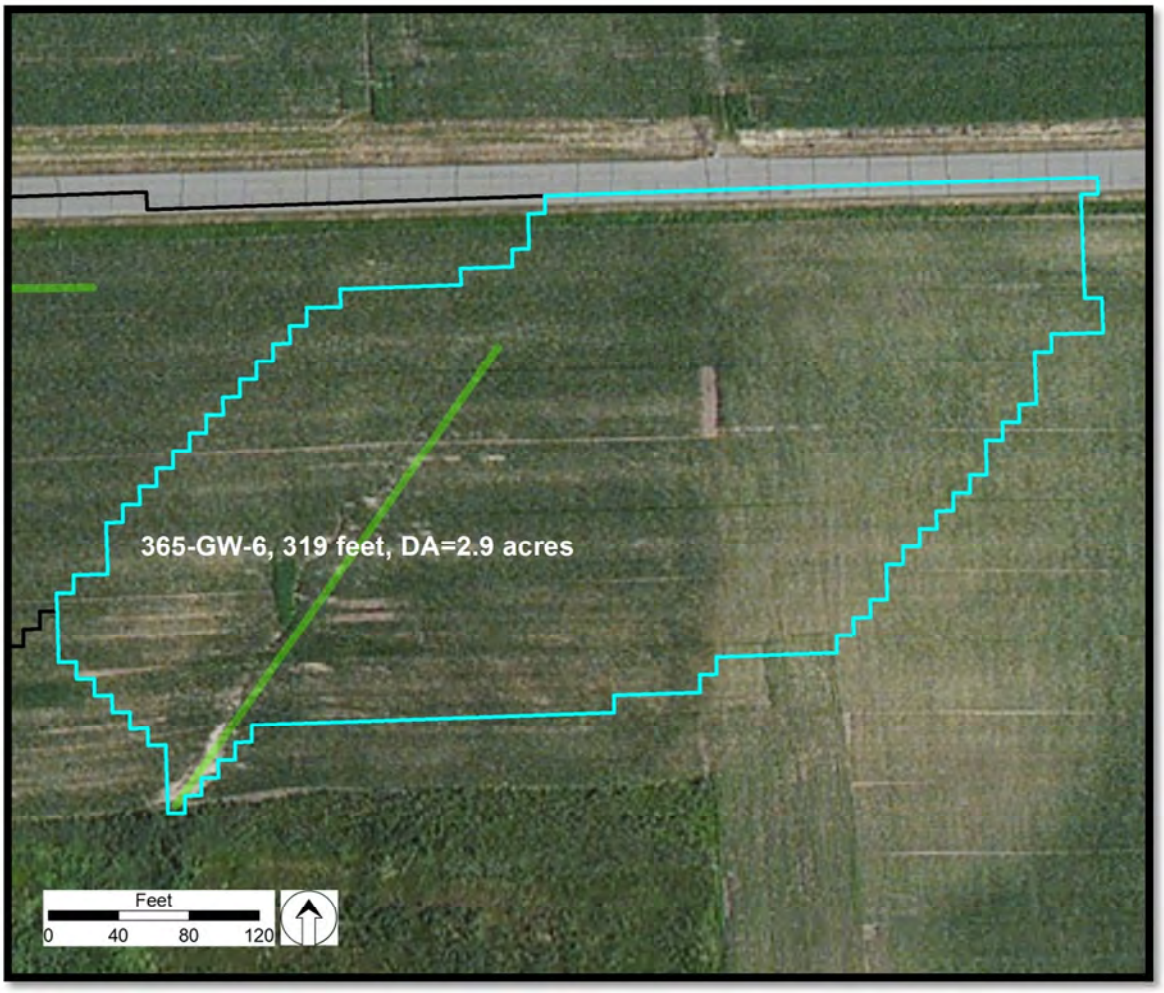


Potential Project 365-GW-6

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.20 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	12 lbs	Represents the annual reduction to the lake
Project Installation Cost	$861	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$220	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.67	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 380-GW-1

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 380-LMC-1)

Notes

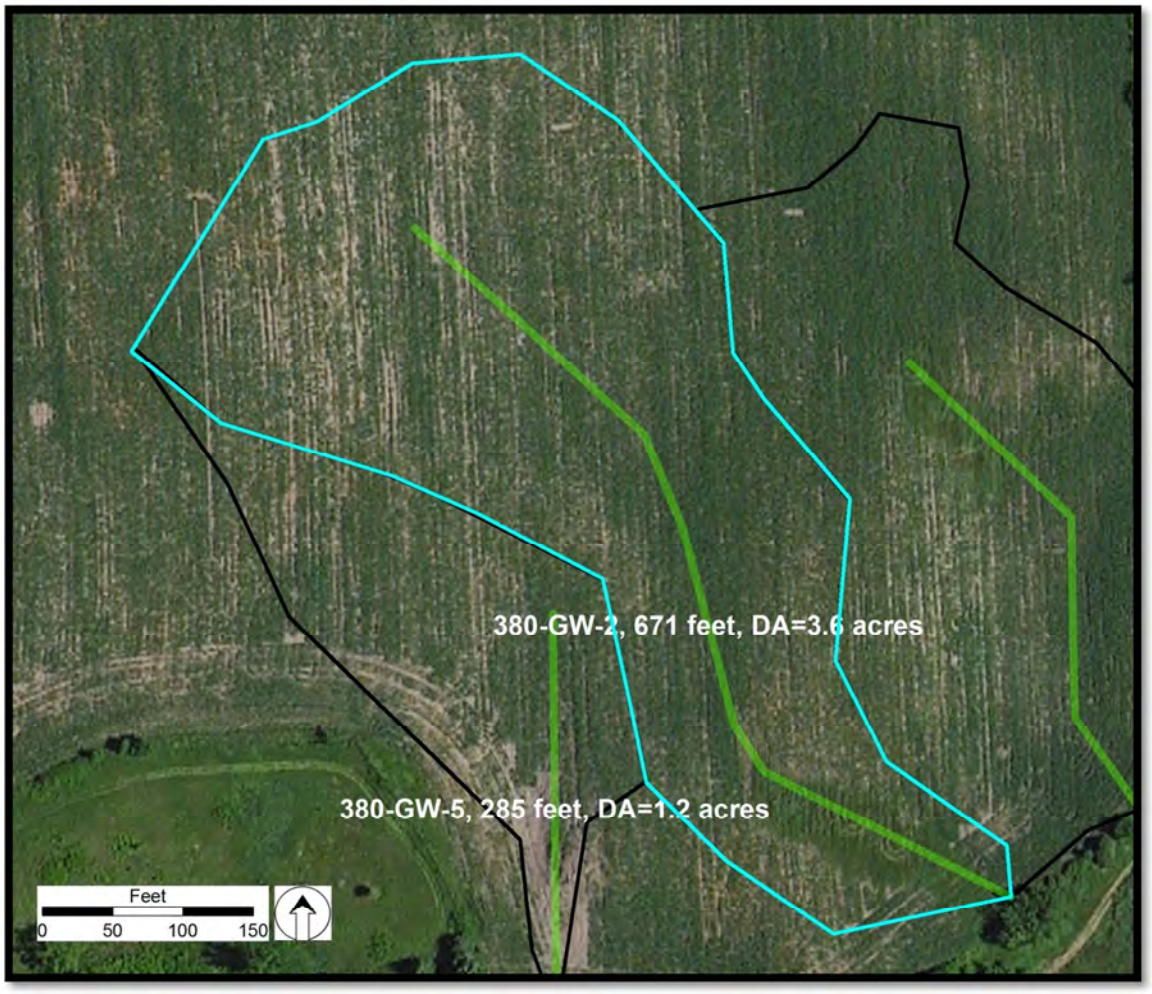
Total Phosphorus (TP) Reduction to Two Rivers Lake	0.62 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	61 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,563	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$125	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$1.28	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 380-GW-2

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 380-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.22 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	22 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,812	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$404	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$4.14	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

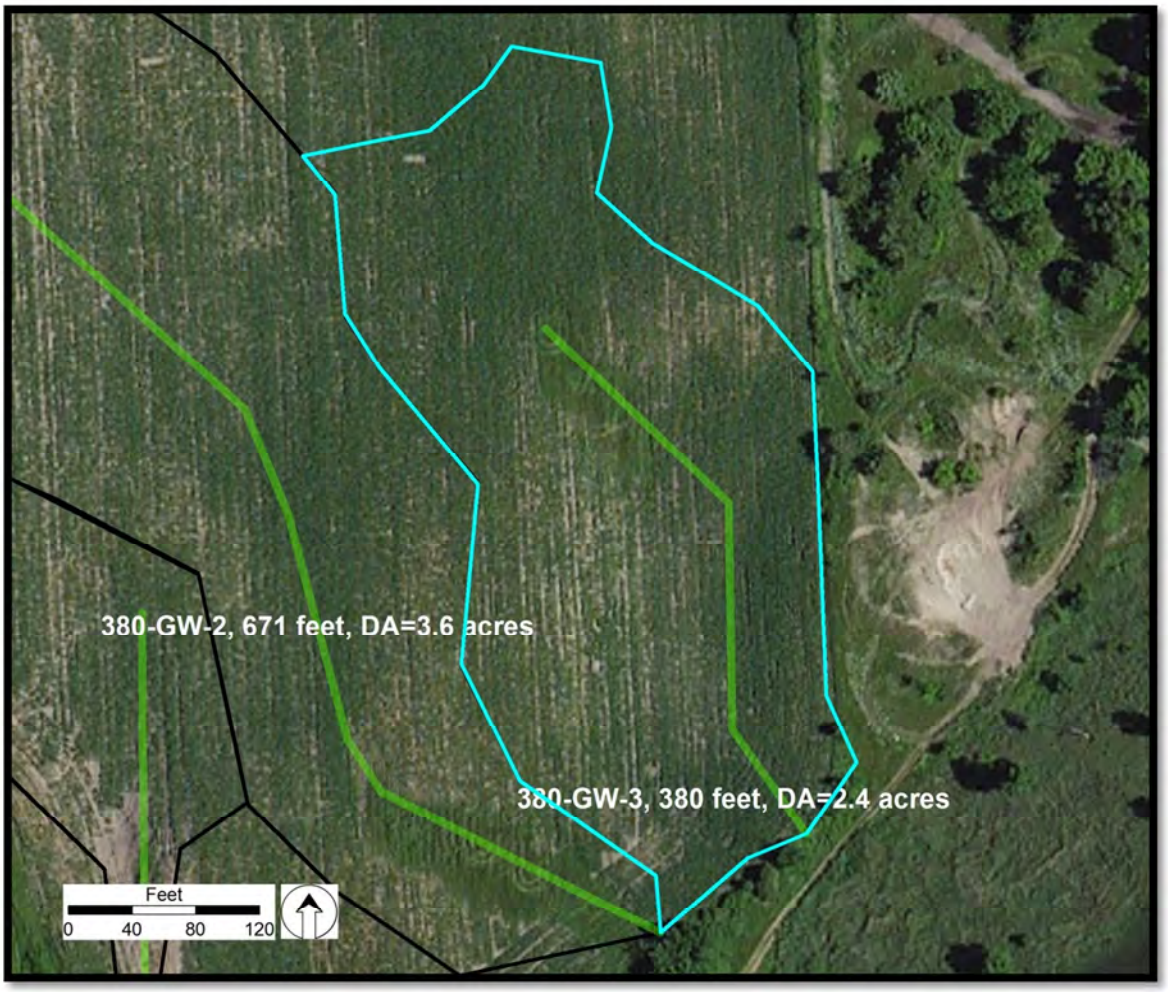


Potential Project 380-GW-3

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 380-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.15 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	15 lbs	Represents the annual reduction to the lake
Project Installation Cost	$1,026	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$343	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.51	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



Potential Project 380-GW-4

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 380-LMC-3)

Notes

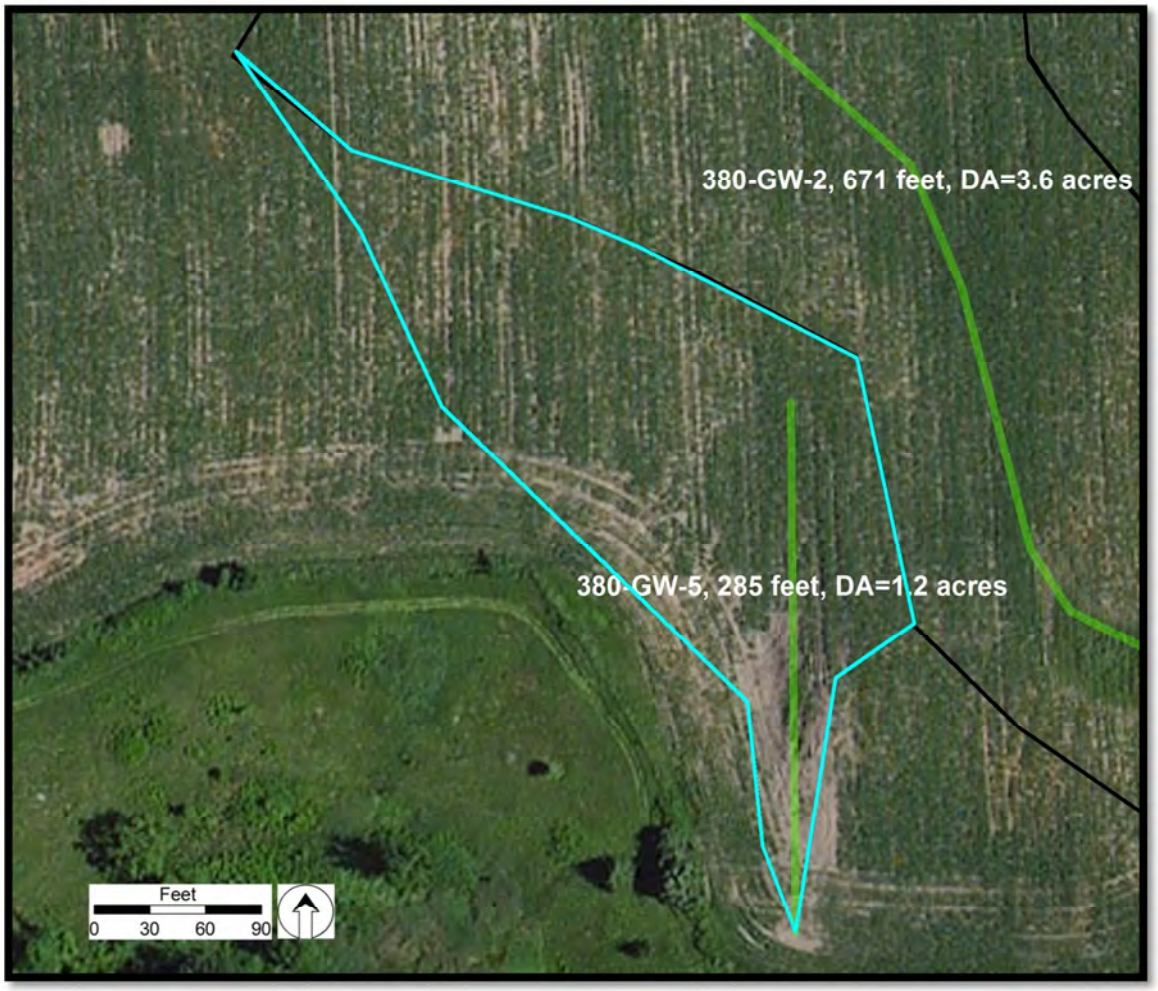
Total Phosphorus (TP) Reduction to Two Rivers Lake	0.14 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	13 lbs	Represents the annual reduction to the lake
Project Installation Cost	$845	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$308	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$3.16	Annual removal rate based on 20-year lifespan and costs of a grassed waterway

Potential Project 380-GW-5

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (Stream Power Index (SPI)
Potential Solution:	Grassed Waterway, Water and Sediment Control Basin, or Land Management Change (See 380-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.07 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	7 lbs	Represents the annual reduction to the lake
Project Installation Cost	$770	Assumes Environmental Quality Incentive Program (EQIP) rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$514	Annual removal rate based on 20-year lifespan and costs of a grassed waterway
Cost per Pound Removal – TSS	$5.27	Annual removal rate based on 20-year lifespan and costs of a grassed waterway



APPENDIX C

AGRICULTURAL PROJECT PROFILES
LAND MANAGEMENT CHANGES

Table C-1. Cost-Benefit Analysis for Implementing Land-Use Management Changes Under the Environmental Quality Incentive Program Soil Health Cover Crop Program

BMP I.D.	Field Size for Cover Crop Practice	2015 EQIP Payment Rate for Cover Crop Soil Health ($/ac)	Total EQIP Payments Over Required 5-Year Contract	Average TP Loading Rate to Lake (lb/ac/yr)[a]	Average TSS Loading Rate to Lake (lb/ac/yr)[a]	Current Annual TP Delivery to Lake (lbs/yr)	Current Annual TSS Delivery to Lake (lbs/yr)	BMP Efficiency for TP Removal[b]	BMP Efficiency for TSS Removal[c]	Annual TP Reduction to Lake With BMP (lbs/yr)	Annual TSS Reduction to Lake With BMP (lbs/yr)	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Reduction to Lake With BMP Over 20 Years (lbs)[d]	TP Removal Cost ($/lb)	TSS Removal Cost ($/lb)
156-LMC-1	238.5	55.55	66,243	0.20	64.7	48.6	15,438	0.765	0.70	37.2	10,806	744	21,6126	89.08	0.31
320-LMC-1	9.0	55.55	2,500	0.11	7.7	1.0	69	0.765	0.70	0.8	49	15	972	163.40	2.57
335-LMC-1	26.8	55.55	7,444	0.14	18.3	3.8	489	0.765	0.70	2.9	343	57	6,852	129.67	1.09
355-LMC-1	18.3	55.55	5,083	0.12	10.4	2.3	190	0.765	0.70	1.7	133	35	2653	146.87	1.92
363-LMC-1	24.1	55.55	6,694	0.14	8.1	3.3	195	0.765	0.70	2.5	136	50	2,725	132.70	2.46
365-LMC-1	87.4	55.55	24,275	0.14	5.3	11.8	459	0.765	0.70	9.0	322	181	6,431	134.47	3.77
365-LMC-2	9.3	55.55	2,583	0.14	5.3	1.3	49	0.765	0.70	1.0	34	19	684	134.47	3.77
380-LMC-1	71.6	55.55	19,887	0.12	7.9	8.9	566	0.765	0.70	6.8	396	137	7,920	145.58	2.51
380-LMC-2	26.6	55.55	7,388	0.12	7.9	3.3	210	0.765	0.70	2.5	147	51	2,942	145.58	2.51
380-LMC-3	19.6	55.55	5,444	0.12	7.9	2.4	155	0.765	0.70	1.9	108	37	2,168	145.58	2.51
380-LMC-4	8.0	55.55	2,222	0.12	7.9	1.0	63	0.765	0.70	0.8	44	15	885	145.58	2.51
380-LMC-5	7.8	55.55	2,166	0.12	7.9	1.0	62	0.765	0.70	0.7	43	15	863	145.58	2.51
380-LMC-6	7.0	55.55	1,944	0.12	7.9	0.9	55	0.765	0.70	0.7	39	13	774	145.58	2.51

(a) Loading rates are specific to each subwatershed and were calculated by using the Two Rivers HSPF model.

(b) Removal efficiency is the average value from Minnesota's Ag BMP Handbook, Appendix B Table 35.

(c) Removal efficiency from Minnesota's Ag BMP Handbook, Appendix B Table 44.

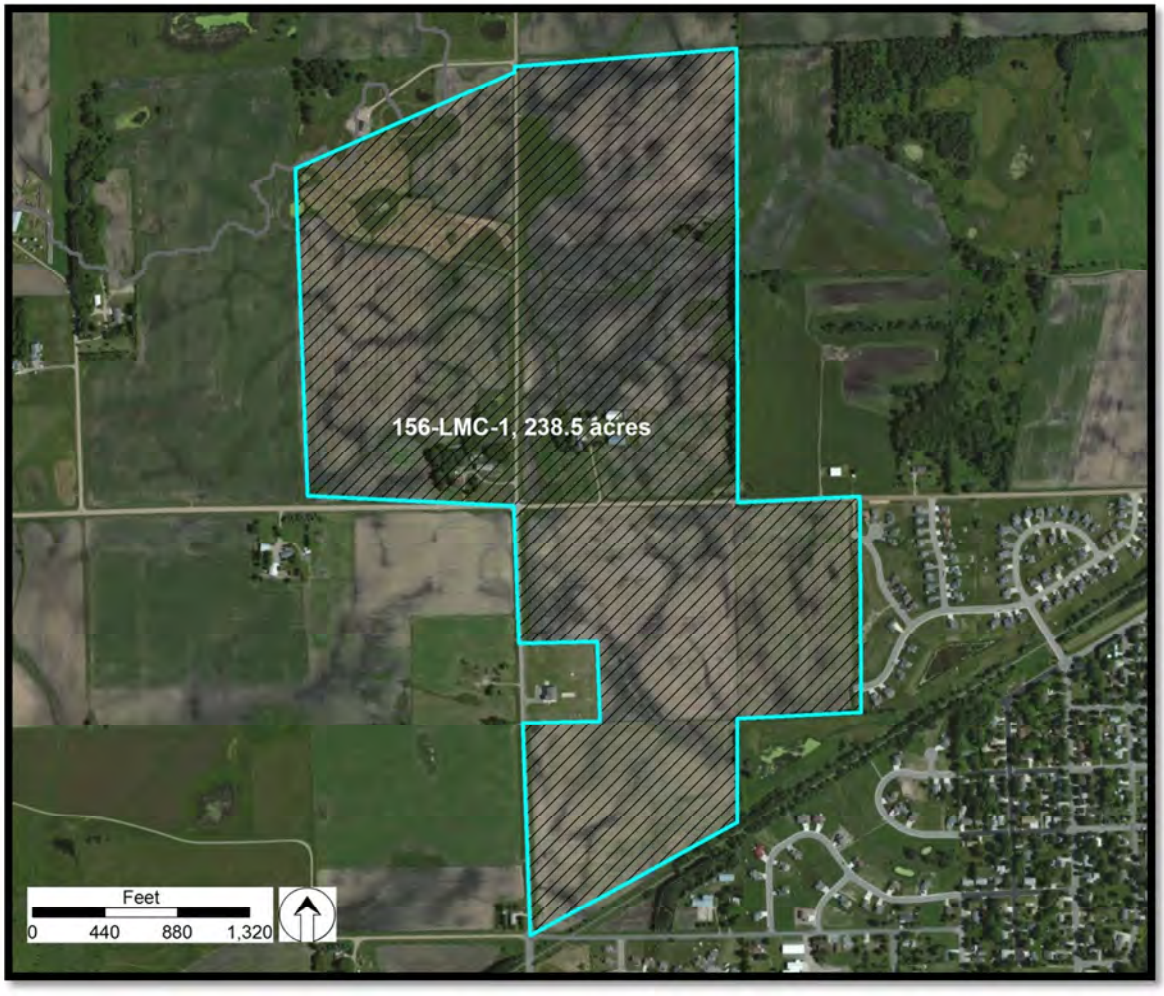
(d) Assumes producer would continue to use soil health techniques for 20 years, even though payments end after 5 years.

Potential Project 156-LMC-1

Problem Description:	Visible Erosion and High Stream Power Index (Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change OR Grassed Waterways (See 156-GW-1, 156-GW-2, 156-GW-4, 156-GW-6, 156-GW-7, 156-GW-8, and 156-GW-11) OR Wetland Expansion (See 156-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	37.2 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	10,800 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$66,243	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$89	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$0.31	Annual removal rate based on 20-year commitment to employing soil health cover crop practices



Potential Project 320-LMC-1

Problem Description:	Visible Erosion and Medium-High Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change OR Grassed Waterways (See 320-GW-1 and 320-GW-2)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.8 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	49 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$2,500	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015) and includes the additional treatment area
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$89	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$0.31	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 335-LMC-1

Problem Description:	Visible Erosion and Medium-High Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	2.9 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	343 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$7,444	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$130	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$1.09	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 355-LMC-1

Problem Description:	Visible Erosion and Medium-High Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change OR Grassed Waterway (See 355-GW-2)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.7 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	133 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$5,083	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$147	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$1.92	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 363-LMC-1

Problem Description:	Visible Erosion and High Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change OR Grassed Waterway (See 363-GW-1)

Notes

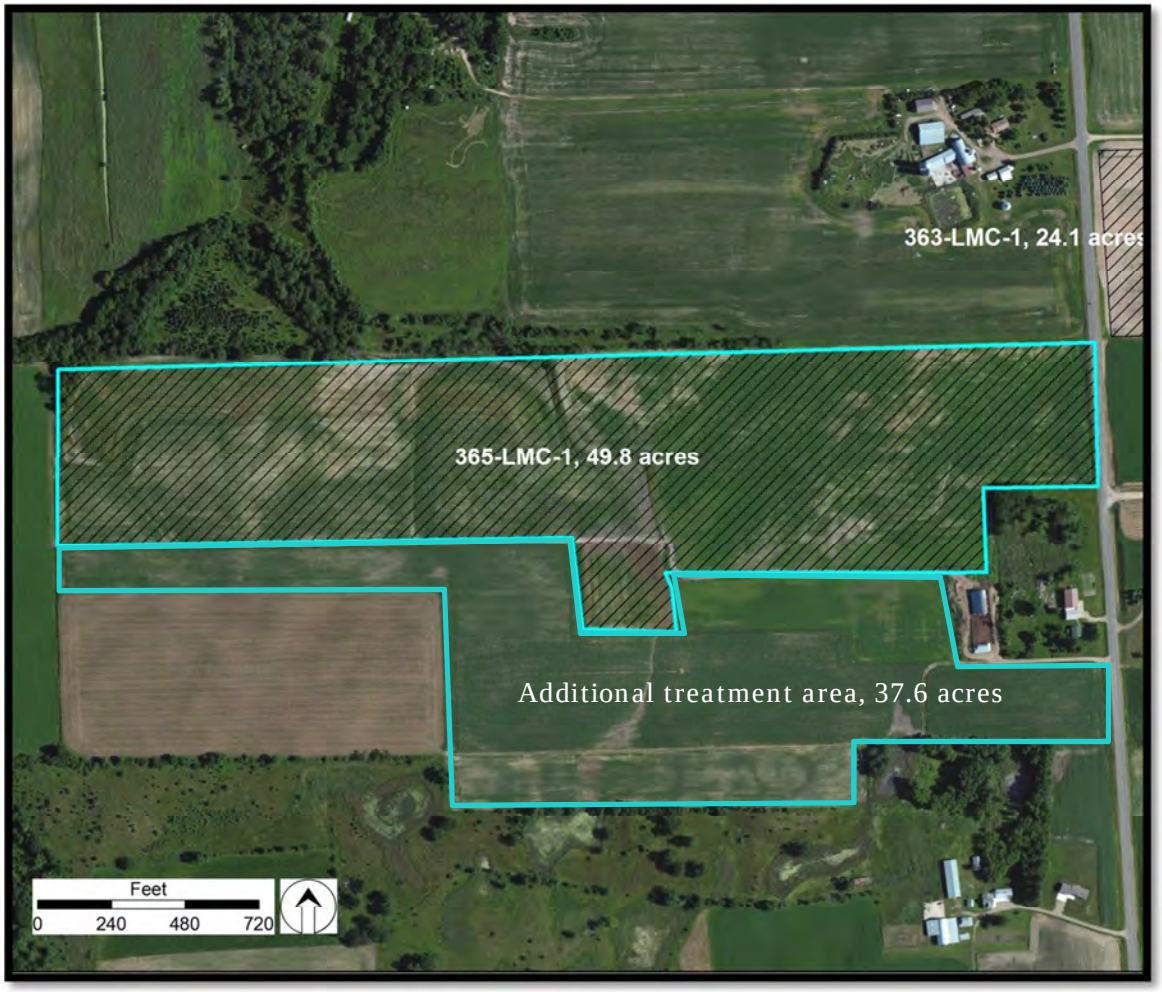
Total Phosphorus (TP) Reduction to Two Rivers Lake	2.5 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	136 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$6,694	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$133	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.46	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 365-LMC-1

Problem Description:	Visible Erosion and High Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change

Notes

TP Reduction to Two Rivers Lake	9.0 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	322 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$24,275	Assumed payments for 5-year Environmental Quality Incentive Program (EQIP) contract and includes the additional treatment area
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$134	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$3.77	Annual removal rate based on 20-year commitment to employing soil health cover crop practices



Potential Project 365-LMC-2

Problem Description:	Visible Erosion and High Stream Power Index (SPI) Throughout Area
Potential Solution:	Land Management Change and/or Grassed Waterways (See 365-GW-4 and 365-GW-6)

Notes

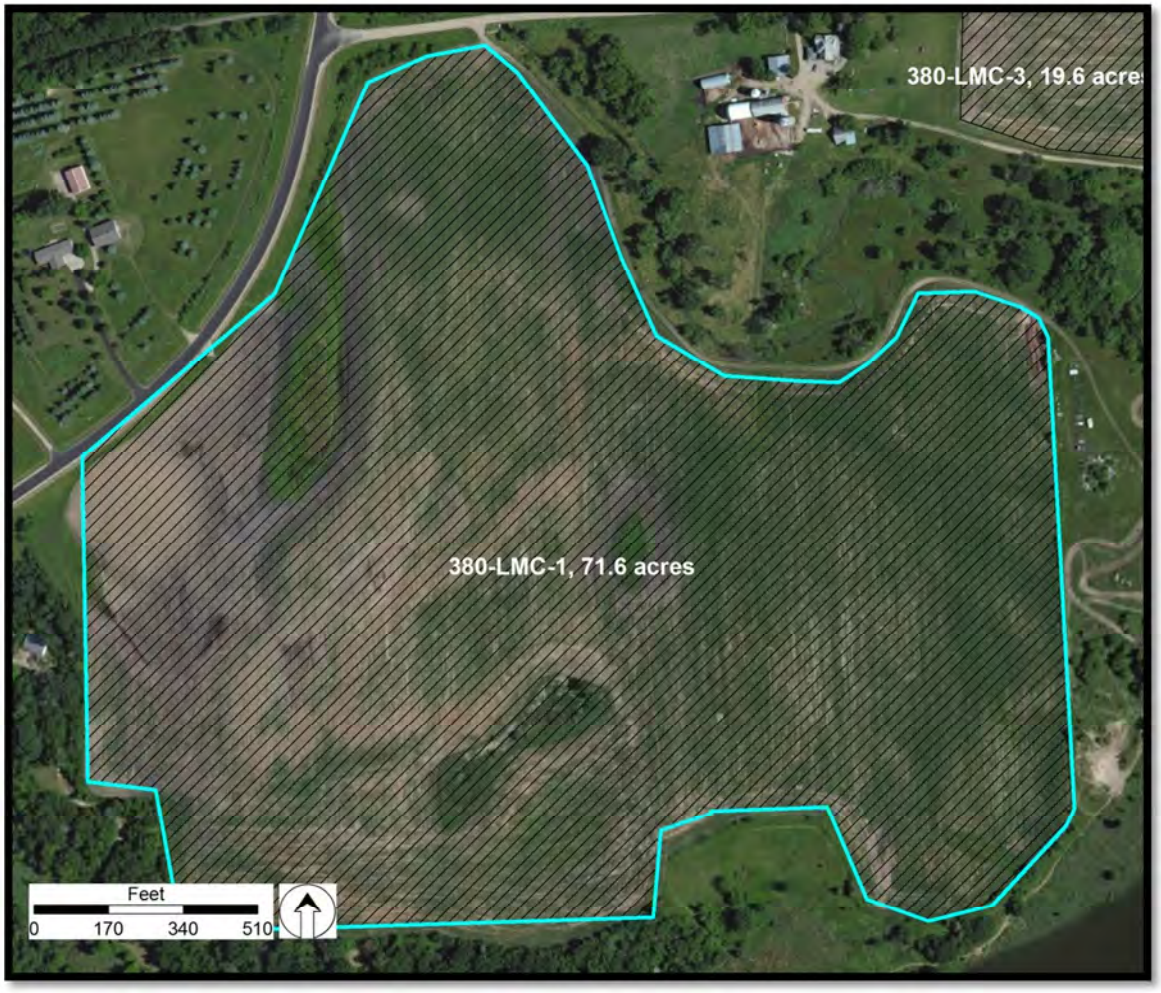
Total Phosphorus (TP) Reduction to Two Rivers Lake	1.0 lb	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	34 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$2,583	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$134	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$3.77	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 380-LMC-1

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI) Throughout Area, Proximity to Lake
Potential Solution:	Land Management Change and/or Wetland Expansion (See 359-WR-1) and/or Grassed Waterways (See 359-GW-2, 380-GW-1, 380-GW-2, 380-GW-3, and 380-GW-5)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	6.8 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	396 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$19,887	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$146	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.51	Annual removal rate based on 20-year commitment to employing soil health cover crop practices



Potential Project 380-LMC-2

Problem Description:	Visible Erosion, High Stream Power Index (SPI) Throughout Area, Proximity to Lake
Potential Solution:	Land Management Change (Current Groundwaters Already Exist)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	2.5 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	147 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$7,388	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$146	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.51	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 380-LMC-3

Problem Description:	Substantial Visible Erosion, Medium-High Stream Power Index (SPI) Throughout Area, Proximity to Lake
Potential Solution:	Land Management Change and/or Grassed Waterway (See 380-GW-4)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.9 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	108 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$5,444	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$146	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.51	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 380-LMC-4

Problem Description:	Visible Erosion, Medium-High Stream Power Index (SPI) Throughout Area, Proximity to Lake
Potential Solution:	Land Management Change OR Wetland Expansion (See 359-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.8 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	44 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$2,222	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$146	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.51	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 380-LMC-5

Problem Description:	Visible Erosion, Medium-High Stream Power Index (SPI) Throughout Area, Proximity to Lake
Potential Solution:	Land Management Change OR Wetland Expansion (See 359-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.7 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	43 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$2,166	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$146	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.51	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

Potential Project 380-LMC-6

Problem Description:	Substantial Visible Erosion, High Stream Power Index (SPI) Throughout Area, Proximity to Lake
Potential Solution:	Land Management Change OR Wetland Expansion (See 359-WR-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.7 lbs	Represents the annual reduction to Two Rivers Lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	39 lbs	Represents the annual reduction to Two Rivers Lake
Project Cost	$1,944	Total Payments for 5-year Environmental Quality Incentive Program (EQIP) contract (2015)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$146	Annual removal rate based on 20-year commitment to employing soil health cover crop practices
Cost per Pound Removal – TSS	$2.51	Annual removal rate based on 20-year commitment to employing soil health cover crop practices

APPENDIX D

AGRICULTURAL PROJECT PROFILES
WETLAND RESTORATIONS

Table D-1. Cost-Benefit Analysis for Wetland Restorations and Expansions

BMP I.D.	Wetland Type	Proposed Additional Wetland Area (ac)	Proposed Total Wetland Area (ac)	Wetland Construction Cost[a] ($)	Average TP Loading Rate to Lake (lb/ac/yr)[b]	Average TSS Loading Rate to Lake (lb/ac/yr)[b]	Current Annual TP Delivery to Lake (lbs/yr)	Current Annual TSS Delivery to Lake (lbs/yr)	BMP Efficiency for TP Removal[c]	BMP Efficiency for TSS Removal[d]	Annual TP Reduction to Lake With BMP (lbs/yr)[e]	Annual TSS Reduction to Lake With BMP (lbs/yr)[e]	TP Reduction to Lake With BMP Over 20 Years (lbs)[f]	TSS Reduction to Lake With BMP Over 20 Years (lbs)[f]	TP Removal Cost ($/lb)[g]	TSS Removal Cost ($/lb)[g]
11-WR-1	Restoration	70.1	70.1	266,708.34	0.08	11.51	58.9	8,128	0.43	0.90	28.6	7,395.7	573	147,915	465.50	1.80
11-WR-2	Expansion	104.2	167.0	396,582.48	0.08	11.51	33.7	4,647	0.43	0.90	22.4	4,374.7	448	87,493	884.73	4.53
11-WR-3	Restoration	5.3	5.3	20,164.82	0.08	11.51	2.0	271	0.43	0.90	1.1	249.6	22	4,993	921.01	4.04
31-WR-1	Restoration	5.1	5.1	19,403.89	0.08	11.12	1.7	237	0.43	0.90	1.0	218.8	19	4,376	997.61	4.43
73-WR-1	Expansion	84.9	84.9	323,017.66	0.05	7.27	35.5	4,899	0.43	0.90	17.8	4,471.0	356	89,419	906.14	3.61
130-WR-1	Restoration	92.0	92.0	350,030.91	0.10	16.90	30.1	5,151	0.43	0.90	18.1	4,791.2	363	95,824	964.35	3.65
156-WR-1	Expansion	28.8	28.8	109,574.89	0.20	64.73	70.8	22,473	0.43	0.90	33.8	20,412.5	675	408,251	162.23	0.27
156-WR-2	Restoration	19.2	19.2	73,049.93	0.20	64.73	17.5	5,567	0.43	0.90	9.8	5,134.2	195	102,684	373.97	0.71
217-WR-2	Expansion	5.9	9.4	22,601.84	0.03	3.70	16.7	1,982	0.43	0.90	7.3	1,787.5	147	35,751	154.02	0.63
217-WR-3	Expansion	19.4	25.1	73,873.97	0.03	3.70	14.1	1,677	0.43	0.90	6.5	1,518.8	130	30,377	567.19	2.43
219-WR-1	Expansion	3.1	6.8	11,769.50	0.07	5.98	4.2	377	0.43	0.90	2.1	343.4	42	6,868	282.38	1.71
297-WR-1	Expansion	56.8	58.8	216,106.04	0.01	1.28	3.3	491	0.43	0.90	1.7	449.4	34	8,988	6,414.98	24.04
297-WR-2	Expansion	16.4	17.4	62,396.82	0.01	1.28	0.7	112	0.43	0.90	0.4	102.7	8	2,055	7,748.20	30.37
337-WR-1	Expansion	29.0	29.2	110,156.61	0.14	19.73	13.6	1,938	0.43	0.90	8.2	1,801.6	163	36,033	675.03	3.06
341-WR-2	Expansion	5.4	5.9	20,545.29	0.12	12.72	13.4	1,389	0.43	0.90	6.2	1,257.3	124	25,146	165.98	0.82
341-WR-3	Expansion	10.1	13.1	38,427.31	0.12	12.72	8.4	870	0.43	0.90	4.5	799.5	91	15,990	423.57	2.40
349-WR-1	Expansion	69.2	69.4	263,104.90	0.11	12.12	27.1	2,879	0.43	0.90	16.2	2,675.4	324	53,508	813.05	4.92
355-WR-1	Expansion	1.3	1.3	4,946.09	0.12	10.36	2.6	220	0.43	0.90	1.2	198.9	24	3,979	202.99	1.24
355-WR-2	Expansion	0.7	0.7	2,663.28	0.12	10.36	1.4	121	0.43	0.90	0.7	109.8	13	2,195	198.41	1.21
357-WR-1	Expansion	43.5	44.0	165,525.78	0.11	10.03	32.1	2,853	0.43	0.90	16.6	2,612.0	332	52,239	498.02	3.17
359-WR-1	Expansion	2.1	2.3	7,810.62	0.16	17.93	2.3	251	0.43	0.90	1.2	230.1	24	4,602	324.03	1.70
363-WR-1	Expansion	45.6	45.8	173,314.36	0.14	8.08	82.3	4,860	0.43	0.90	39.0	4,411.2	779	88,223	222.36	1.96

(a) Wetland construction costs are based on an average wetland construction cost of $3,804.68 per acre provided by Stearns Soil and Water Conservation District.

(b) Loading rates are specific to each subwatershed and were calculated using the Two Rivers HSPF model.

(c) Removal efficiency is taken from Woltemade [2000]: Ability of Restored Wetlands to Reduce Nitrogen and Phosphorus Concentrations in Agricultural Drainage Water (http://webspace.ship.edu/cjwolt/main/JSWC.pdf).

(d) Removal efficiency from Lenhart, Brooks, Magner, and Suppes [2010] Attenuating Excessive Sediment and Loss of Biotic Habitat in an Intensively Managed Midwestern Agricultural Watershed.

(e) Assumes 100% removal from wetland area.

(f) Assumes 20 years of benefits.

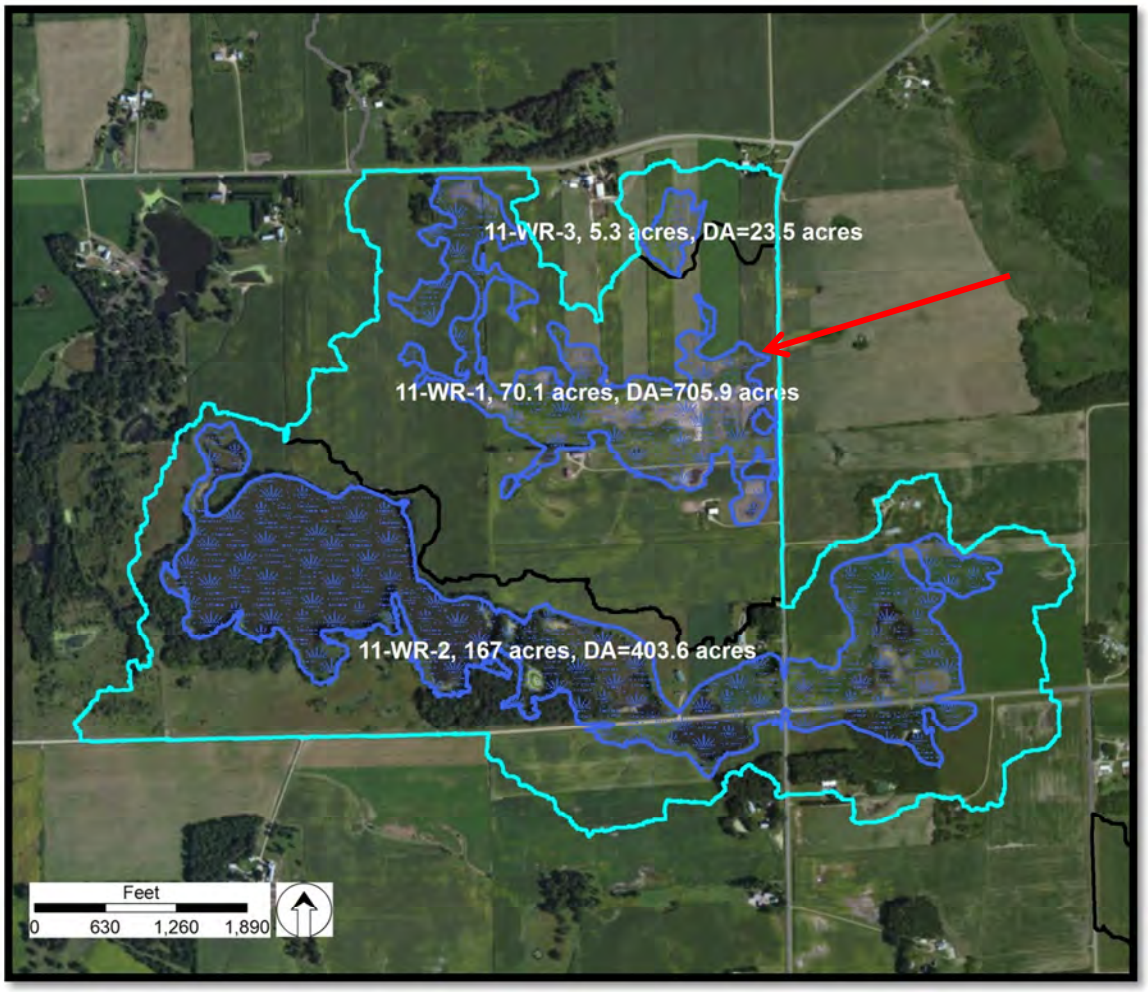
(g) Removal cost assumes that construction cost is the major expense of project implementation.

Potential Project 11-WR-1

Problem Description:	No Wetland Present, High compound topographic index (CTI) signature
Potential Solution:	Wetland Restoration

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	28.6 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	7396 lbs	Represents the annual reduction to the lake
Project Cost	$266,708	Based on Stearns County Soil and Water Conservation District (SWCD) Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$466	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$1.80	Annual removal rate based on 20-year lifespan of project

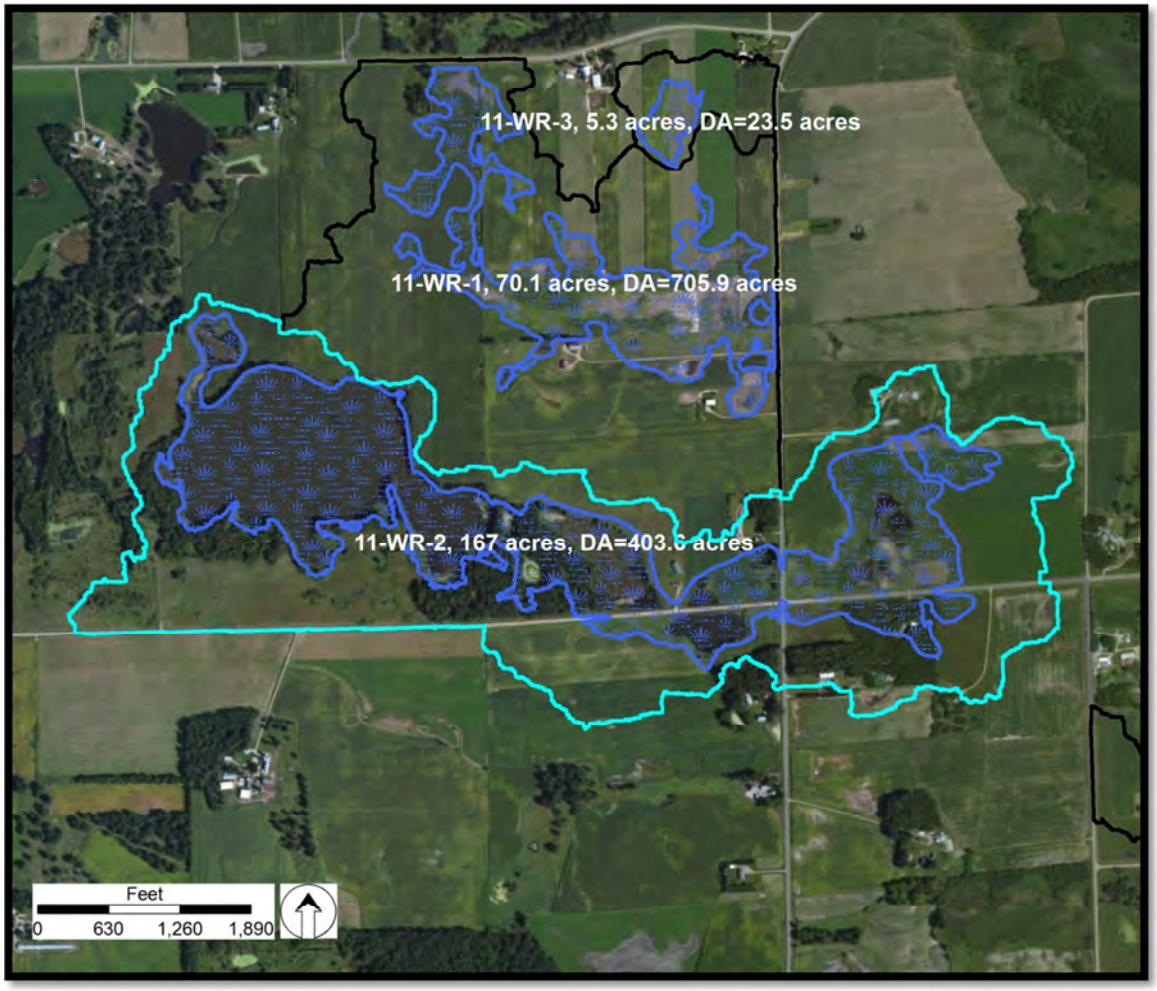


Potential Project 11-WR-2

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	22.4 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	4375 lbs	Represents the annual reduction to the lake
Project Cost	$396,582	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$885	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$4.53	Annual removal rate based on 20-year lifespan of project

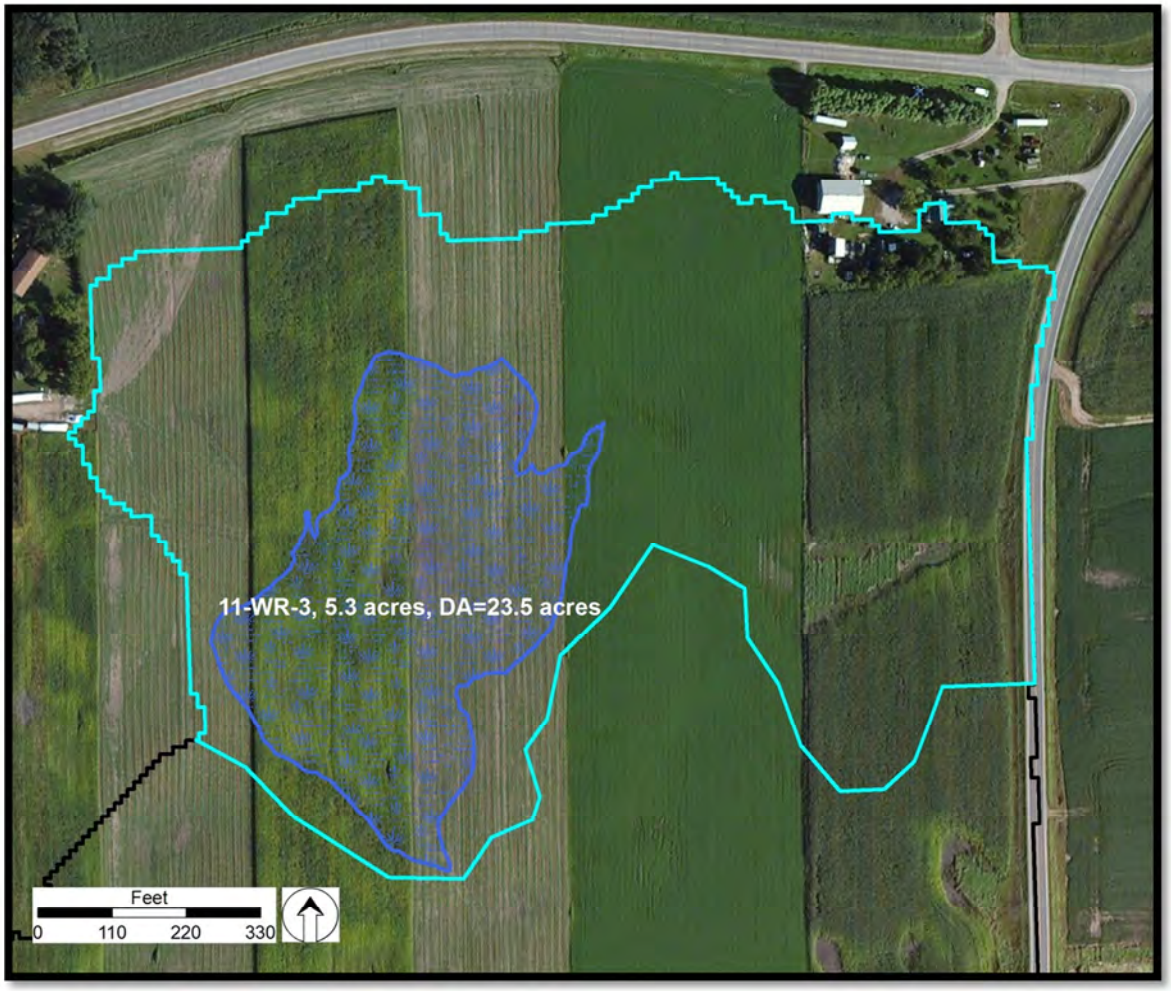


Potential Project 11-WR-3

Problem Description:	No Wetland Present, High CTI
Potential Solution:	Wetland Restoration

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.1 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	250 lbs	Represents the annual reduction to the lake
Project Cost	$20,165	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$921	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$4.04	Annual removal rate based on 20-year lifespan of project

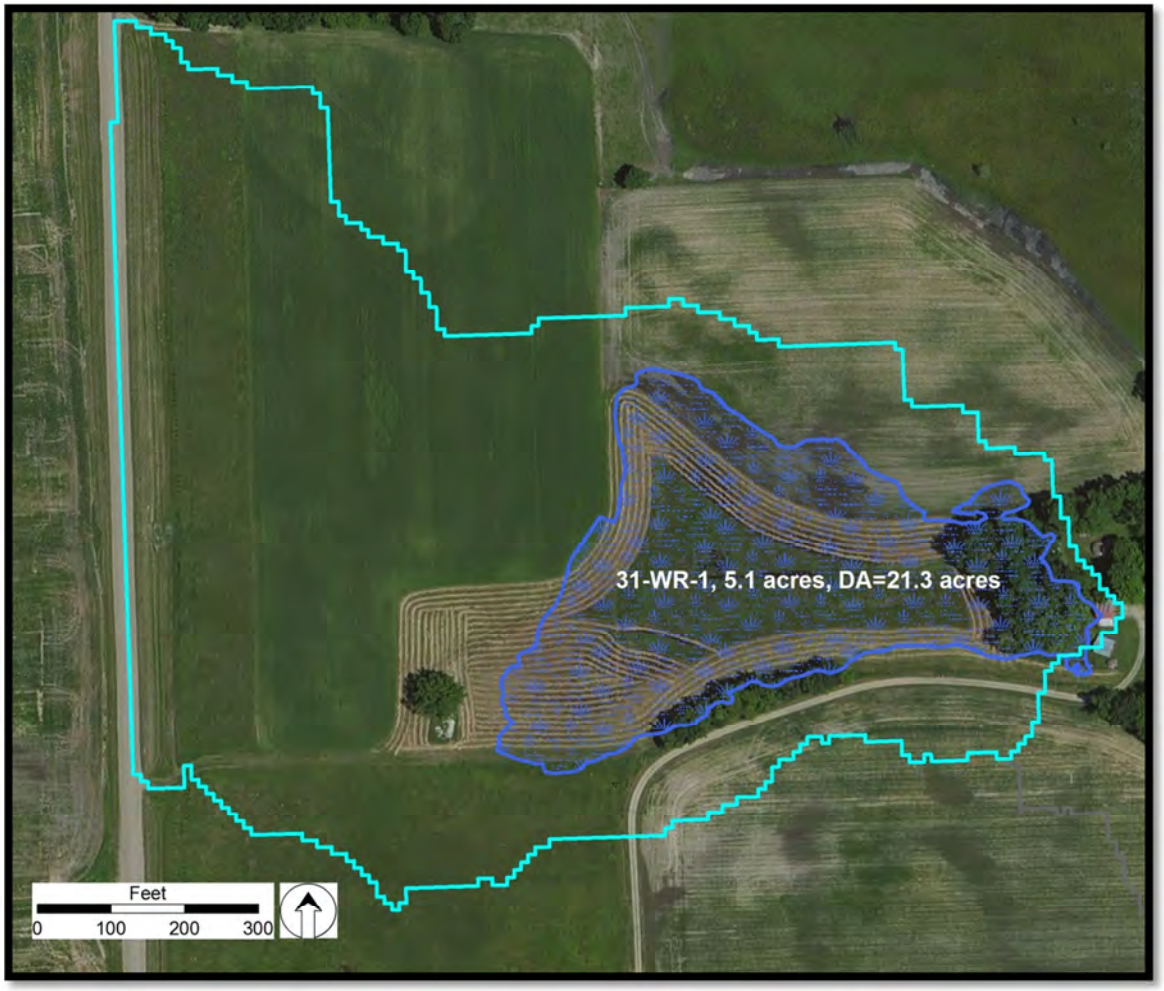


Potential Project 31-WR-1

Problem Description:	No Wetland Present, High CTI
Potential Solution:	Wetland Restoration

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.0 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	219 lbs	Represents the annual reduction to the lake
Project Cost	$19,404	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$998	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$4.43	Annual removal rate based on 20-year lifespan of project

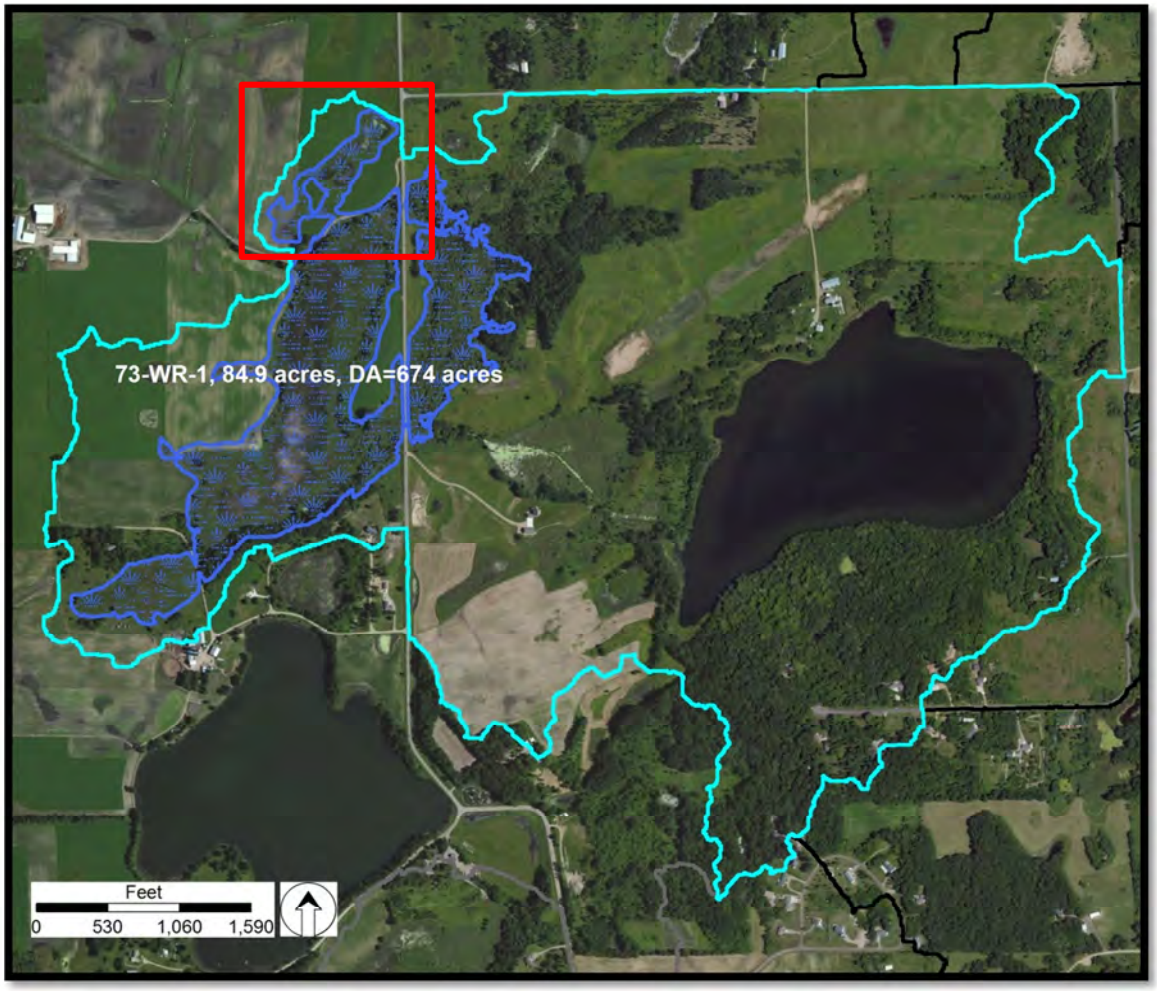


Potential Project 73-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	17.8 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	4471 lbs	Represents the annual reduction to the lake
Project Cost	$323,018	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$906	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$3.61	Annual removal rate based on 20-year lifespan of project

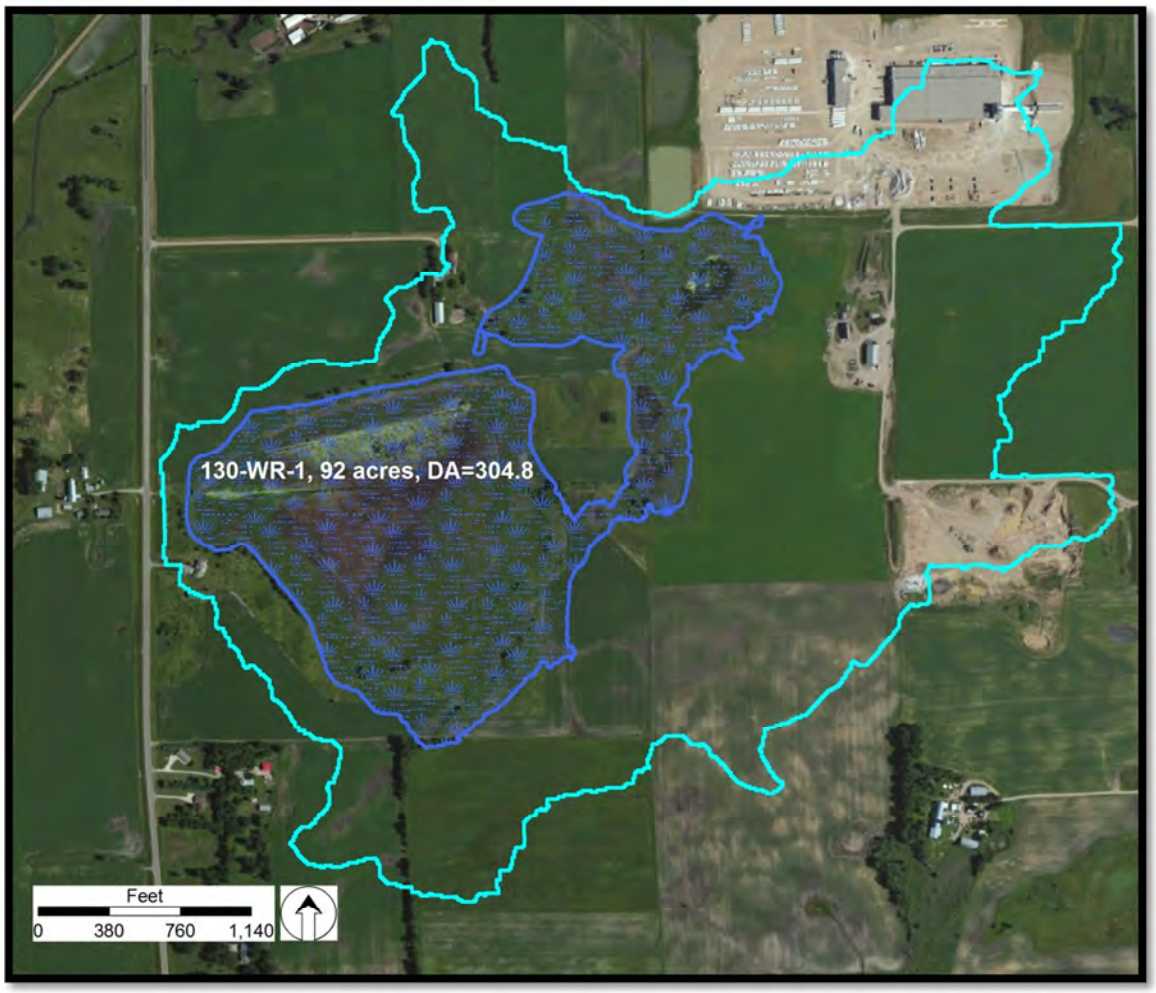


Potential Project 130-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Restoration

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	18.1 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	4791 lbs	Represents the annual reduction to the lake
Project Cost	$350,031	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$964	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$3.65	Annual removal rate based on 20-year lifespan of project

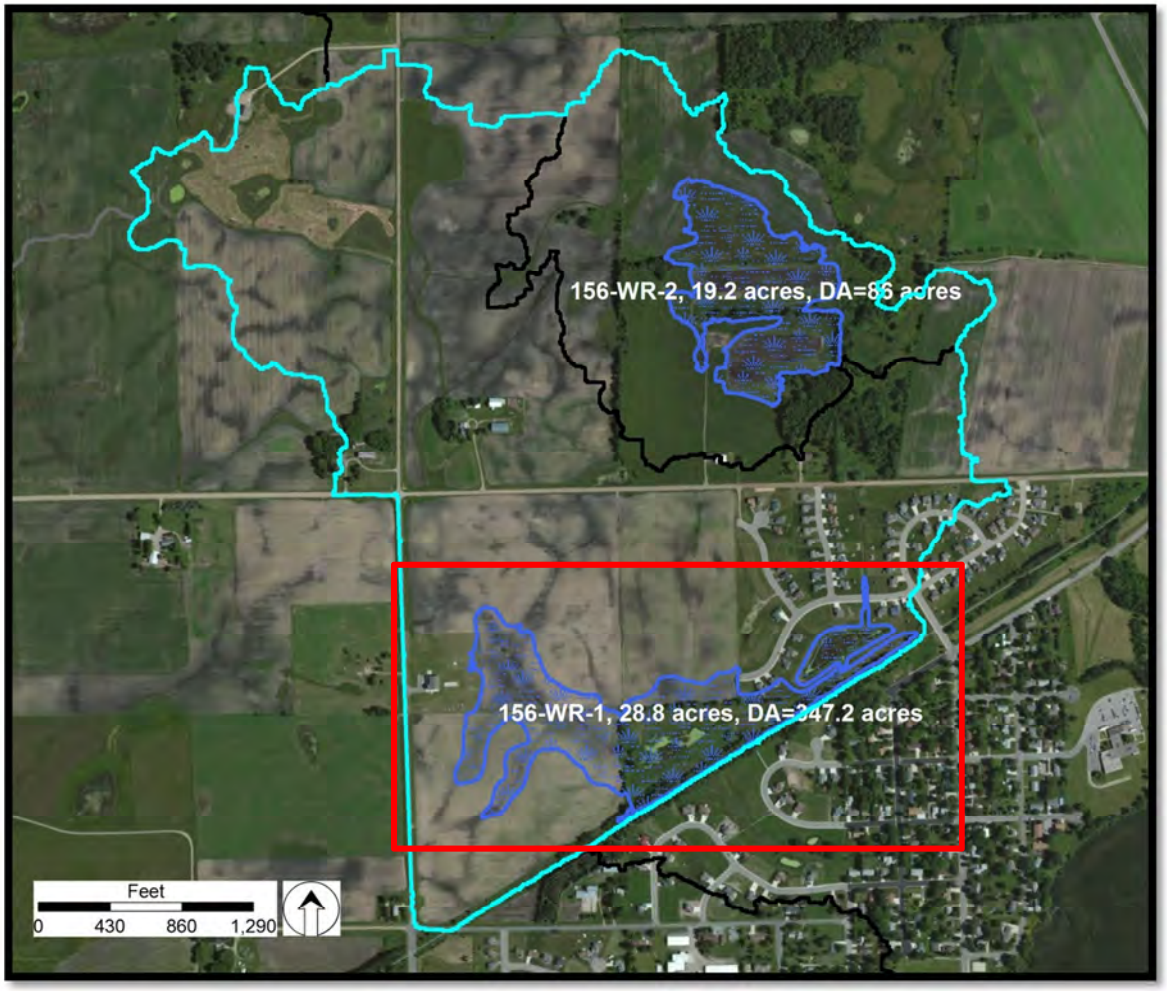


Potential Project 156-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion and/or Grassed Waterway (See 156-GW-2, 156-GW-6, and 156-GW-8) and/or Land Management Change (See 156-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	33.8 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	20413 lbs	Represents the annual reduction to the lake
Project Cost	$109,575	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$162	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$0.27	Annual removal rate based on 20-year lifespan of project

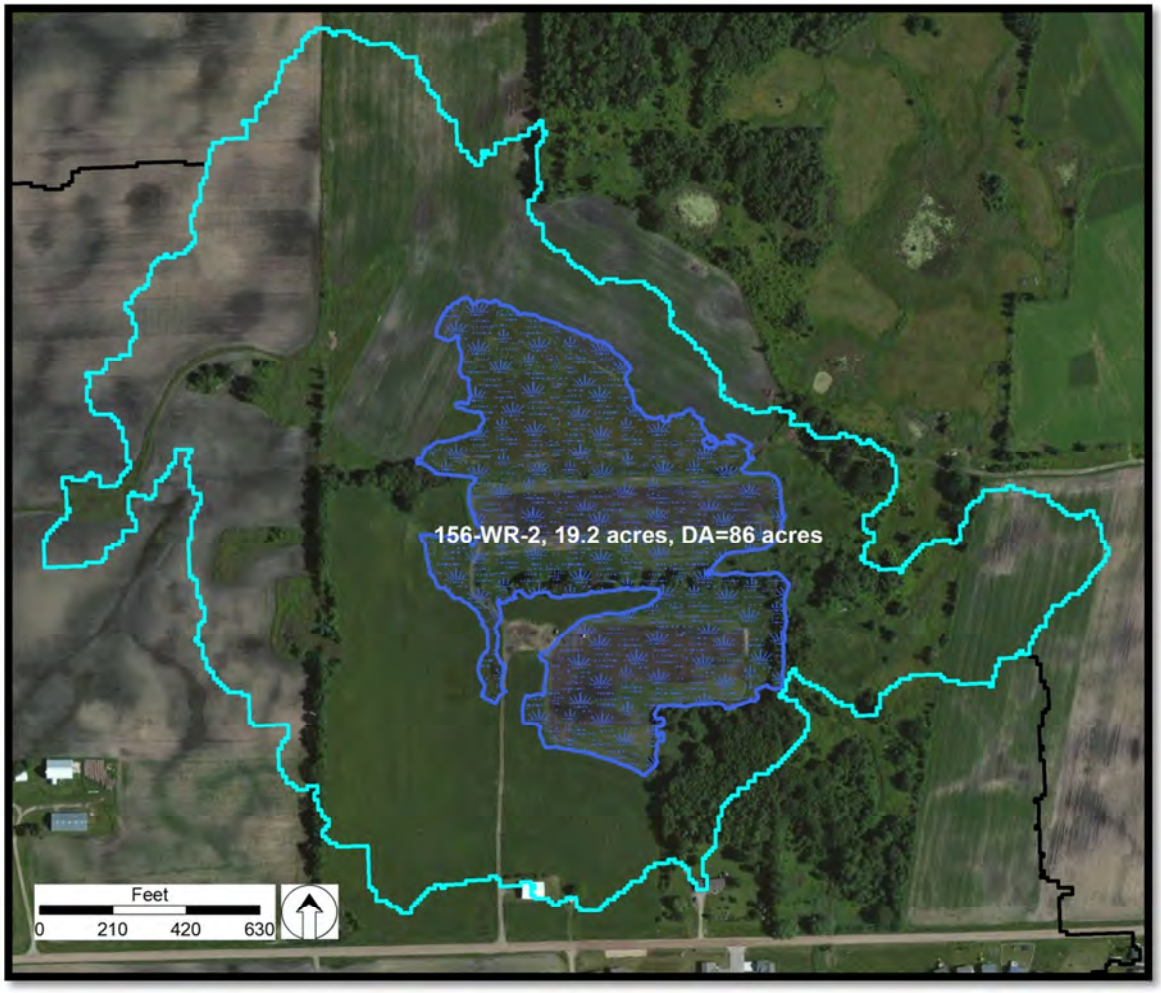


Potential Project 156-WR-2

Problem Description:	No Wetland Present, High CTI
Potential Solution:	Wetland Restoration

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	9.8 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	5134 lbs	Represents the annual reduction to the lake
Project Cost	$73,050	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$374	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$0.71	Annual removal rate based on 20-year lifespan of project

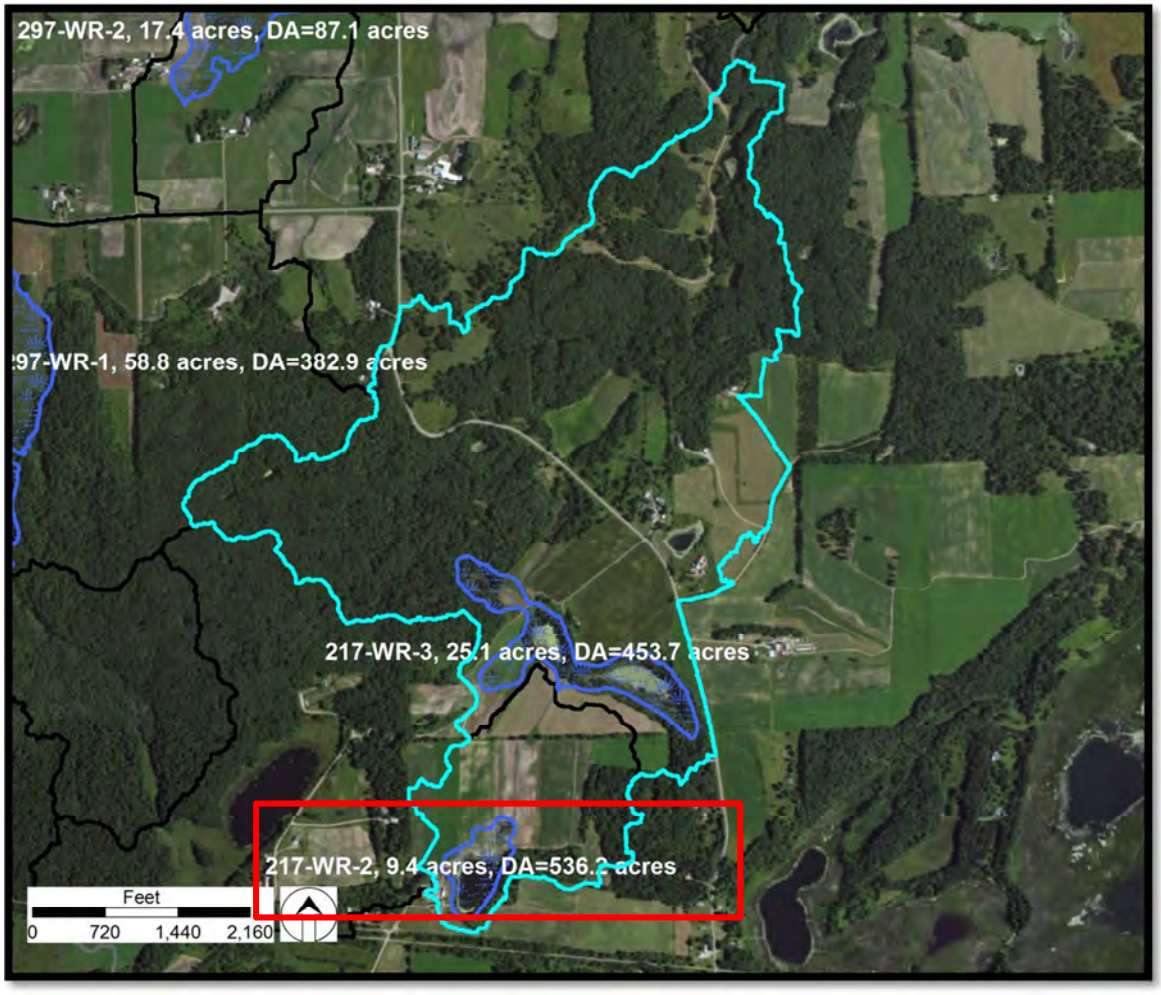


Potential Project 217-WR-2

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	7.3 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1,788 lbs	Represents the annual reduction to the lake
Project Cost	$22,602	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$154	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$0.63	Annual removal rate based on 20-year lifespan of project

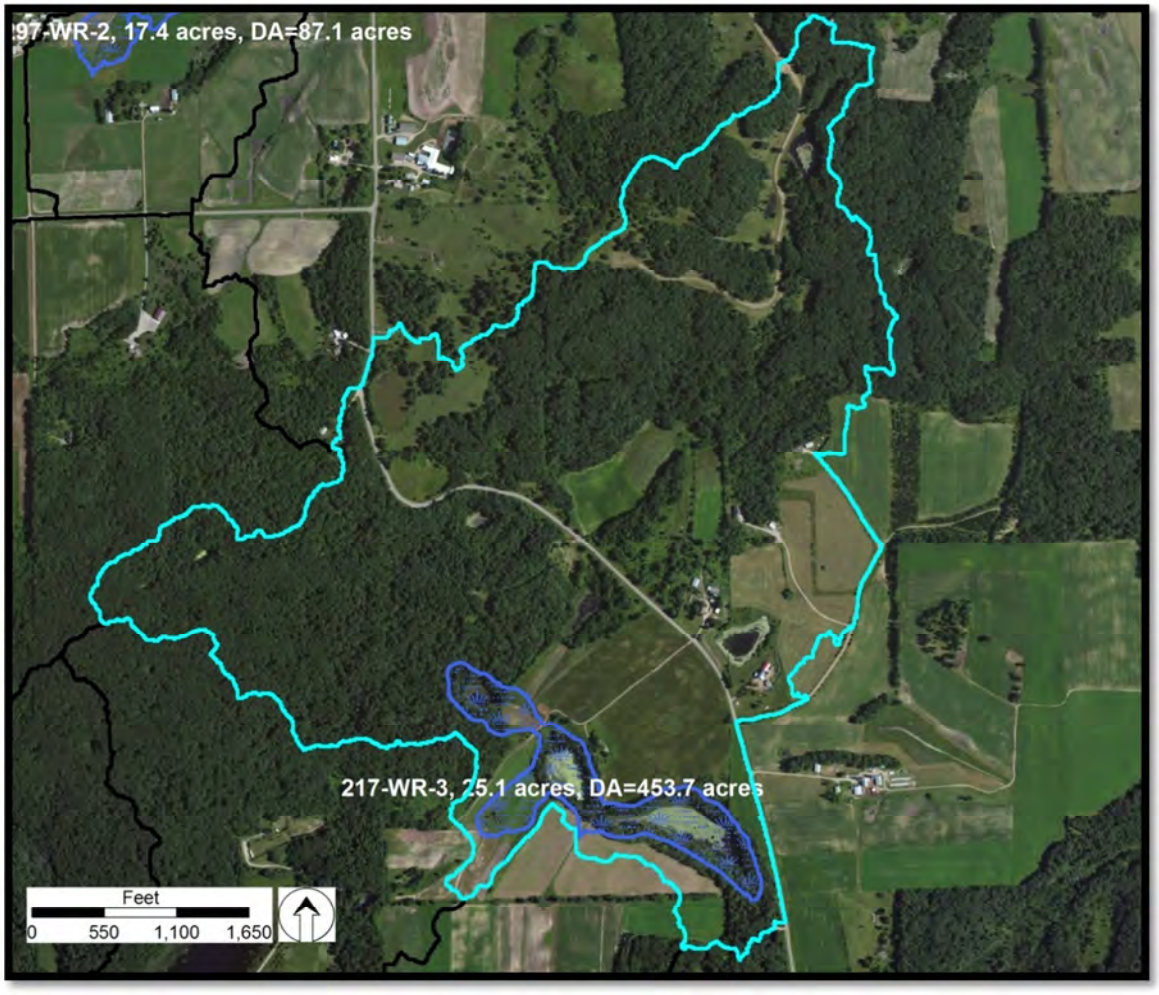


Potential Project 217-WR-3

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	6.5 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1519 lbs	Represents the annual reduction to the lake
Project Cost	$73,874	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$567	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$2.43	Annual removal rate based on 20-year lifespan of project

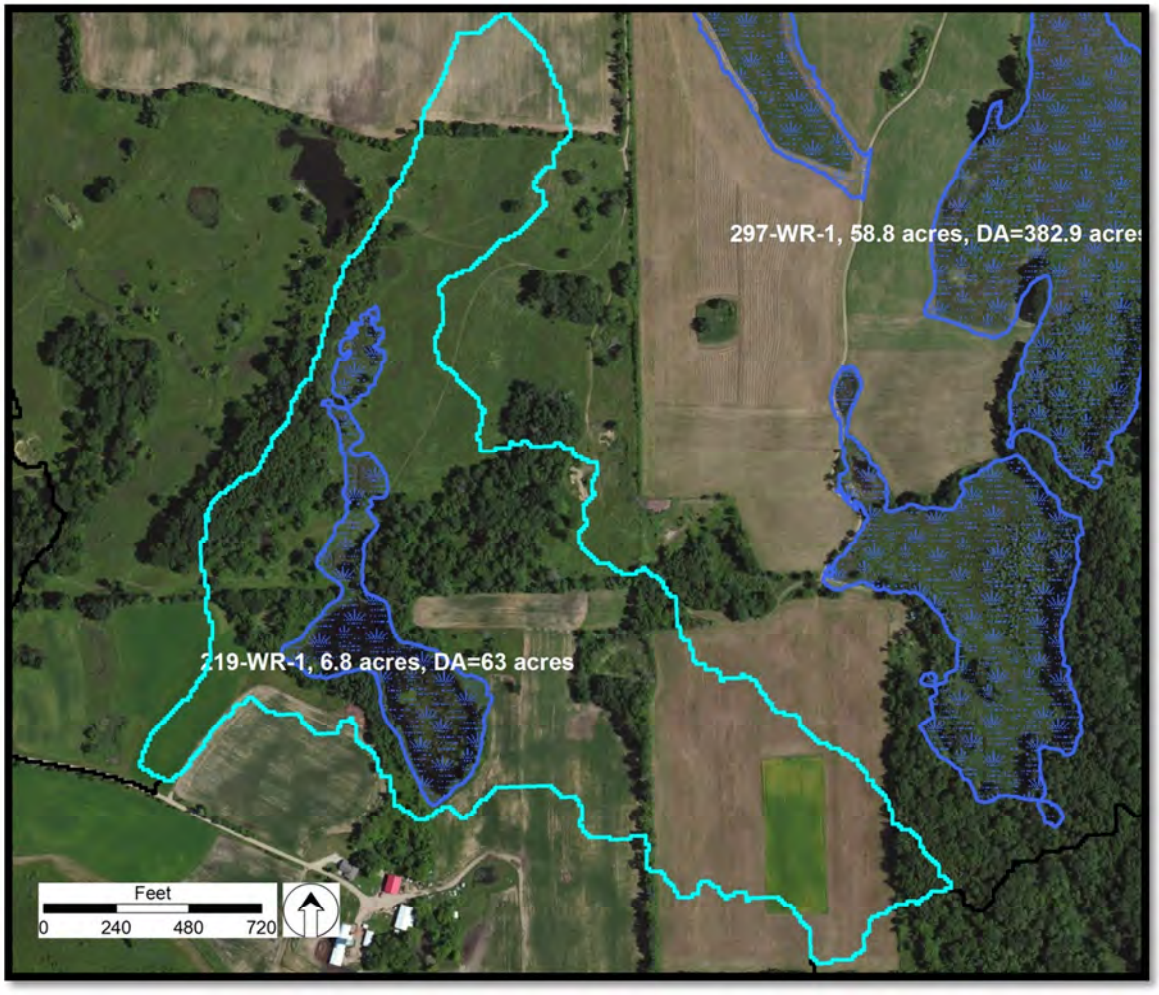


Potential Project 219-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	2.1 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	343 lbs	Represents the annual reduction to the lake
Project Cost	$11,770	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$282	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$1.71	Annual removal rate based on 20-year lifespan of project

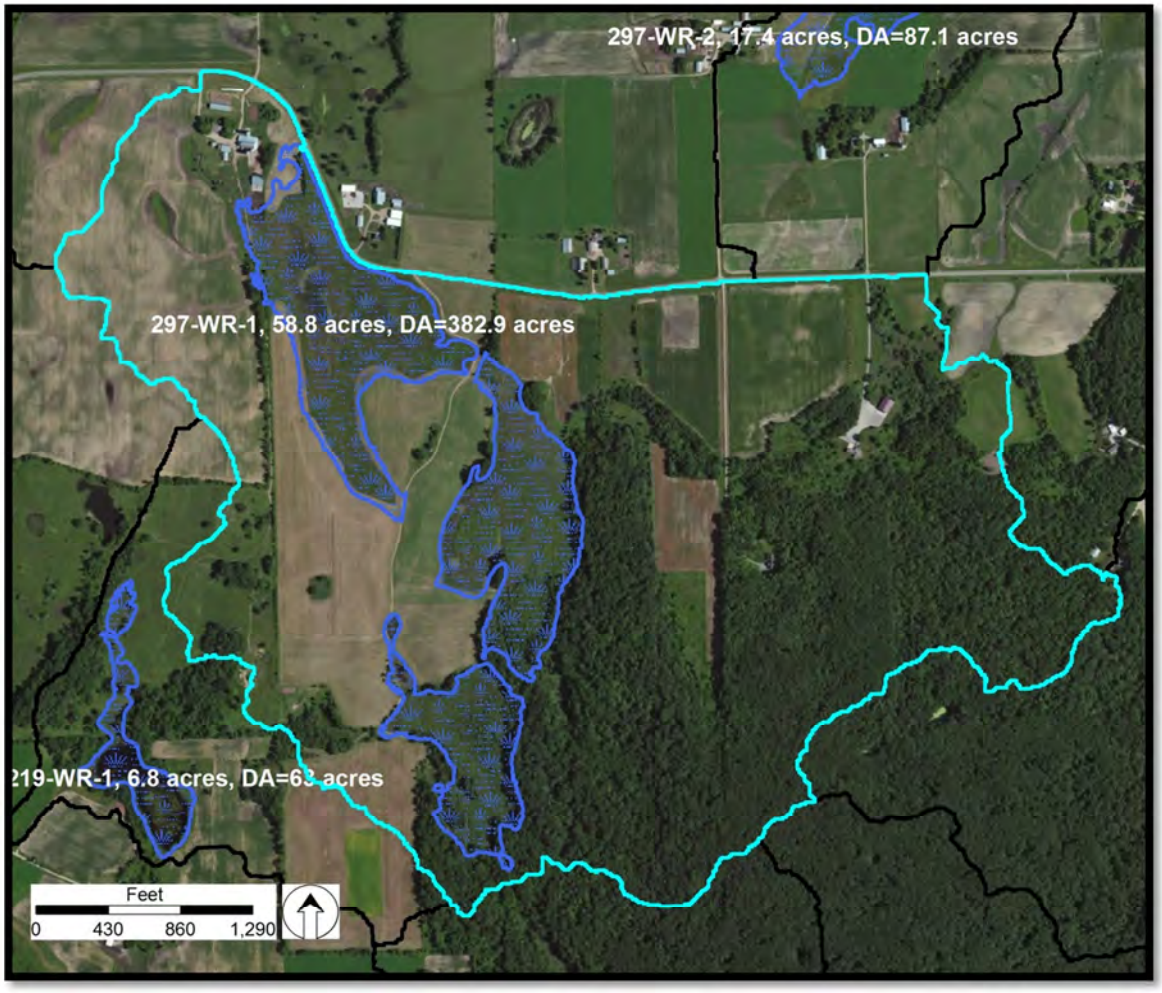


Potential Project 297-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.7 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	449 lbs	Represents the annual reduction to the lake
Project Cost	$216,106	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$6,415	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$24.04	Annual removal rate based on 20-year lifespan of project

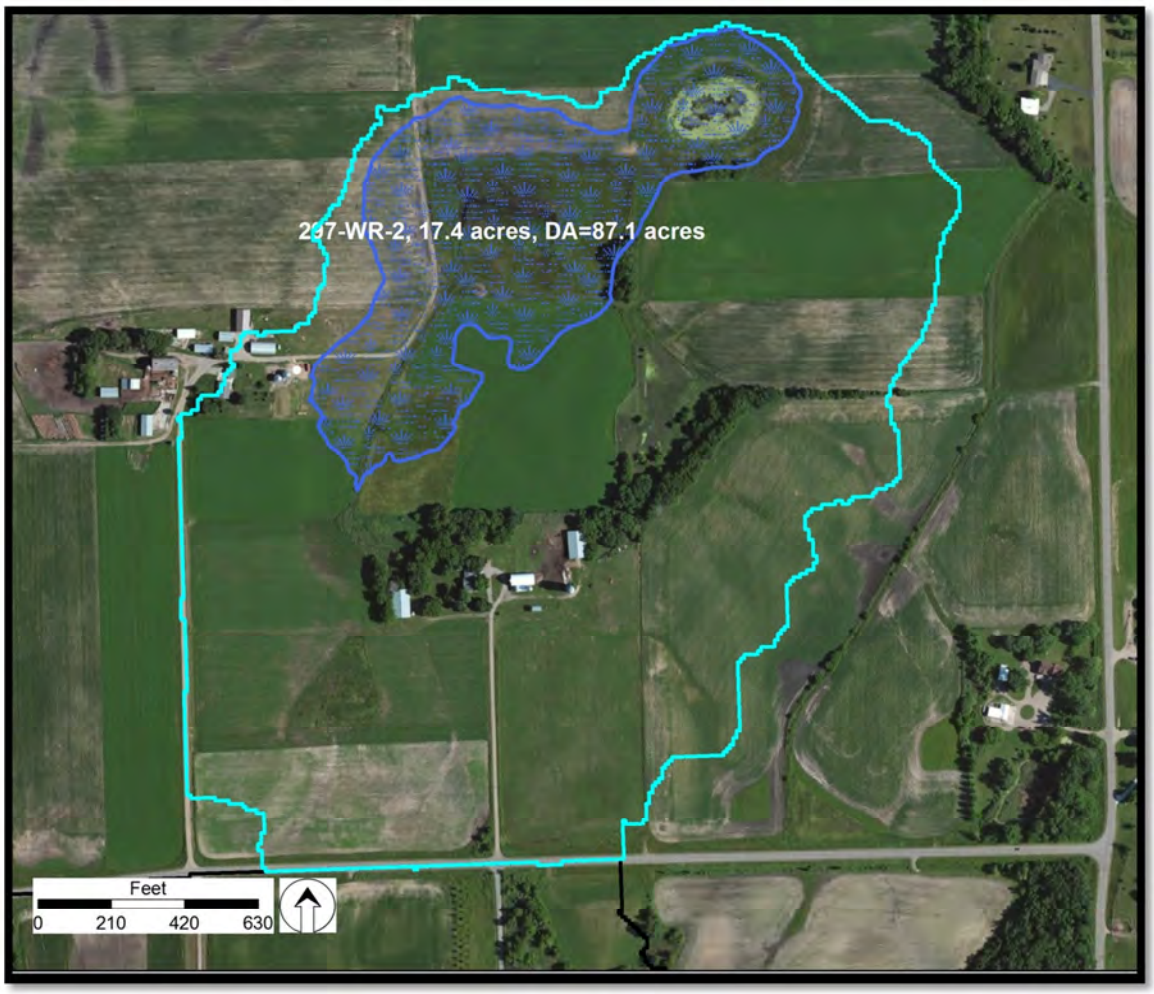


Potential Project 297-WR-2

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.4 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	103 lbs	Represents the annual reduction to the lake
Project Cost	$62,397	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$7,748	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$30.37	Annual removal rate based on 20-year lifespan of project

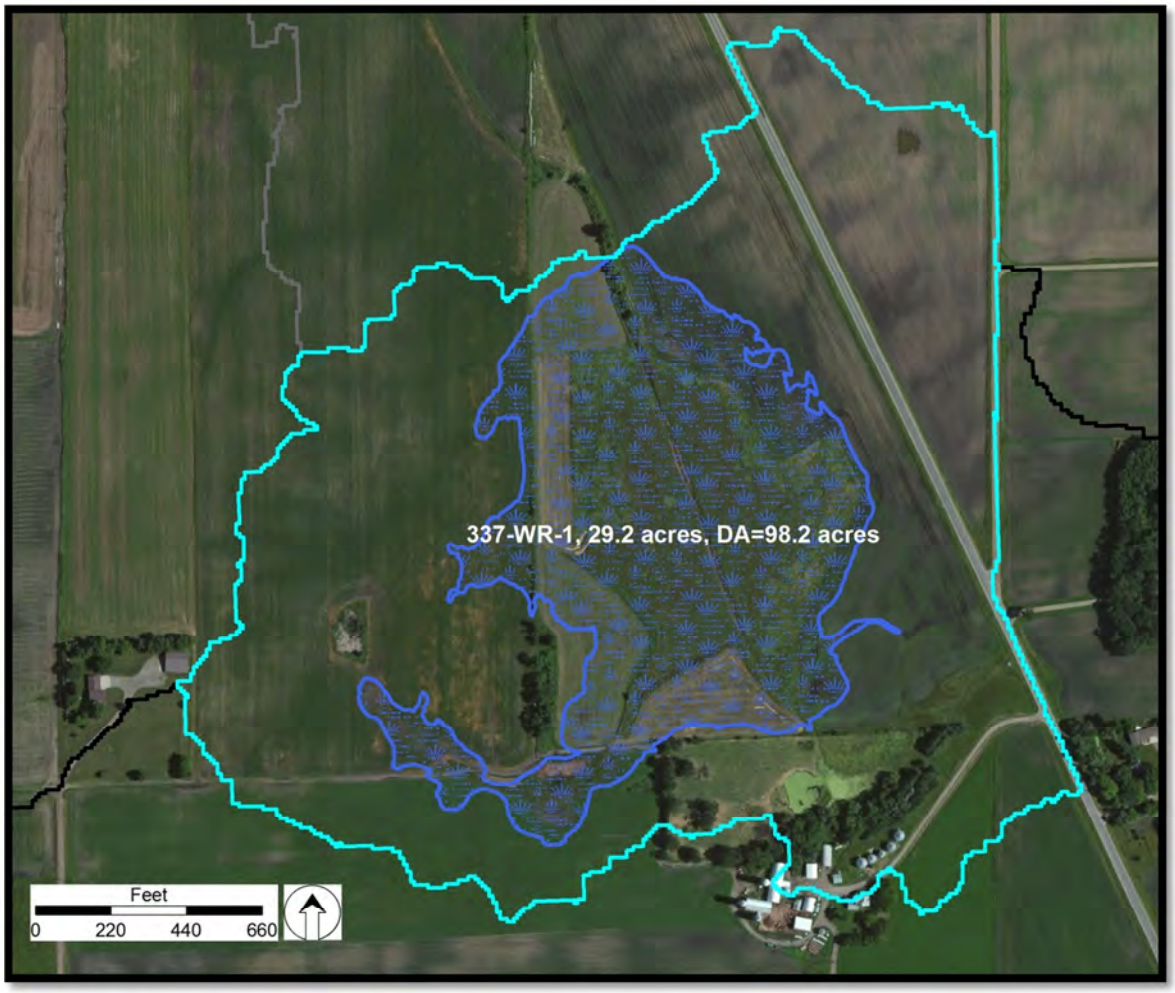


Potential Project 337-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	8.2 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1802 lbs	Represents the annual reduction to the lake
Project Cost	$110,157	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$675	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$3.06	Annual removal rate based on 20-year lifespan of project

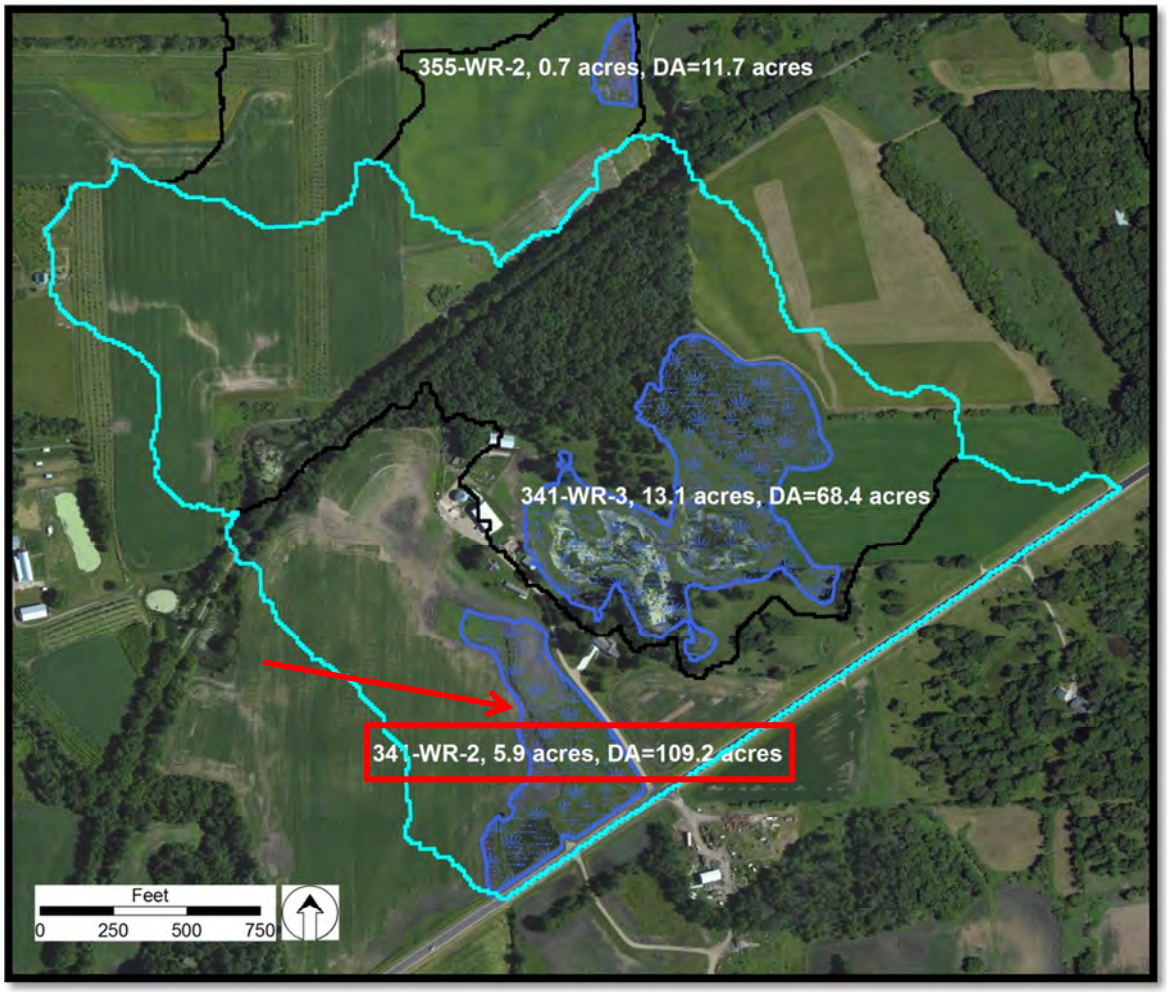


Potential Project 341-WR-2

Problem Description:3	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	6.2 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1257 lbs	Represents the annual reduction to the lake
Project Cost	$20,545	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$166	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$0.82	Annual removal rate based on 20-year lifespan of project

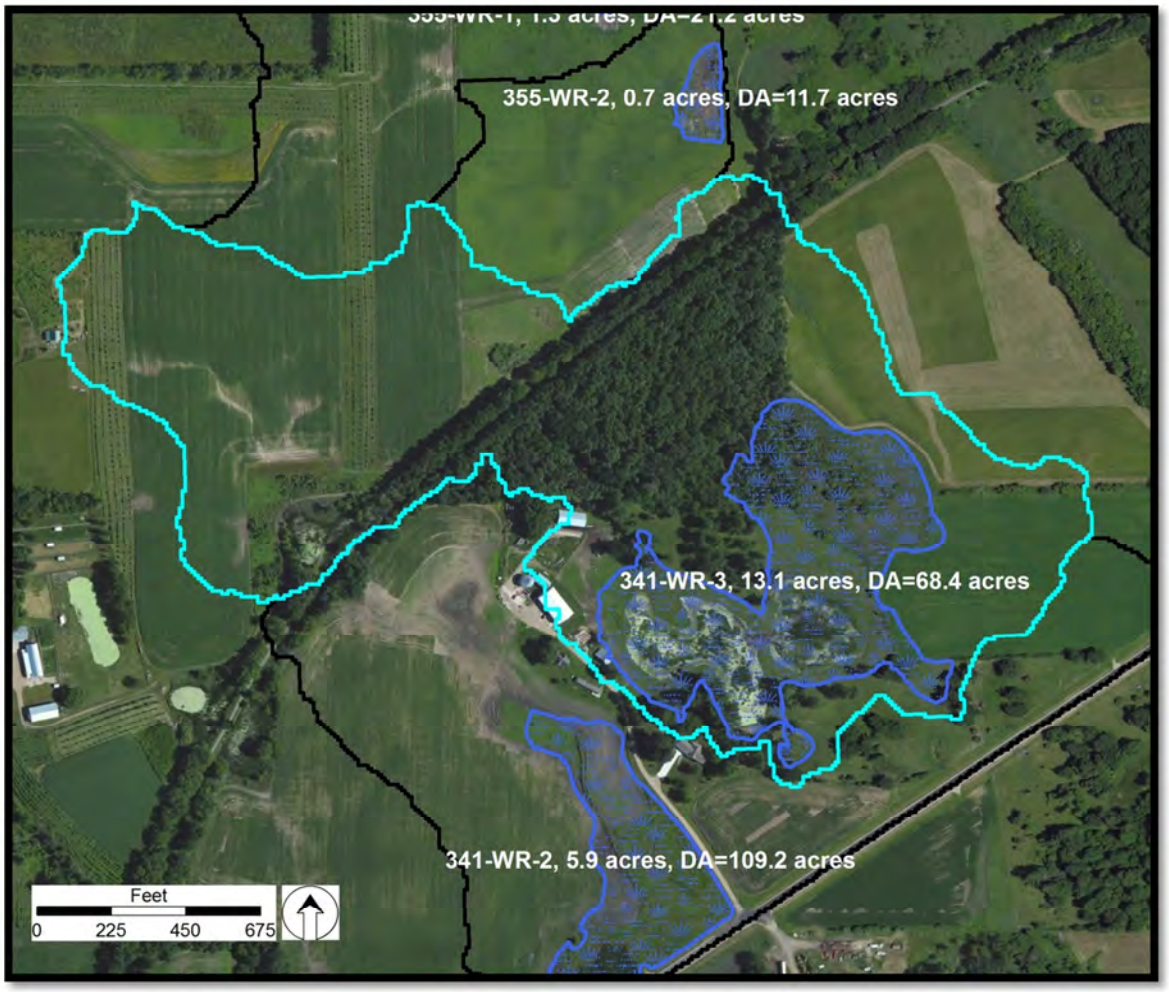


Potential Project 341-WR-3

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	4.5 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	800 lbs	Represents the annual reduction to the lake
Project Cost	$38,427	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$424	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$2.40	Annual removal rate based on 20-year lifespan of project

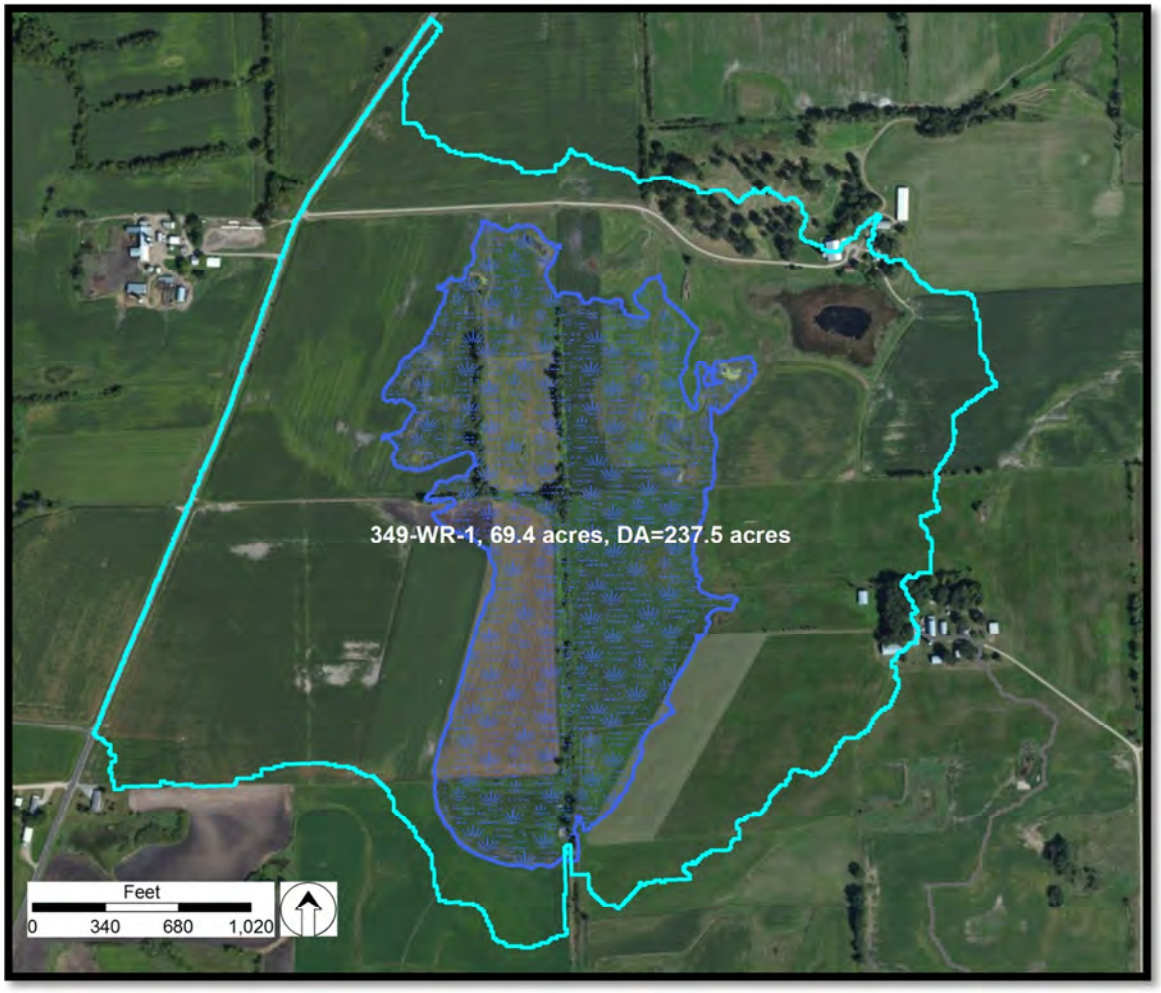


Potential Project 349-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	16.2 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	2675 lbs	Represents the annual reduction to the lake
Project Cost	$263,105	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$813	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$4.92	Annual removal rate based on 20-year lifespan of project

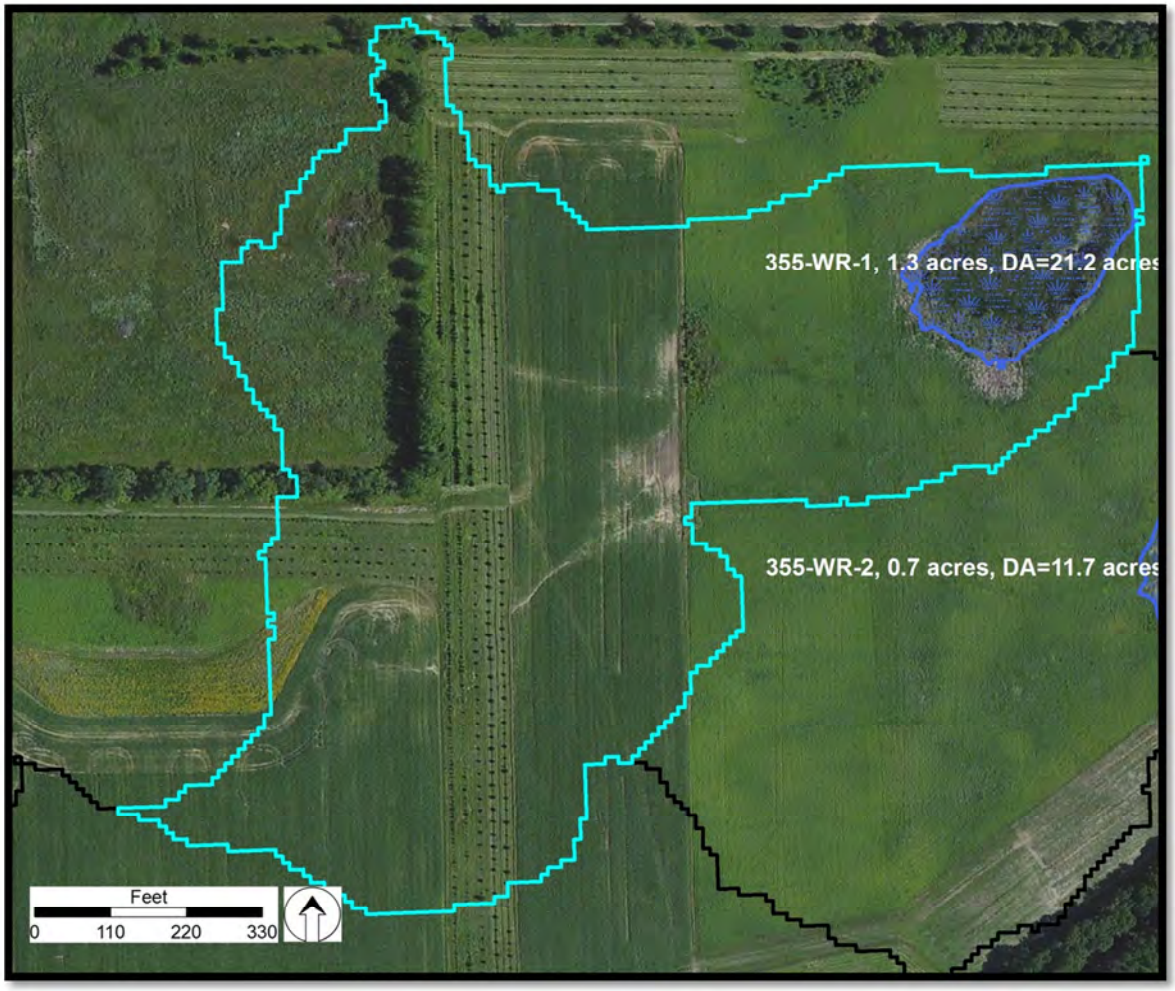


Potential Project 355-WR-1

Problem Description:	Highly Degraded Wetland Present, High CTI
Potential Solution:	Wetland Expansion and/or Grassed Waterway (See GW-355-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.2 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	199 lbs	Represents the annual reduction to the lake
Project Cost	$4,946	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$203	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$1.24	Annual removal rate based on 20-year lifespan of project

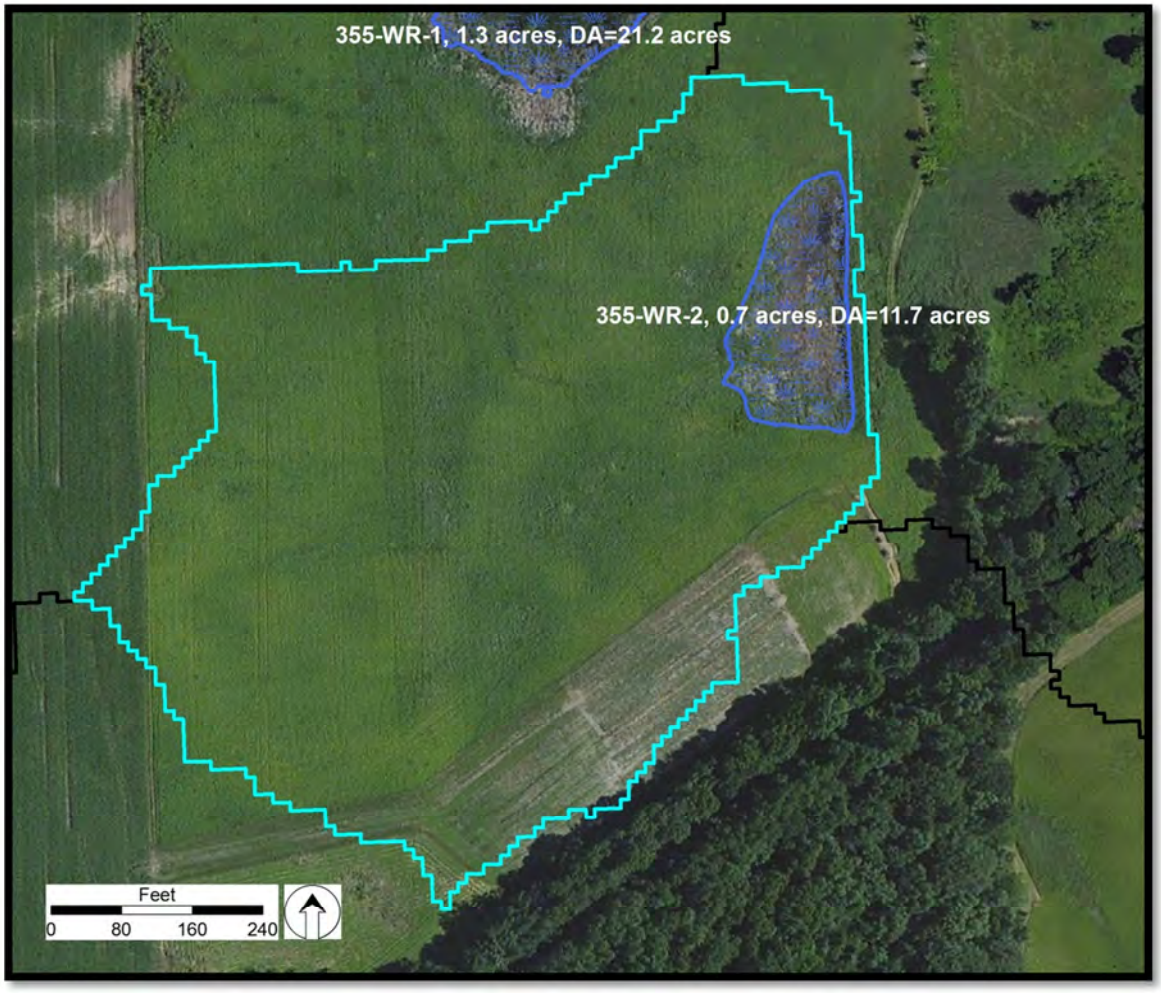


Potential Project 355-WR-2

Problem Description:	Highly Degraded Wetland Present, High CTI
Potential Solution:	Wetland Expansion and/or Grassed Waterway (See GW-355-4)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	0.7 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	110 lbs	Represents the annual reduction to the lake
Project Cost	$2,663	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$198	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$1.21	Annual removal rate based on 20-year lifespan of project



Potential Project 357-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

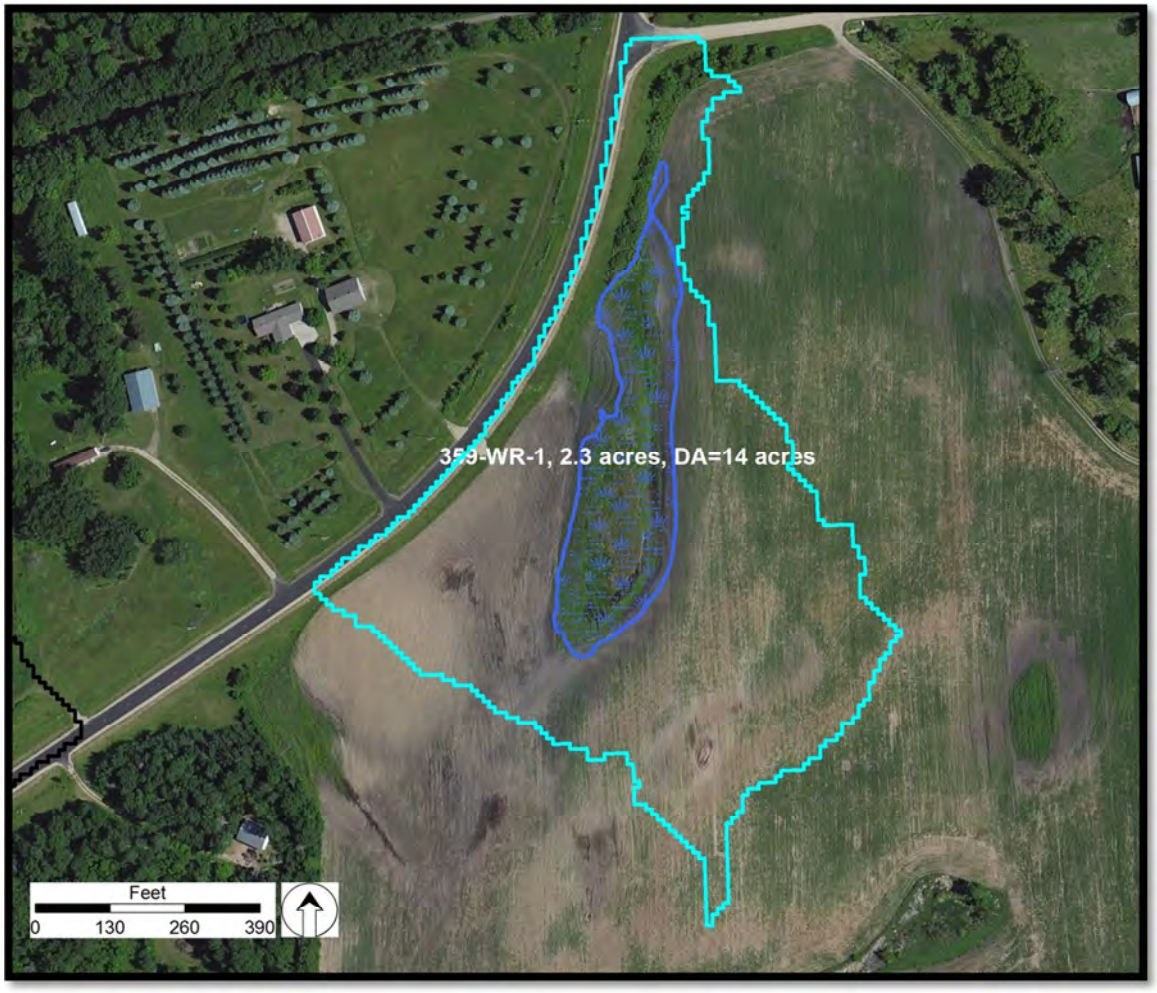
Total Phosphorus (TP) Reduction to Two Rivers Lake	16.6 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	2612 lbs	Represents the annual reduction to the lake
Project Cost	$165,526	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$498	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$3.17	Annual removal rate based on 20-year lifespan of project

Potential Project 359-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion and/or Land Management Change (See 380-LMC-1)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.2 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	230 lbs	Represents the annual reduction to the lake
Project Cost	$7,811	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$324	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$1.70	Annual removal rate based on 20-year lifespan of project

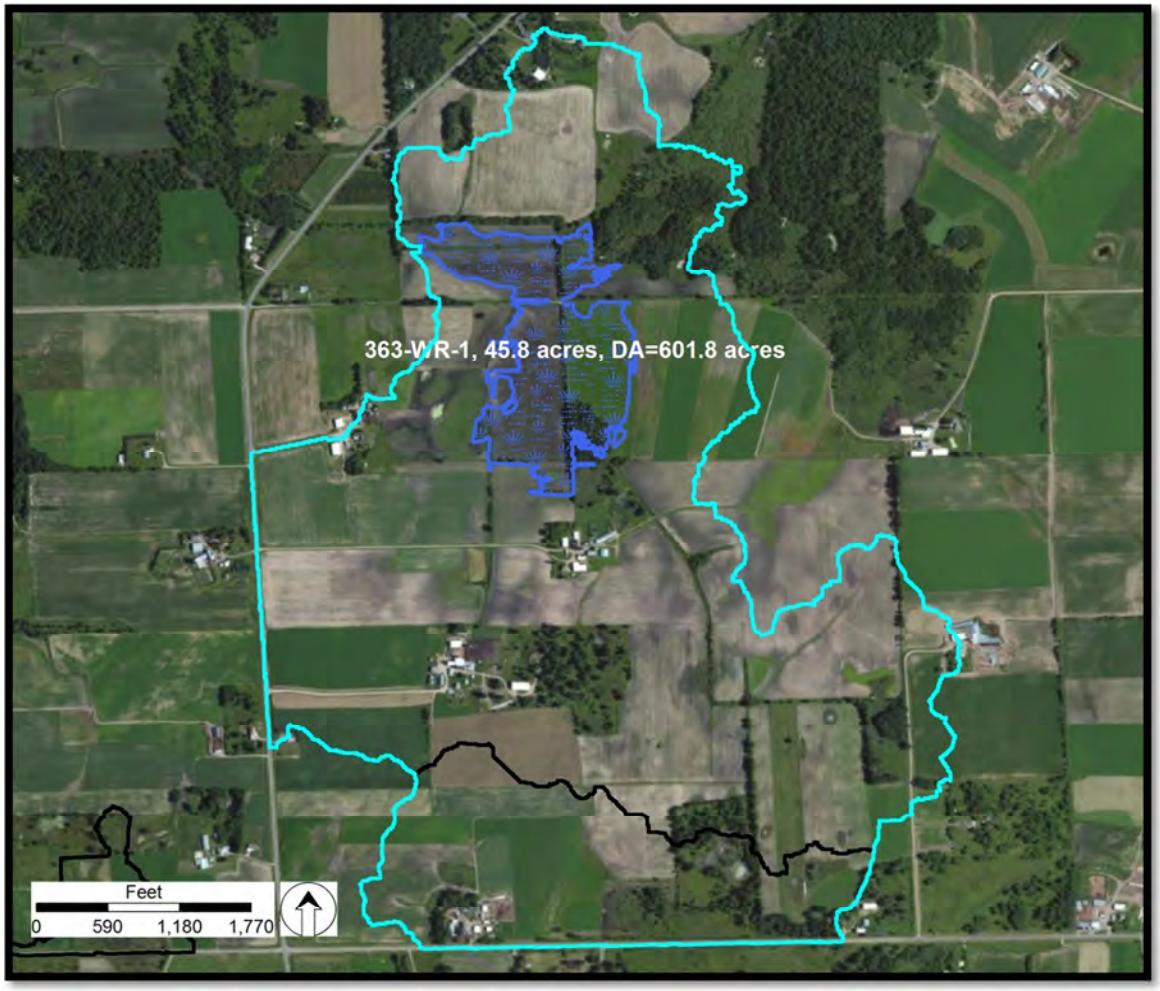


Potential Project 363-WR-1

Problem Description:	High CTI
Potential Solution:	Wetland Expansion

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	39.0 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	4411 lbs	Represents the annual reduction to the lake
Project Cost	$173,314	Based on Stearns County Soil and Water Conservation District Construction Cost Estimates
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$222	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal – TSS	$1.96	Annual removal rate based on 20-year lifespan of project



APPENDIX E

LAKESHORE PROJECT PROFILES

Table E-1. Cost-Benefit Analysis for Implementing Shoreline Buffers Around Two Rivers Lake

BMP I.D.	Unbuffered Shoreline (ft)	Number of Projects	Implementation Cost for Residential Shoreline Buffers ($/lot)[a]	2015 EQIP Payment Rate for Shoreline Stabilization ($/LF)[b]	Total Construction Cost ($)	Average TP Loading Rate to Lake (lb/ac/yr)[c]	Average TSS Loading Rate to Lake (lb/ac/yr)[c]	TP Loading From Unbuffered Shoreline Area (lbs/yr)	TSS Loading From Unbuffered Shoreline Area (lbs/yr)	BMP Efficiency for TP Removal[d]	BMP Efficiency for TSS Removal[d]	Annual TP Reduction to Lake With BMP (lbs/yr)	Annual TSS Reduction to Lake With BMP (lbs/yr)	TP Reduction to Lake With BMP Over 20 Years (lbs)[e]	TSS Reduction to Lake With BMP Over 20 Years (lbs)[e]	TP Removal Cost ($/lb)	TSS Removal Cost ($/lb)
380-BUF-3	998	18	12,017.12	–	216,308	0.292	131.49	4.5	2,025	0.65	0.86	2.94	1,748	58.8	34968	3,680	6.19
380-BUF-4	2,062	18	12,017.12	–	216,308	0.125	47.90	13.1	5,023	0.65	0.86	8.54	4,343	170.9	86850	1,266	2.49
380-BUF-5	1,155	16	12,017.12	–	192,274	0.466	209.44	2.4	1,089	0.65	0.86	1.57	937	31.5	18732	6,106	10.26
380-BUF-6	1,484	13	12,017.12	–	156,223	0.326	146.51	6.9	3,106	0.65	0.86	4.49	2,671	89.8	53424	1,739	2.92
380-BUF-7	1,926	19	12,017.12	–	228,325	0.194	87.34	2.0	881	0.65	0.86	1.28	762	25.6	15235	8,915	14.99
380-BUF-9	708	3	–	16.55	11,717	0.125	7.90	2.8	177	0.65	0.86	1.82	152	36.4	3048	322	3.84
380-BUF-10	948	2	–	16.55	15,689	0.125	11.27	5.6	509	0.65	0.86	3.66	438	73.2	8752	214	1.79

(a) Installation costs are based on average buffer construction costs (per lot) provided by Stearns County Soil and Water Conservation District; this method was used for residential lots.

(b) Installation costs are based on 2015 EQIP payment rates for bioengineered streambank and shoreline stabilization; this method was used for agricultural parcels.

(c) Loading rates are specific to each subwatershed and lakeshore zone and were calculated using the Two Rivers HSPF model.

(d) Removal efficiency is the mean value from Minnesota's Ag BMP Handbook for filter strips and field borders, page 126.

(e) Assumes producer would continue to use soil health techniques for 20 years, even though payments end after 5 years.

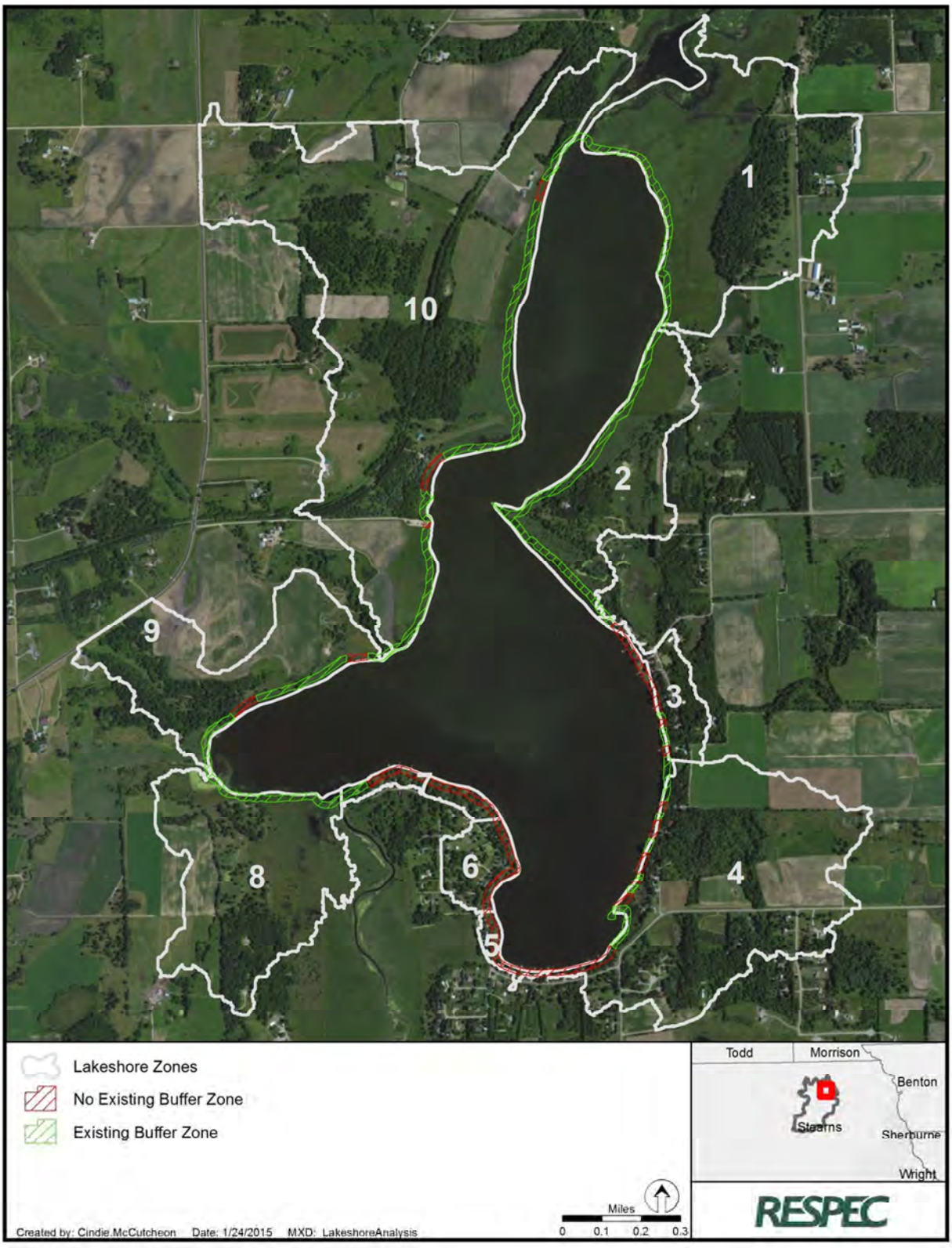


Figure E-1. Two Rivers Lakeshore Zones.

Potential Project 380-BUF-3

Problem Description:	Unbuffered areas along lake (red) in Zone 3
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

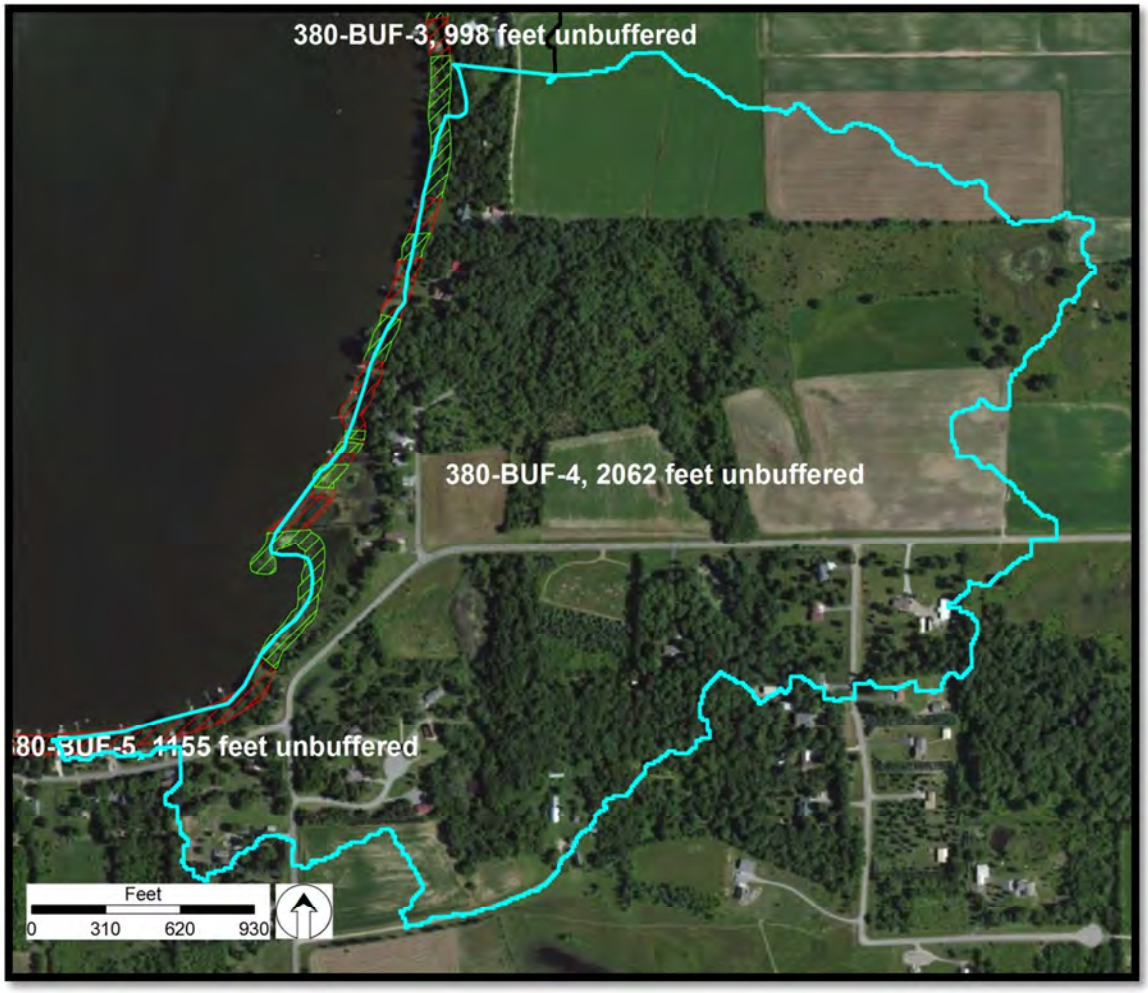
Total Phosphorus (TP) Reduction to Two Rivers Lake	2.94 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	1,748 lbs	Represents the annual reduction to the lake
Number of Unbuffered Lots	18	Number of unbuffered lots on lakeshore in subwatershed
Project Cost	$216,308	Based on average project costs (from Stearns County Soil and Water Conservation District)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$3,680	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$6.19	Annual removal rate based on 20-year lifespan of project

Potential Project 380-BUF-4

Problem Description:	Unbuffered areas along lake (red) in Zone 4
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	8.54 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	4,343 lbs	Represents the annual reduction to the lake
Number of Unbuffered Lots	18	Number of unbuffered lots on lakeshore in subwatershed
Project Installation Cost	$216,308	Based on average project costs (from Stearns County Soil and Water Conservation District)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$1,266	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$2.49	Annual removal rate based on 20-year lifespan of project



Potential Project 380-BUF-5

Problem Description:	Unbuffered areas along lake (red) in Zone 5
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.57 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	937 lbs	Represents the annual reduction to the lake
Number of Unbuffered Lots	16	Number of unbuffered lots on lakeshore in subwatershed
Project Installation Cost	$192,274	Based on average project costs (from Stearns County Soil and Water Conservation District)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$6,106	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$10.26	Annual removal rate based on 20-year lifespan of project

Potential Project 380-BUF-6

Problem Description:	Unbuffered areas along lake (red) in Zone 6
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	4.49 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	2,671 lbs	Represents the annual reduction to the lake
Number of Unbuffered Lots	13	Number of unbuffered lots on lakeshore in subwatershed
Project Installation Cost	$156,223	Based on average project costs (from Stearns County Soil and Water Conservation District)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$1,739	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$2.92	Annual removal rate based on 20-year lifespan of project

Potential Project 380-BUF-7

Problem Description:	Unbuffered areas along lake (red) in Zone 7
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

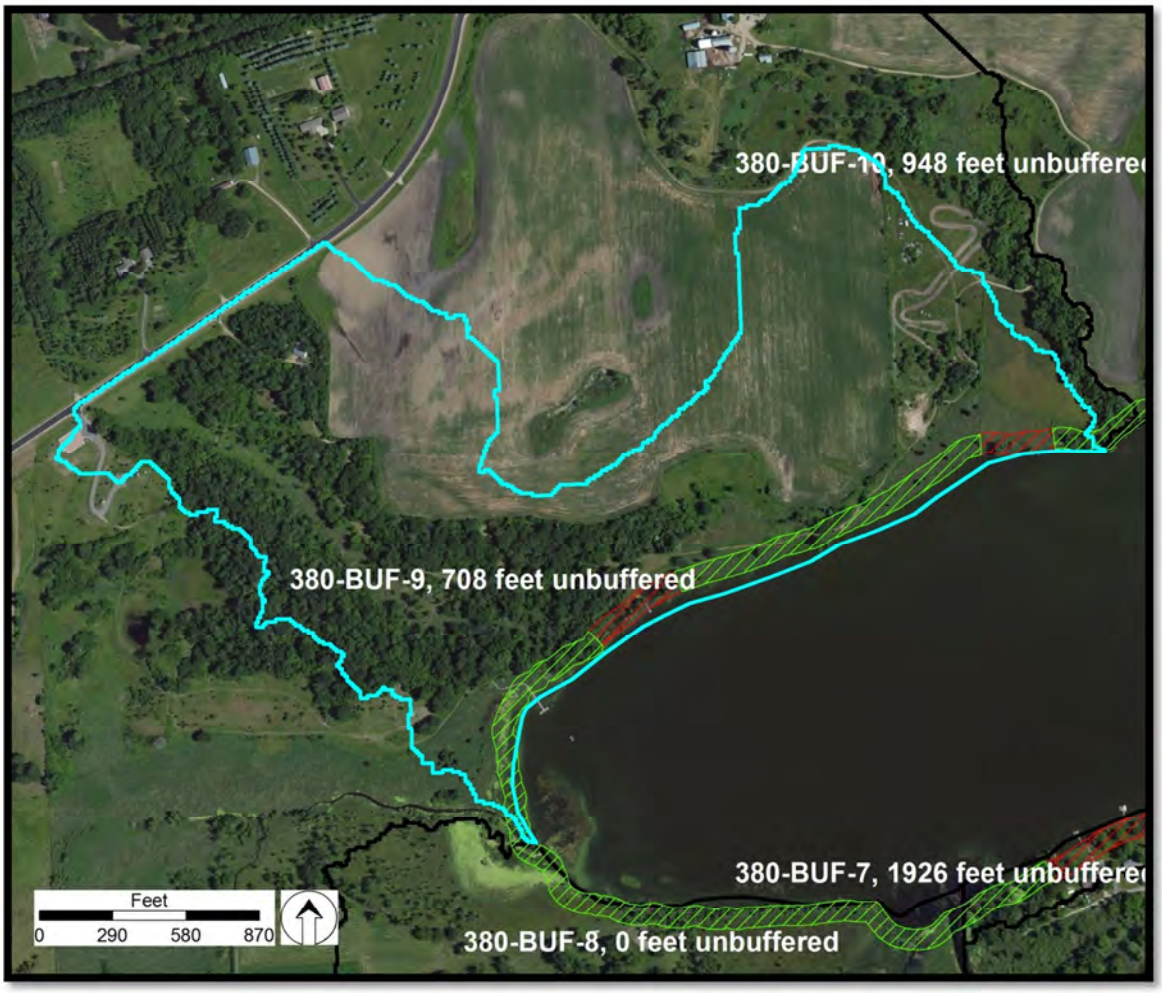
Total Phosphorus (TP) Reduction to Two Rivers Lake	1.28 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	762 lbs	Represents the annual reduction to the lake
Number of Unbuffered Lots	19	Number of unbuffered lots on lakeshore in subwatershed
Project Installation Cost	$228,325	Based on average project costs (from Stearns County Soil and Water Conservation District)
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$8,915	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$14.99	Annual removal rate based on 20-year lifespan of project

Potential Project 380-BUF-9

Problem Description:	Unbuffered areas along lake (red) in Zone 9
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	1.82 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	152 lbs	Represents the annual reduction to the lake
Length of Missing Buffers	708 ft	
Project Installation Cost	$11,717	Assumes Environmental Quality Incentives Program rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$322	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$3.84	Annual removal rate based on 20-year lifespan of project

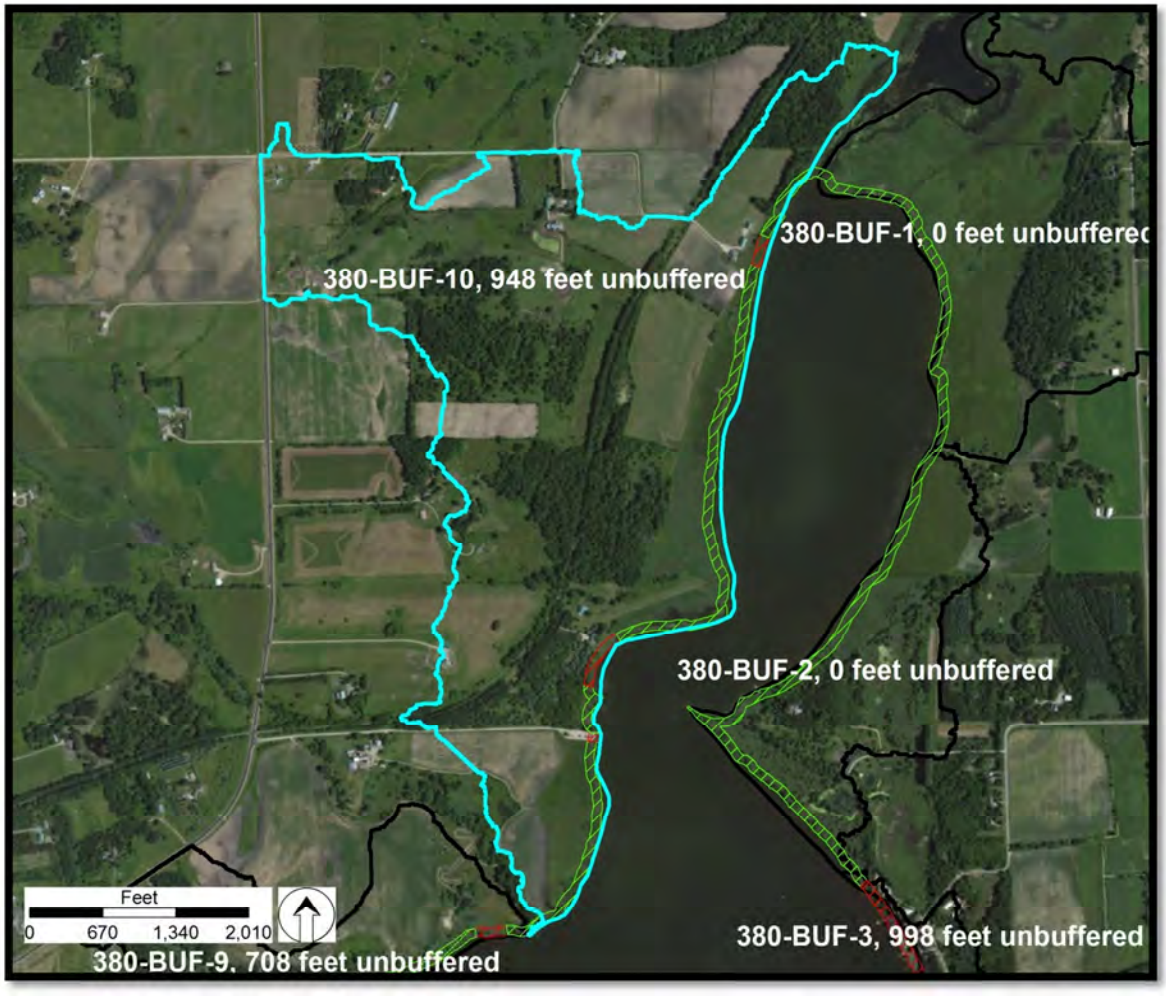


Potential Project 380-BUF-10

Problem Description:	Unbuffered areas along lake (red) in Zone 10
Potential Solution:	Add a 25-foot buffer in areas lacking a buffer (shown in red)

Notes

Total Phosphorus (TP) Reduction to Two Rivers Lake	3.66 lbs	Represents the annual reduction to the lake
Total Suspended Solids (TSS) Reduction to Two Rivers Lake	438 lbs	Represents the annual reduction to the lake
Length of Missing Buffers	948 ft	
Project Installation Cost	$15,689	Assumes Environmental Quality Incentives Program rate represents 50% of project cost
Maintenance Costs	$0	Maintenance costs were not included in the calculation
Cost per Pound Removal – TP	$214	Annual removal rate based on 20-year lifespan of project
Cost per Pound Removal –TSS	$1.79	Annual removal rate based on 20-year lifespan of project



APPENDIX F

URBAN LOADING METHODS AND RESULTS

APPENDIX F
URBAN METHODS AND RESULTS

To analyze the city of Albany's existing water quality infrastructure and plan for future improvements, the study area was delineated into 54 subwatersheds. The delineations were performed using the Digital Elevation Model (DEM), 2-foot contour lines, and storm sewer system information furnished by the city of Albany, one for each existing water quality best management practice (BMP) and/or regional outfall.

Model input parameters were based on the following:

- **Curve numbers:** An area-weighted curve number was developed for each watershed by using aerial photographs to determine land use and the U.S. Department of Agriculture (USDA) soil maps for soil type. Soils in the study area are predominantly categorized as Hydrologic Soils Group B, with successively smaller areas of Hydrologic Soil Groups B/D, A/D, and A. All of the soil was assumed to be Hydrologic Soil Group B for this analysis. The resulting area-weighted curve numbers ranged from 58 (a small watershed with only meadow) to 98 (a small watershed consisting of a building, parking lot, and a wet pond).
- **Pervious and Impervious Fraction:** The impervious area within each subwatershed was determined from 2011 National Land Cover Database (NLCD). The Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds (P8) separates impervious areas into the following two categories: (1) indirectly connected impervious areas, which flow onto pervious areas, and (2) directly connected impervious areas, which flow directly to curbs or storm sewer systems. All impervious areas were assumed to be directly connected, with the exception of small areas (gravel roads) in Subwatersheds 1 and 2 that flow onto pervious areas.
- **Temperature and Precipitation:** The daily mean temperature and hourly precipitation data were provided with the P8 software; the data spans 1949 to 1989 for the Minneapolis-Saint Paul region. All model outputs are reported as average annual values for the 40-year period.
- **Pollutant Particle Sizes:** The default particle size and associated pollutant characteristics provided with P8 were used to simulate particles and pollutant loading in the urban analysis.

Twenty-five existing stormwater BMPs were identified within the study area with assistance from the city of Albany. The BMPs treat runoff from 44 percent of the area (860 acres). Most of the stormwater BMPs currently installed in Albany are wet ponds, with the exception of two dry ponds and a sedimentation structure. These BMPs are designed to remove sediment and associated pollutants through settling. Existing BMPs primarily treat runoff from recently

developed areas, while many areas within the downtown and older neighborhoods of Albany receive no treatment.

All existing BMPs were modeled as ponds because of limitations on the variety of structures currently supported within P8. Pond areas and volumes were determined from engineering plans provided by the city, when available. In cases where engineering plans were not available, estimates were made by using available data and engineering judgment.

- **Permanent and Flood Pools:** Elevations and areas were estimated by using 2-foot contours generated from the DEM.
- **Pond bottom:** Areas were calculated by assuming a permanent pool depth of 3 feet and side slopes of 4:1 within the permanent pool.
- **Outlets**: All of the current BMPs had orifice or weir outlets. When specific data were not available, weir length was determined by inspecting the DEM, contours, and aerial photographs. Outlet structure characteristics were included to drive the stage-discharge and stage-storage relationships that determine residence times.
- **Infiltration:** Assumed to be zero in all ponds.

North Lake was also included in the model as a wet pond to better understand how the treatment train is currently functioning. Bathymetry data for North Lake were not available, but an average lake depth of 4.42 feet was reported Healthy Lakes & Rivers Partnership and City of Albany [2011][1]. To provide a conservative estimate, the permanent pool depth was assumed to be 3.5 feet. The estimate of the flood pool depth was obtained by visually inspecting the DEM and contour lines surrounding the lake and information about the outlet structure controlling the permanent pool elevation.

[1] **Healthy Lakes & Rivers Partnership and City of Albany, 2011.** *Lake Management Plan for North Lake, Albany, Minnesota, Stearns County, Minnesota*, prepared by the Healthy Lakes & Rivers Partnership, Excelsior, MN, and the City of Albany, MN, July 11.

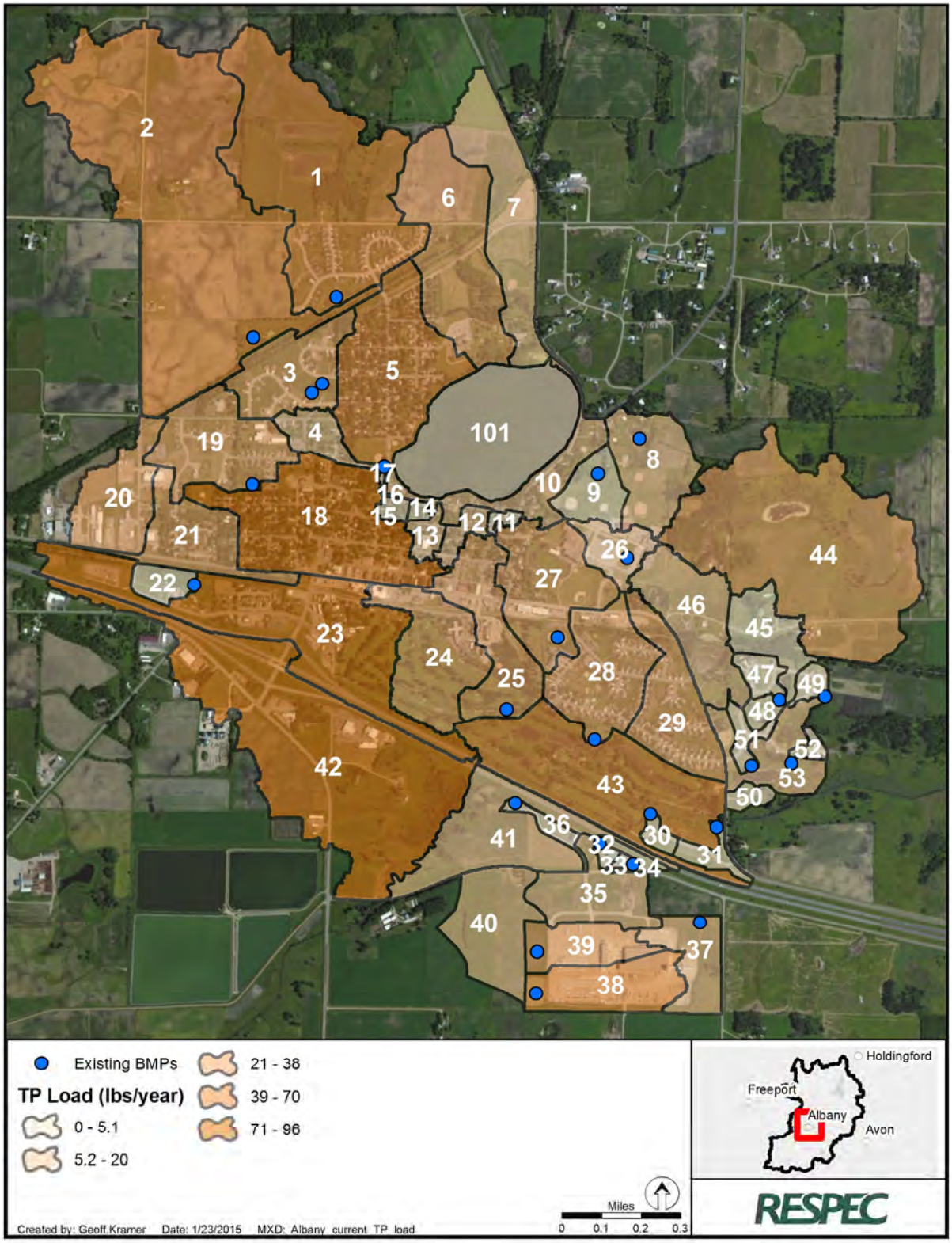


Figure F-1. Total Phosphorus Loading by Subwatershed for the Existing Conditions P8 Model.

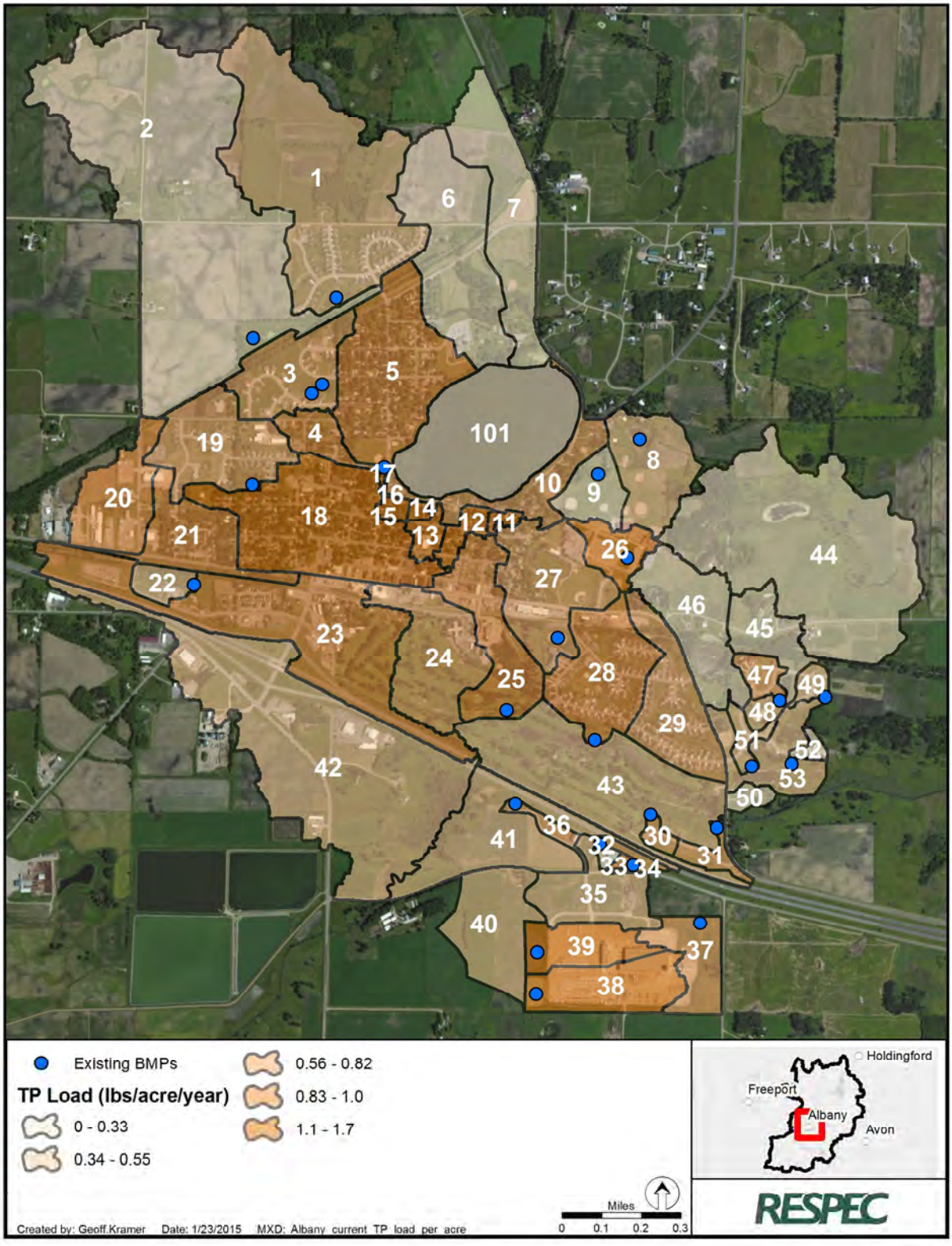


Figure F-2. Total Phosphorus Loading per Acre by Subwatershed for the Existing Conditions P8 Model.

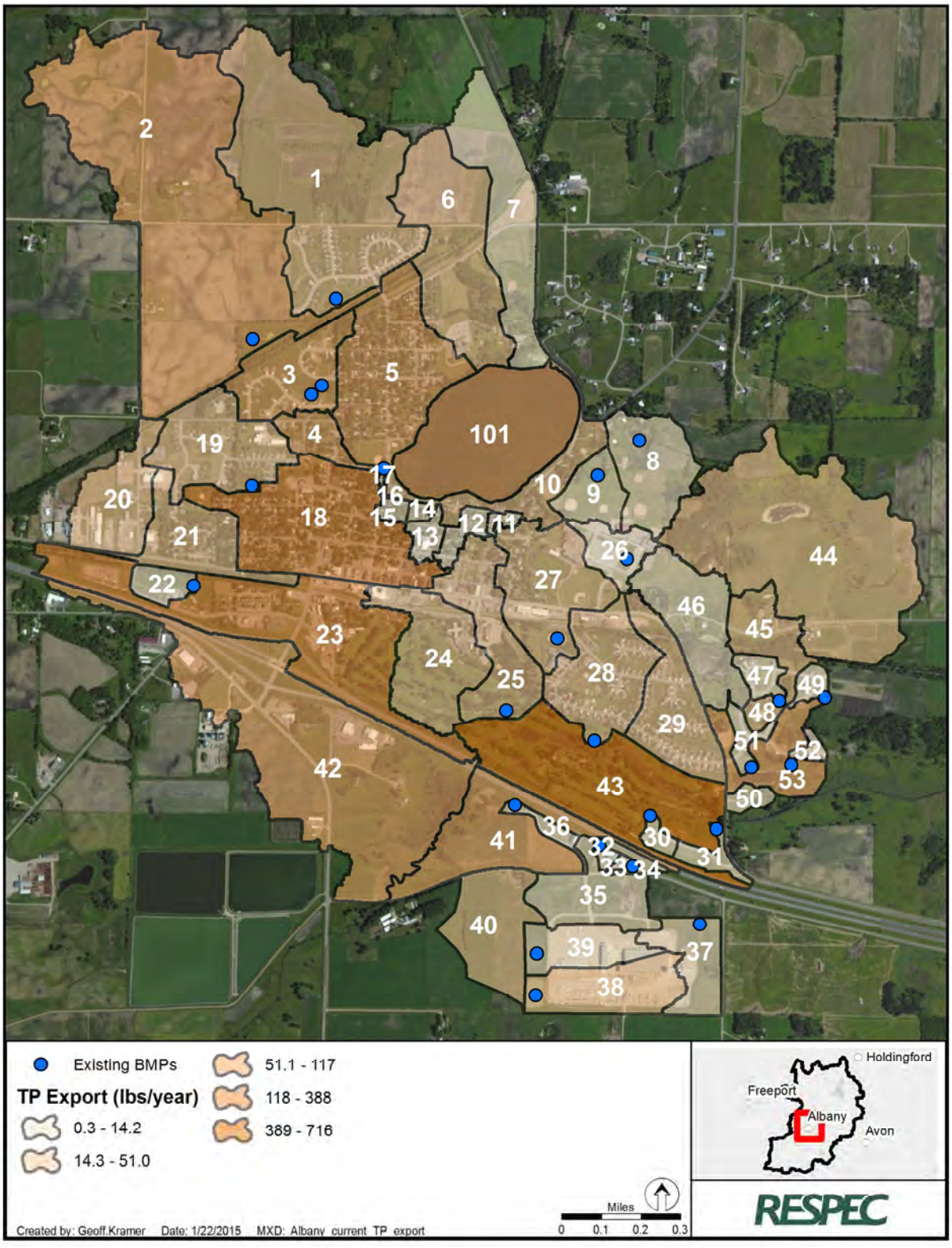


Figure F-3. Total Phosphorus Export by Subwatershed for the Existing Conditions P8 Model.

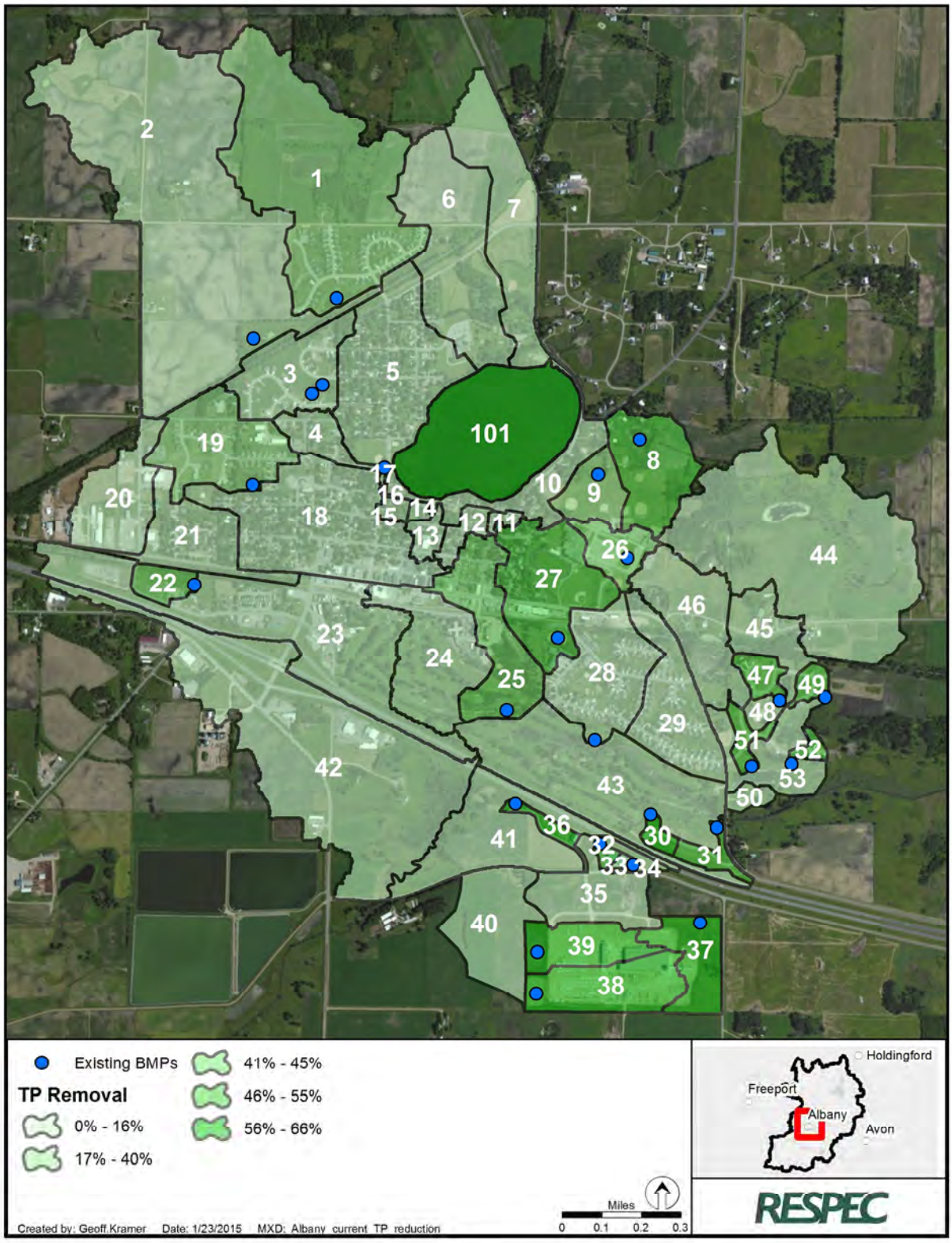


Figure F-4. Total Phosphorus Removal Within Subwatershed for the Existing Conditions P8 Model.

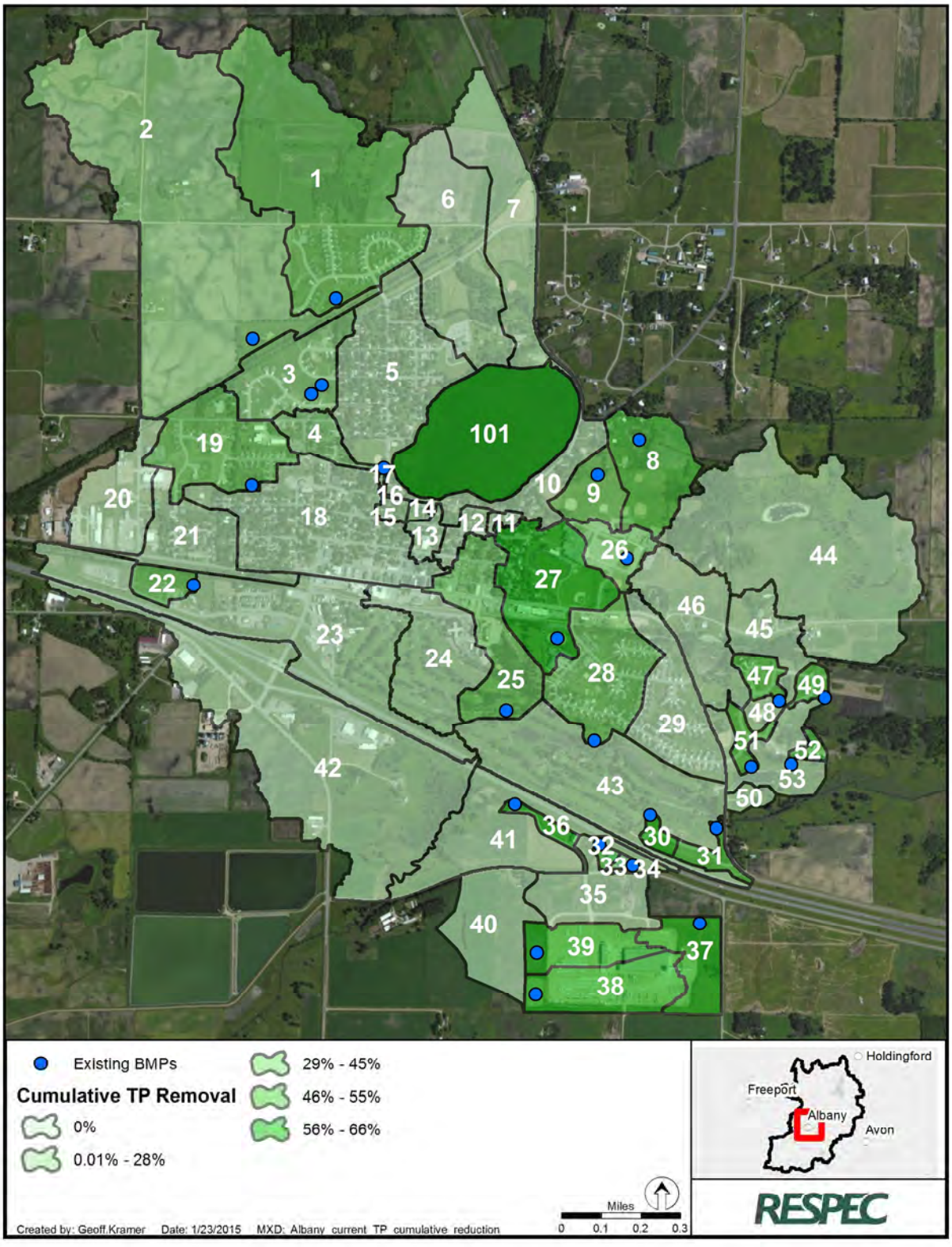


Figure F-5. Cumulative Total Phosphorus Removal by Subwatershed for the Existing Conditions P8 Model.

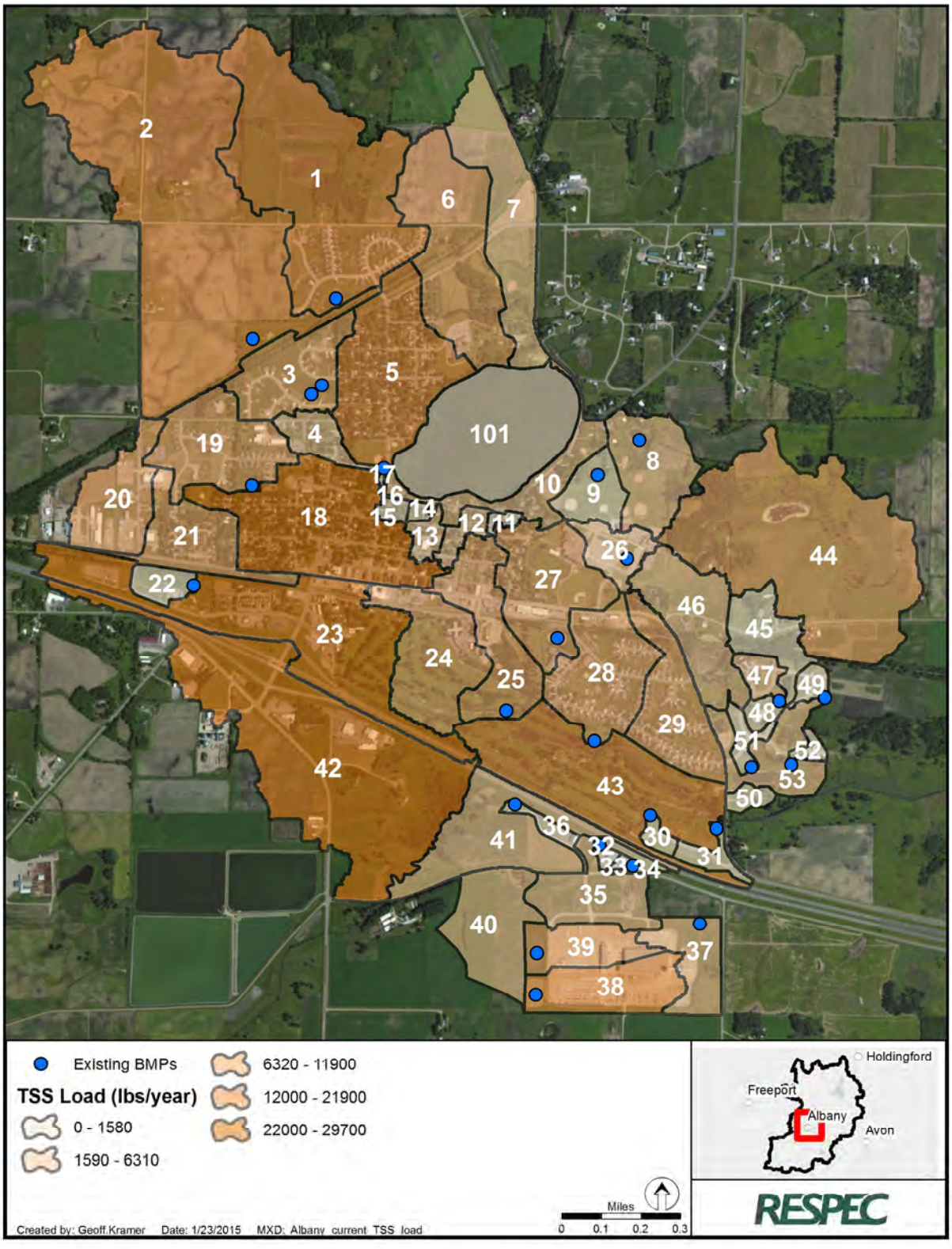


Figure F-6. Total Suspended Solids Loading by Subwatershed for the Existing Conditions P8 Model.

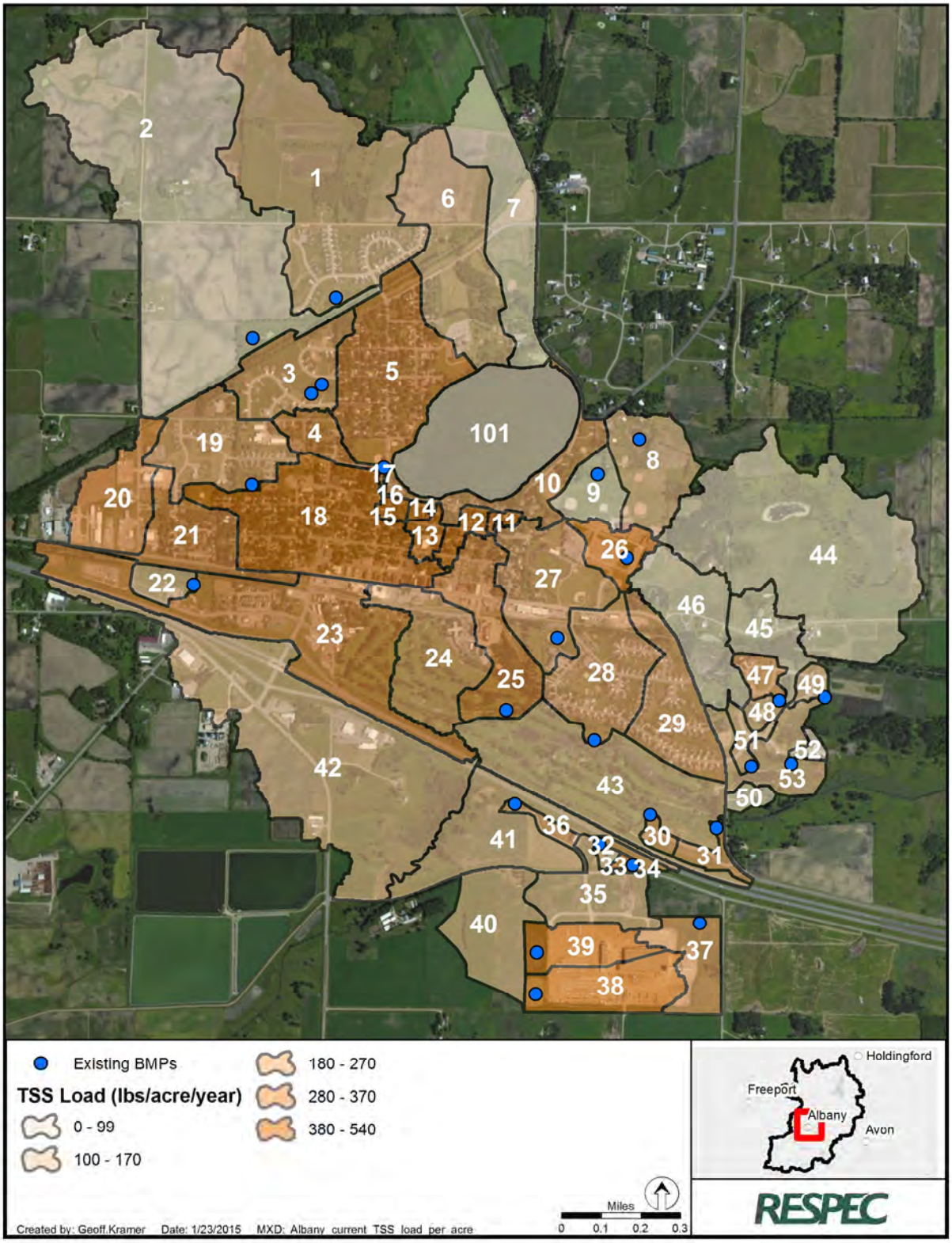


Figure F-7. Total Suspended Solids Loading per Acre by Subwatershed for the Existing Conditions P8 Model.

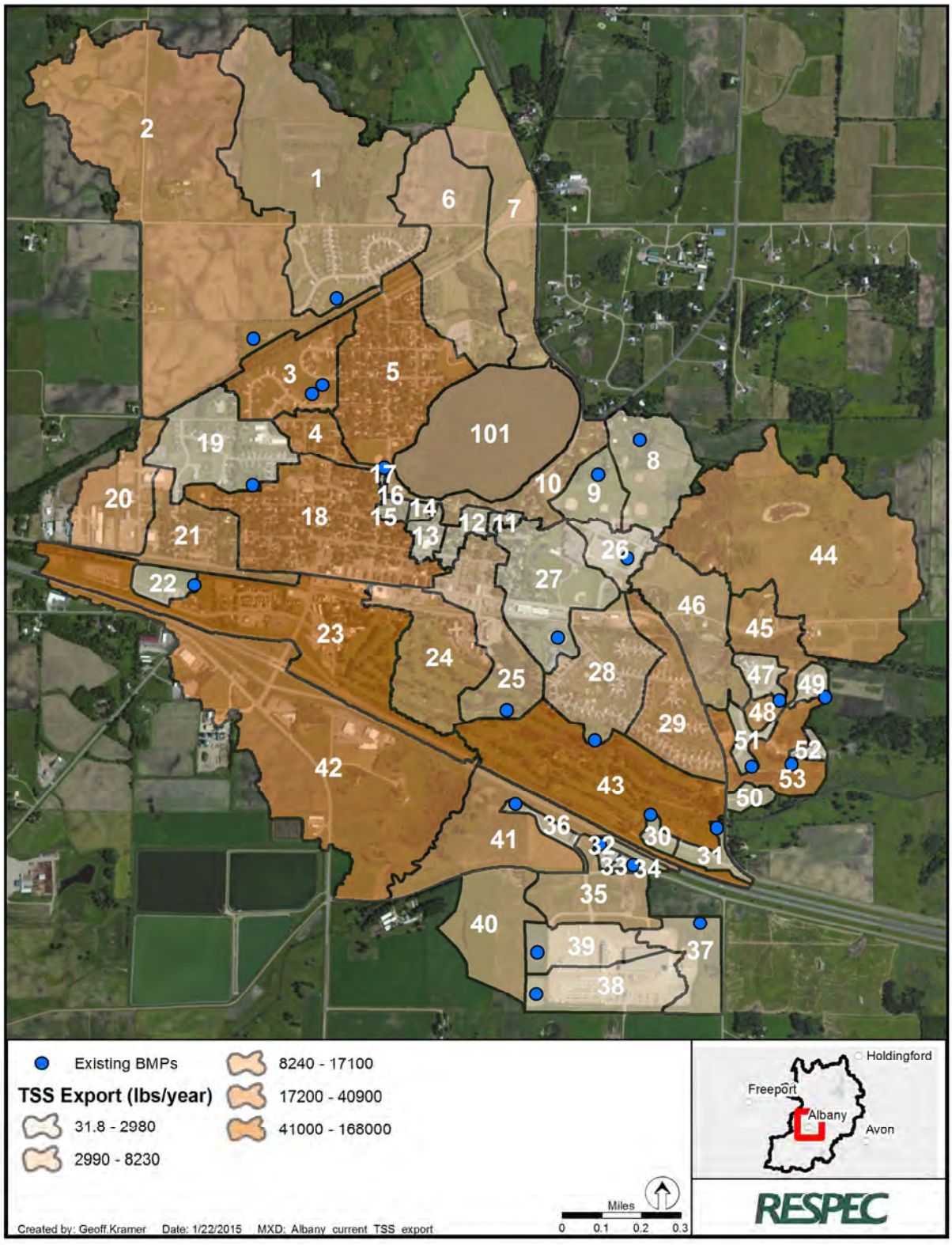


Figure F-8. Total Suspended Solids Export by Subwatershed for the Existing Conditions P8 Model.

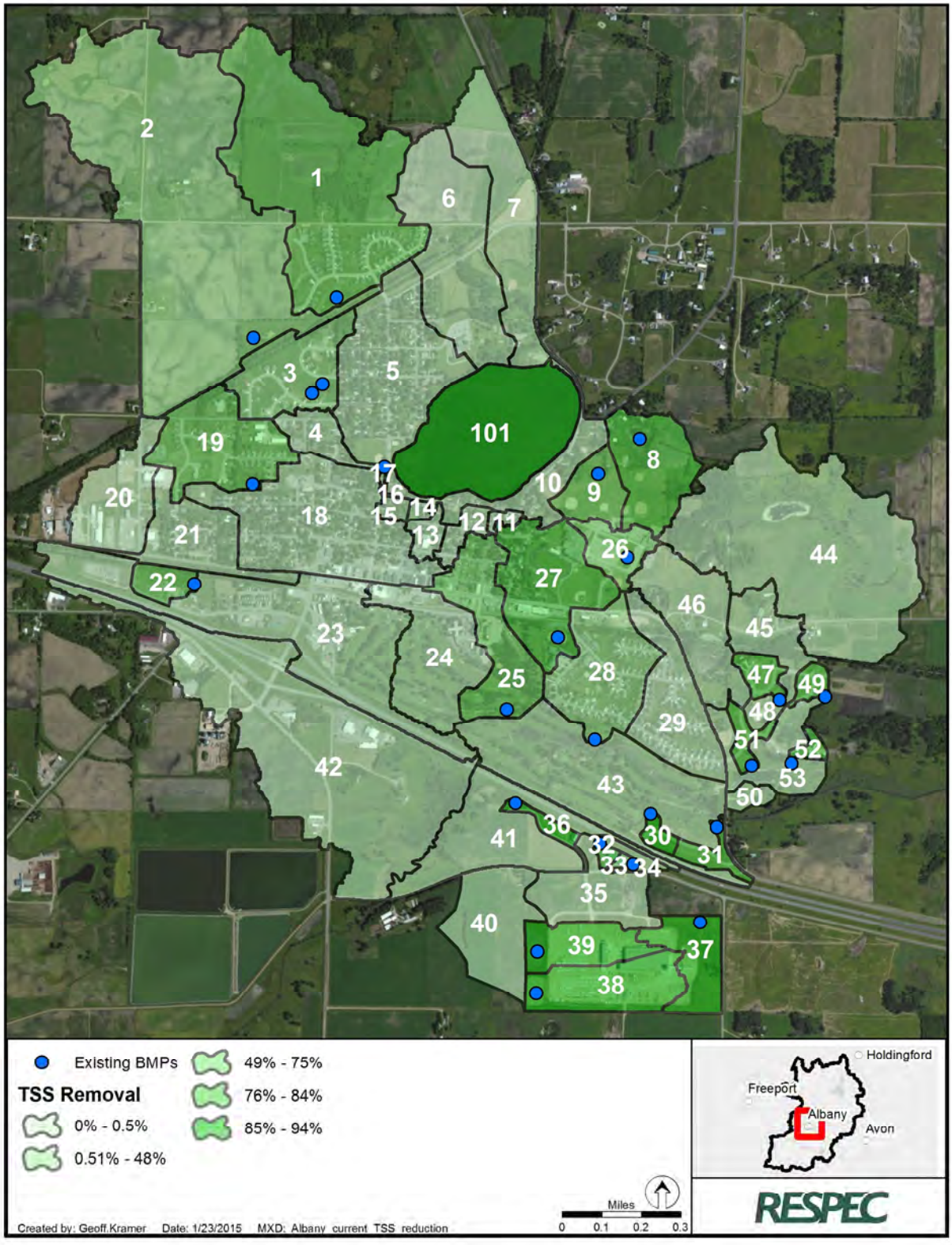


Figure F-9. Total Suspended Solids Removal Within Subwatershed for the Existing Conditions P8 Model.

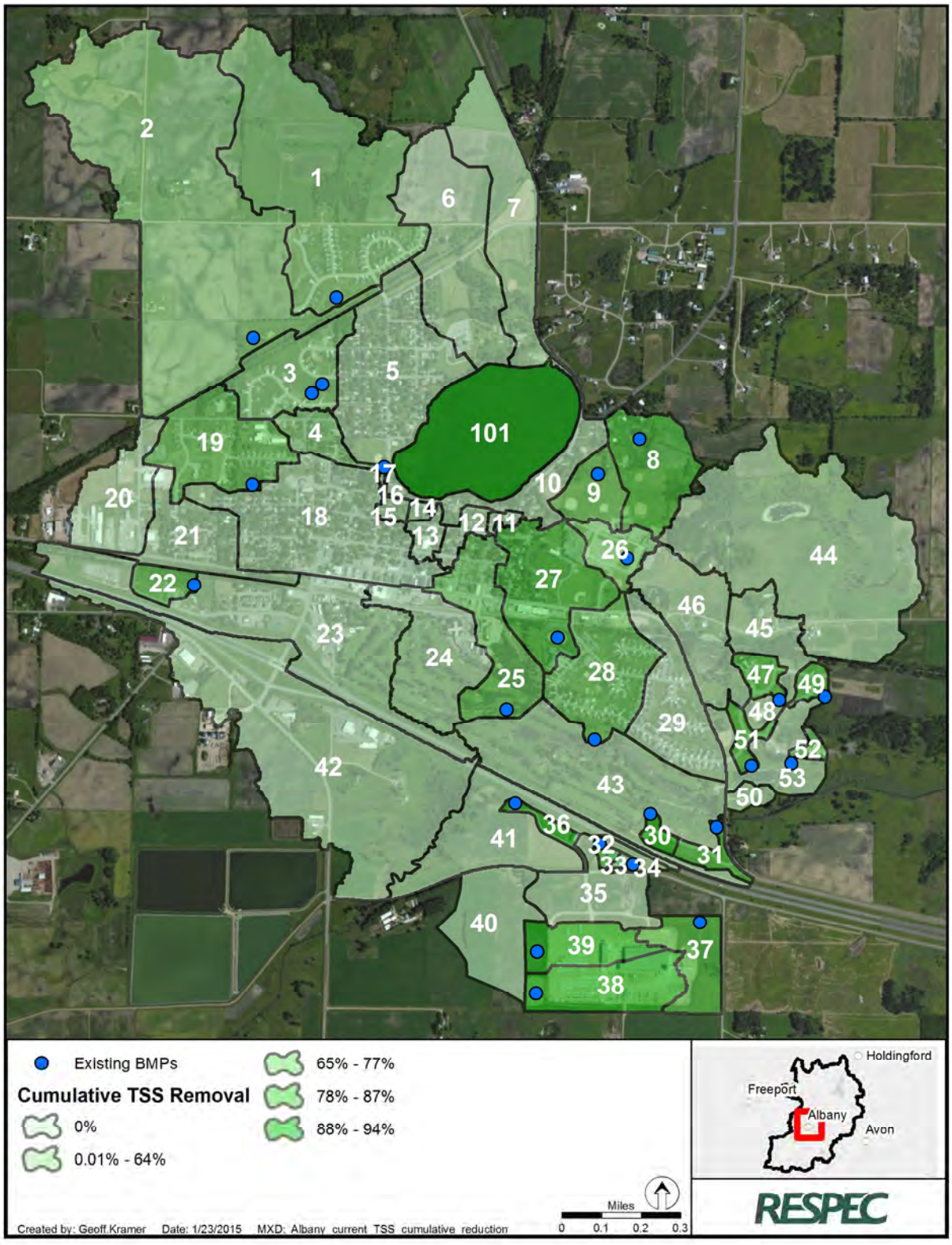


Figure F-10. Cumulative Total Suspended Solids Removal by Watershed for the Existing Conditions P8 Model.

Table F-1. P8 Model Output for the Existing Conditions Model (Page 1 of 2)

Watershed	Area (acres)	Structure	TP					TSS				
			Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction	Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction
1	128.3	Wet Pond 1	50.4	0.39	50.4	32.6	35.3	15,804.5	123	15,804.5	5,616.7	64.5
2	220.1	Wet Pond 2	69.5	0.32	102.1	88.0	13.8	21,853.7	99	27,470.4	17,023.4	38.0
3	34.1	Wet Pond 3a/3b	22.1	0.65	110.1	101.6	7.7	6,887.2	202	23,910.6	18,966.6	20.7
4	11.6	Sed Structure 4	10.3	0.89	111.9	111.9	0.0	3,208.4	276	2,2175.0	22,062.8	0.5
5	66.0	Pipe 5	62.5	0.95	62.5	62.5	0.0	19,467.8	295	19,467.8	19,467.8	0.0
6	67.2	Pipe 6	22.3	0.33	22.3	22.3	0.0	6,998.7	104	6,998.7	6,998.7	0.0
7	51.6	Pipe 7	13.9	0.27	13.9	13.9	0.0	4,373.2	85	4,373.2	4,373.2	0.0
8	32.5	Wet Pond 8	11.7	0.36	11.7	5.9	49.6	3,676.9	113	3,676.9	744.5	79.8
9	15.4	Wet Pond 9	4.0	0.26	4.0	2.4	40.0	1,253.7	81	1,253.7	386.6	69.2
10	23.4	Pipe 10	19.3	0.82	19.3	19.3	0.0	6,014.3	257	6,014.3	6,014.3	0.0
11	2.1	Pipe 11	2.8	1.33	2.8	2.8	0.0	870.5	412	870.5	870.5	0.0
12	6.6	Pipe 12	8.4	1.28	8.4	8.4	0.0	2,609.8	397	2,609.8	2,609.8	0.0
13	5.5	Pipe 13	8.4	1.51	8.4	8.4	0.0	2,617.2	472	2,617.2	2,617.2	0.0
14	1.7	Pipe 14	2.0	1.21	2.0	2.0	0.0	623.6	377	623.6	623.6	0.0
15	2.8	Pipe 15	3.7	1.30	3.7	3.7	0.0	1,155.5	407	1,155.5	1,155.5	0.0
16	0.3	Pipe 16	0.3	1.05	0.3	0.3	0.0	105.1	367	105.1	105.1	0.0
17	0.4	Pipe 17	0.5	1.22	0.5	0.5	0.0	144.4	353	144.4	144.4	0.0
101	75.0	North Lake	0.0	0.00	264.3	116.2	56.0	0.0	0	68,173.9	8,198.4	88.0
19	41.6	Wet Pond 19	33.0	0.79	33.0	20.1	39.1	10,296.9	248	10,296.9	2,977.5	71.1
18	76.6	Pipe 18	95.5	1.25	231.8	231.8	0.0	29,666.2	387	40,842.1	40,842.1	0.0
20	30.3	Pipe 20	30.3	1.00	30.3	30.3	0.0	9,442.4	312	9,442.4	9,442.4	0.0
21	30.2	Pipe 21	31.0	1.03	31.0	31.0	0.0	9,654.3	319	9,654.3	9,654.3	0.0
22	8.4	Wet Pond 22	4.5	0.54	4.5	2.6	42.2	1,397.8	167	1,397.8	383.1	72.6
23	97.4	Pipe 23	91.5	0.94	387.3	387.3	0.0	28,492.2	293	88,814.1	88,814.1	0.0
24	43.5	Pipe 24	31.1	0.72	31.1	31.1	0.0	9,709.6	223	9,709.6	9,709.6	0.0
25	38.9	Wet Pond 25	39.7	1.02	70.8	39.6	44.1	12,352.7	318	22,062.3	5,615.5	74.5
26	13.7	Wet Pond 26	18.9	1.38	18.9	10.8	42.9	5,862.6	428	5,862.6	1,440.9	75.4
27	46.4	Wet Pond 27	38.1	0.82	48.9	24.5	49.9	11,870.1	256	13,310.9	2,311.3	82.6
28	42.4	Wet Pond 28	36.1	0.85	60.6	51.0	15.8	11,257.7	266	13,568.9	7,077.0	47.8

Table F-1. P8 Model Output for the Existing Conditions Model (Page 2 of 2)

Watershed	Area (acres)	Structure	TP					TSS				
			Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction	Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction
29	36.8	Pipe 29	28.6	0.78	28.6	28.6	0.0	8,906.6	242	8,906.6	8,906.6	0.0
30	3.6	Wet Pond 30	2.5	0.70	2.5	1.0	60.0	784.7	221	784.7	68.1	91.3
31	5.9	Wet Pond 31	4.5	0.76	4.5	2.3	48.9	1,393.9	236	1,393.9	289.4	79.2
32	1.8	Wet Pond 32	0.6	0.33	0.6	0.3	50.0	200.9	110	200.9	31.8	84.2
33	1.1	Wet Pond 33	1.8	1.62	1.8	1.1	38.9	597.0	538	597.0	170.7	71.4
34	3.4	Pipe 34	2.7	0.79	3.7	3.7	0.0	833.2	243	1,003.9	1,003.9	0.0
35	27.1	Pipe 35	10.2	0.38	14.2	14.2	0.0	3,201.0	118	4,236.8	4,236.8	0.0
36	4.6	Wet Pond 36	2.8	0.61	2.8	1.1	60.7	862.3	189	862.3	84.0	90.3
37	20.6	Wet Pond 37	13.9	0.68	13.9	6.0	56.8	4,342.6	211	4,342.6	584.7	86.5
38	31.0	Wet Pond 38	51.7	1.67	51.7	19.8	61.7	16,035.6	518	16,035.6	1,387.3	91.3
39	20.5	Wet Pond 39	27.3	1.33	27.3	9.4	65.6	8,465.8	413	8,465.8	466.1	94.5
40	34.9	Pipe 40	12.6	0.36	41.8	41.8	0.0	3,937.6	113	5,791.0	5,791.0	0.0
41	49.3	Pipe 41	20.1	0.41	77.3	77.3	0.0	6,306.0	128	16,417.8	16,417.8	0.0
42	157.0	Pipe 42	86.5	0.55	86.5	86.5	0.0	27,016.2	172	27,016.2	27,016.2	0.0
43	83.4	Pipe 43	45.2	0.54	718.6	718.6	0.0	14,118.7	169	168,323.2	168,323.2	0.0
44	139.6	Pipe 44	30.8	0.22	30.8	30.8	0.0	9,765.9	70	9,765.9	9,765.9	0.0
45	20.2	Pipe 45	3.7	0.18	34.5	34.5	0.0	1,171.8	58	10,937.7	10,937.7	0.0
46	38.7	Pipe 46	12.0	0.31	12	12.0	0.0	3,784.7	98	3,784.7	3,784.7	0.0
47	6.9	Wet Pond 47	5.1	0.74	5.1	2.3	54.9	1,581.1	230	1,581.1	266.6	83.1
48	4.0	Pipe 48	2.0	0.49	50.9	50.9	0.0	637.5	158	15,626.6	15,626.6	0.0
49	4.4	Wet Pond 49	2.2	0.50	2.2	1.1	50.0	691.5	156	691.5	135.5	80.4
50	4.1	Pipe 50	0.7	0.17	0.7	0.7	0.0	227.8	56	227.8	227.8	0.0
51	5.8	Wet Pond 51	2.2	0.38	2.2	1.0	54.5	678.1	116	678.1	111.9	83.5
52	2.7	Wet Pond 52	0.8	0.30	0.8	0.4	50.0	242.1	89	242.1	56.7	76.6
53	23.4	Pipe 53	8.9	0.38	62.9	62.9	0.0	2,802.0	120	18,960.5	18,960.5	0.0
Total	**1,944.9**	**Overall**	**1,141.2**	**0.59**	**1,141.2**	**787.5**	**31.0**	**356,251.9**		**356,251.9**	**187,868.4**	**47.3**

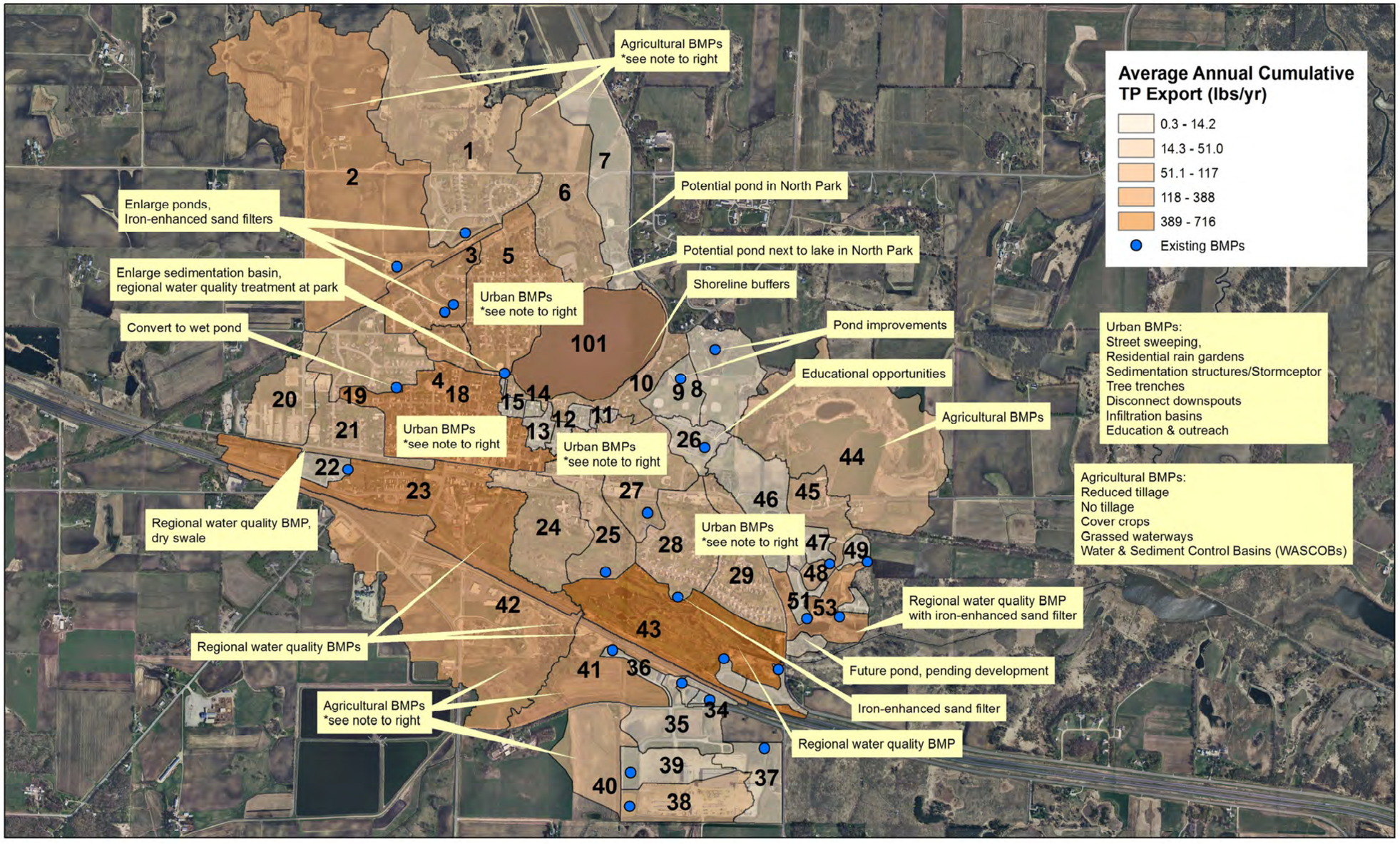


Figure F-11. Map of Best Management Practice Alternatives Presented to the City of Albany and Stearns County Soil and Water Conservation District at a Meeting on January 13, 2015.

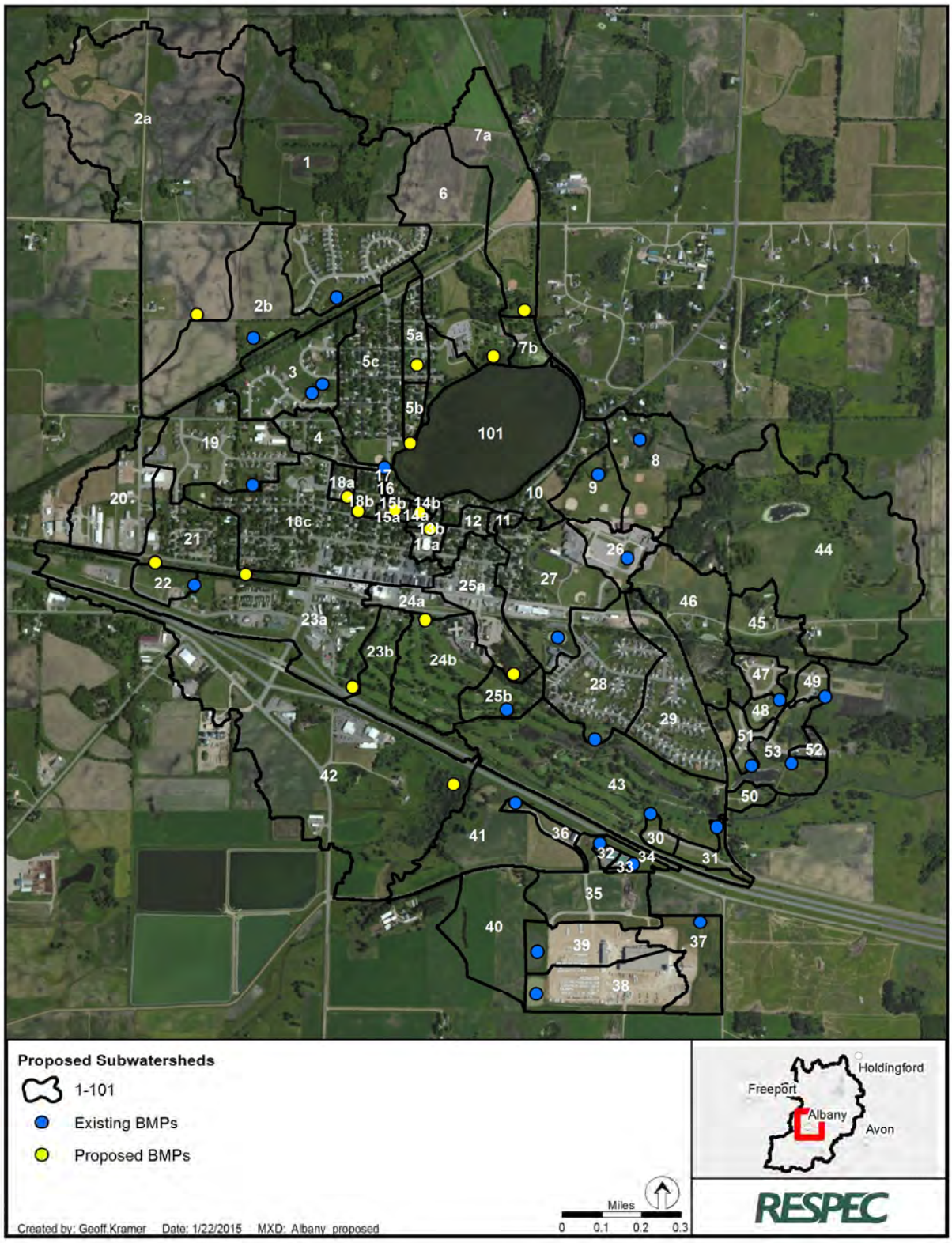


Figure F-12. Map of Existing and Proposed Best Management Practices With Subwatersheds for the Proposed Analysis.

Table F-2. P8 Model Output for the Proposed Conditions Model (Page 1 of 3)

Watershed	Area (acres)	Structure	TP					TSS				
			Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction	Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction
1	128.27	Wet Pond 1	50.4	0.39	50.4	32.6	35.3	15,804.5	123	15,804.5	5,616.7	64.5
2a	164.67	Wet Pond 2a	53.5	0.32	53.5	48.6	9.2	16,808.1	102	16,808.1	12,153.6	27.7
2b	55.45	Wet Pond 2b	16.2	0.29	97.4	85.3	12.4	5,098.0	92	22,868.3	15,702.6	31.3
3	34.14	Wet Pond 3a	22.1	0.65	107.3	99	7.7	6,887.2	202	22,589.8	17,789.8	21.2
4	11.63	Sed Structure 4	10.3	0.89	109.3	109.3	0.0	3,208.4	276	20,998.2	20,885.5	0.5
5a	9.31	Bioretention 5a	9.8	1.05	9.8	0.8	91.8	3,058.9	329	3,058.9	129	95.8
5b	4.65	Wet Pond 5b	4.9	1.05	5.5	3.5	36.4	1,529.5	329	1,658.5	548.5	66.9
5c	52.01	Pipe 5c	47.8	0.92	51.3	51.3	0.0	14,880.4	286	15,428.9	15,428.9	0.0
6	67.17	Wet Pond 6	22.3	0.33	22.3	17	23.8	6,998.7	104	6,998.7	3,830.4	45.3
7a	45.40	Wetland 7a	12.6	0.28	12.6	10.8	14.3	3,959.9	87	3,959.9	2,730.5	31.0
7b	6.25	Pipe 7b	1.4	0.22	12.2	12.2	0.0	452.1	72	3,182.6	3,182.6	0.0
8	32.51	Wet Pond 8	11.7	0.36	11.7	5.9	49.6	3,676.9	113	3,676.9	744.5	79.8
9	15.43	Wet Pond 9	4.0	0.26	4	2.4	40.0	1,253.7	81	1,253.7	386.6	69.2
10	23.44	Pipe 10	19.3	0.82	19.3	19.3	0.0	6,014.3	257	6,014.3	6,014.3	0.0
11	2.11	Pipe 11	2.8	1.33	2.8	2.8	0.0	870.5	412	870.5	870.5	0.0
12	6.57	Pipe 12	8.4	1.28	8.4	8.4	0.0	2,609.8	397	2,609.8	2,609.8	0.0
13a	3.70	Bioretention 13a	5.6	1.52	5.6	0.3	94.6	1,742.8	472	1,742.8	28	98.4
13b	1.85	Pipe 13b	2.8	1.51	3	3	0.0	874.4	472	902.4	902.4	0.0
14a	1.10	Bioretention 14a	1.3	1.18	1.3	0.1	92.3	414.4	377	414.4	11.2	97.3
14b	0.55	Pipe 14b	0.7	1.26	0.7	0.7	0.0	209.2	377	220.3	220.3	0.0
15a	1.89	Bioretention 15a	2.5	1.32	2.5	0.2	92.0	769.2	407	769.2	17.7	97.7
15b	0.95	pipe 15b	1.2	1.27	1.3	1.3	0.0	386.3	407	404	404	0.0
16	0.29	Pipe 16	0.3	1.05	0.3	0.3	0.0	105.1	367	105.1	105.1	0.0
17	0.41	Pipe 17	0.5	1.22	0.5	0.5	0.0	144.4	353	144.4	144.4	0.0
North Lake	75.00	North Lake	0.0	0.00	234.4	111.7	52.3	0.0	0	55,729.4	8,223.5	85.2
18a	3.46	Bioretention 18a	4.9	1.42	4.9	0.3	93.9	1,519.4	439	1,519.4	31.1	98.0
18b	4.95	Wet Pond 18b	5.7	1.15	117.5	116.4	0.9	1,758.3	355	10,012.9	9,110.4	9.0
19	41.57	Wet Pond 19	33.0	0.79	33	20.1	39.1	10,296.9	248	10,296.9	2,977.5	71.1
18c	68.22	Pipe 18c	84.8	1.24	221.4	221.4	0.0	26,358.2	386	38,446.1	38,446.1	0.0

Table F-2. P8 Model Output for the Proposed Conditions Model (Page 2 of 3)

Watershed	Area (acres)	Structure	TP					TSS				
			Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction	Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction
20	30.27	Swale 21a	30.3	1.00	30.3	22.6	25.4	9,442.4	312	9,442.4	4,073.6	56.9
21	30.22	Swale 21b	31.0	1.03	53.6	44.8	16.4	9,654.3	319	13,727.9	7,910.8	42.4
22	8.39	Wet Pond 22	4.5	0.54	4.5	2.6	42.2	1,397.8	167	1,397.8	383.1	72.6
23a	76.07	Wet Pond 23a	78.7	1.03	347.4	318.3	8.4	24,484.0	322	71,224.1	46,526.3	34.7
23b	21.32	Pipe 23b	12.8	0.60	331.2	331.2	0.0	4,008.2	188	50,534.5	50,534.5	0.0
24a	8.84	Infiltration 24a	13.6	1.54	13.6	3.2	76.5	4,226.1	478	4,226.1	488.2	88.4
24b	34.65	Pipe 24b	17.5	0.51	20.4	20.4	0.0	5,483.5	158	5,971.7	5,971.7	0.0
25a	26.42	Wet Pond 25a	35.0	1.32	35	17.2	50.9	10,871.7	412	10,871.7	1,992.1	81.7
25b	12.44	Wet Pond 25b	4.7	0.38	42.4	28.2	33.5	1,481.7	119	9,445.5	3,153	66.6
26	13.70	Wet Pond 26	18.9	1.38	18.9	9.8	48.1	5,862.6	428	5,862.6	1,183.8	79.8
27	46.40	Wet Pond 27	38.1	0.82	47.9	24.2	49.5	11,870.1	256	13,053.9	2,229.9	82.9
28	42.36	Wet Pond 28	36.1	0.85	60.3	50.7	15.9	11,257.7	266	13,487.5	7,012.9	48.0
29	36.82	Pipe 29	28.6	0.78	28.6	28.6	0.0	8,906.6	242	8,906.6	8,906.6	0.0
30	3.55	Wet Pond 30	2.5	0.70	2.5	1	60.0	784.7	221	784.7	68.1	91.3
31	5.91	Wet Pond 31	4.5	0.76	4.5	2.3	48.9	1,393.9	236	1,393.9	289.4	79.2
32	1.83	Wet Pond 32	0.6	0.33	0.6	0.3	50.0	200.9	110	200.9	31.8	84.2
33	1.11	Wet Pond 33	1.8	1.62	1.8	1.1	38.9	597.0	538	597	170.7	71.4
34	3.42	Pipe 34	2.7	0.79	3.7	3.7	0.0	833.2	243	1,003.9	1,003.9	0.0
35	27.13	Pipe 35	10.2	0.38	14.2	14.2	0.0	3,201.0	118	4,236.8	4,236.8	0.0
36	4.55	Wet Pond 36	2.8	0.61	2.8	1.1	60.7	862.3	189	862.3	84	90.3
37	20.58	Wet Pond 37	13.9	0.68	13.9	6	56.8	4,342.6	211	4,342.6	584.7	86.5
38	30.98	Wet Pond 38	51.7	1.67	51.7	19.8	61.7	16,035.6	518	16,035.6	1,387.3	91.3
39	20.52	Wet Pond 39	27.3	1.33	27.3	9.4	65.6	8,465.8	413	8,465.8	466.1	94.5
40	34.88	Pipe 40	12.6	0.36	41.8	41.8	0.0	3,937.6	113	5,791	5,791	0.0
41	49.27	Pipe 41	20.1	0.41	77.3	77.3	0.0	6,306.0	128	16,417.8	16,417.8	0.0
42	157.00	Wetland 42	86.5	0.55	86.5	52.9	38.8	27,016.2	172	27,016.2	9,227	65.8
43	83.43	Pipe 43	45.2	0.54	617.2	617.2	0.0	14,118.7	169	109,728	109,728	0.0
44	139.63	Pipe 44	30.8	0.22	30.8	30.8	0.0	9,765.9	70	9,765.9	9,765.9	0.0
45	20.17	Pipe 45	3.7	0.18	34.5	34.5	0.0	1,171.8	58	10,937.7	10,937.7	0.0

Table F-2. P8 Model Output for the Proposed Conditions Model (Page 3 of 3)

Watershed	Area (acres)	Structure	TP					TSS				
			Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction	Watershed Inflow	Watershed Inflow per Acre	Total Inflow	Total Outflow	% Reduction
46	38.71	Pipe 46	12.0	0.31	12	12	0.0	3,784.7	98	3,784.7	3,784.7	0.0
47	6.88	Wet Pond 47	5.1	0.74	5.1	2.3	54.9	1,581.1	230	1,581.1	266.6	83.1
48	4.04	Pipe 48	2.0	0.49	50.9	50.9	0.0	637.5	158	15,626.6	15,626.6	0.0
49	4.43	Wet Pond 49	2.2	0.50	2.2	1.1	50.0	691.5	156	691.5	135.5	80.4
50	4.05	Pipe 50	0.7	0.17	0.7	0.7	0.0	227.8	56	227.8	227.8	0.0
51	5.83	Wet Pond 51	2.2	0.38	2.2	1	54.5	678.1	116	678.1	111.9	83.5
52	2.71	Wet Pond 52	0.8	0.30	0.8	0.4	50.0	242.1	89	242.1	56.7	76.6
53	23.42	Pipe 53	8.9	0.38	62.9	62.9	0.0	2,802.0	120	18,960.5	18,960.5	0.0
Total	**1,944.84**	**Overall**	**1,141.4**	**0.59**	**1,163.8**	**687.1**	**41.0**	**35,6314.2**	**183**	**366,016.3**	**129,273.3**	**64.7**

Table F-3. Comparison of Pollutant Export for the Existing and Proposed P8 Models (Page 1 of 4)

Watershed	TP				TSS			
	Export		Change		Export		Change	
	Existing	Proposed	Pounds per Year	% Decrease	Existing	Proposed	Pounds per Year	% Decrease
1	32.6	32.6	0	0	5,616.7	5,616.7	0	0
2	88	85.3	2.7	3	17,023.4	15,702.6	1,320.8	8
3	101.6	99	2.6	3	18,966.6	17,789.8	1,176.8	6
4	111.9	109.3	2.6	2	22,062.8	20,885.5	1,177.3	5
5	62.5	51.3	11.2	18	19,467.8	15,428.9	4,038.9	21
6	22.3	17	5.3	24	6,998.7	3,830.4	3,168.3	45
7	13.9	12.2	1.7	12	4,373.2	3,182.6	1,190.6	27
8	5.9	5.9	0	0	744.5	744.5	0	0
9	2.4	2.4	0	0	386.6	386.6	0	0
10	19.3	19.3	0	0	6,014.3	6,014.3	0	0
11	2.8	2.8	0	0	870.5	870.5	0	0
12	8.4	8.4	0	0	2,609.8	2,609.8	0	0
13	8.4	3	5.4	64	2,617.2	902.4	1,714.8	66
14	2	0.7	1.3	65	623.6	220.3	403.3	65
15	3.7	1.3	2.4	65	1,155.5	404	751.5	65
16	0.3	0.3	0	0	105.1	105.1	0	0
17	0.5	0.5	0	0	144.4	144.4	0	0

Table F-3. Comparison of Pollutant Export for the Existing and Proposed P8 Models (Page 2 of 4)

Watershed	TP				TSS			
	Export		Change		Export		Change	
	Existing	Proposed	Pounds per Year	% Decrease	Existing	Proposed	Pounds per Year	% Decrease
101 (North Lake)	116.2	111.7	4.5	4	8,198.4	8,223.5	–25.1[a]	0
19	20.1	20.1	0	0	2,977.5	2,977.5	0	0
18	231.8	221.4	10.4	4	40,842.1	38,446.1	2,396	6
20	30.3	22.6	7.7	25	9,442.4	4,073.6	5,368.8	57
21	61.3	44.8	16.5	27	9,654.3	7,910.8	1,743.5	18
22	2.6	2.6	0	0	383.1	383.1	0	0
23	387.3	331.2	56.1	14	88,814.1	50,534.5	38,279.6	43
24	31.1	20.4	10.7	34	9,709.6	5,971.7	3,737.9	38
25	39.6	28.2	11.4	29	5,615.5	3,153	2,462.5	44
26	10.8	9.8	1	9	1,440.9	1,183.8	257.1	18
27	24.5	24.2	0.3	1	2,311.3	2,229.9	81.4	4
28	51	50.7	0.3	1	7,077	7,012.9	64.1	1
29	28.6	28.6	0	0	8,906.6	8,906.6	0	0
30	1	1	0	0	68.1	68.1	0	0
31	2.3	2.3	0	0	289.4	289.4	0	0
32	0.3	0.3	0	0	31.8	31.8	0	0
33	1.1	1.1	0	0	170.7	170.7	0	0

Table F-3. Comparison of Pollutant Export for the Existing and Proposed P8 Models (Page 3 of 4)

Watershed	TP				TSS			
	Export		Change		Export		Change	
	Existing	Proposed	Pounds per Year	% Decrease	Existing	Proposed	Pounds per Year	% Decrease
34	3.7	3.7	0	0	1,003.9	1,003.9	0	0
35	14.2	14.2	0	0	4,236.8	4,236.8	0	0
36	1.1	1.1	0	0	84	84	0	0
37	6	6	0	0	584.7	584.7	0	0
38	19.8	19.8	0	0	1,387.3	1,387.3	0	0
39	9.4	9.4	0	0	466.1	466.1	0	0
40	41.8	41.8	0	0	5,791	5791	0	0
41	77.3	77.3	0	0	16,417.8	16,417.8	0	0
42	86.5	52.9	33.6	39	27,016.2	9,227	17,789.2	66
43	718.6	617.2	101.4	14	168,323.2	10,9728	58,595.2	35
44	30.8	30.8	0	0	9,765.9	9,765.9	0	0
45	34.5	34.5	0	0	10,937.7	10,937.7	0	0
46	12	12	0	0	3,784.7	3,784.7	0	0
47	2.3	2.3	0	0	266.6	266.6	0	0
48	50.9	50.9	0	0	15,626.6	15,626.6	0	0
49	1.1	1.1	0	0	135.5	135.5	0	0
50	0.7	0.7	0	0	227.8	227.8	0	0
51	1	1	0	0	111.9	111.9	0	0

Table F-3. Comparison of Pollutant Export for the Existing and Proposed P8 Models (Page 4 of 4)

Watershed	TP				TSS			
	Export		Change		Export		change	
	Existing	Proposed	Pounds per Year	% Decrease	Existing	Proposed	Pounds per Year	% Decrease
52	0.4	0.4	0	0	56.7	56.7	0	0
53	62.9	62.9	0	0	18,960.5	18,960.5	0	0
Total	**787.5**	**687.1**	**100.4**	**13**	**187,868.4**	**129,273.3**	**58,595.1**	**31**

(a) The increase in TSS export from North Lake is from slight errors associated with small differences in area-weighted curve numbers for subwatersheds in the existing and proposed P8 models.

Table F-4. Cost Summary With Rankings (by Total Phosphorus Removal Cost) of All Best Management Practices, With Total Phosphorus and Total Suspended Solids Removal Rates (2015 Dollars) (Page 1 of 2)

Watershed	Structure	Quantity	Excavated Volume (cu yd)	Unit Cost		Total Cost		Total Present Cost ($)	Additional Pollutant Removal		Price per Pound TP (for 20 Years) ($)	Price per Pound TSS (for 20 Years) ($)	TP Removal Cost Ranking
				Construction Cost ($)	Annual O&M Cost ($)	Construction Cost	Annual O&M Cost ($)		TP (pounds per year)	TSS (pounds per year)			
28 IESF	Iron-Enhanced Sand Filter	1		44,068	500	44,068	500	54,068	32.6	0	83	-	1
25b IESF	Iron-Enhanced Sand Filter	1		37,381	500	37,381	500	47,381	24.8	0	96	-	2
23a with IESF	Wet Pond with IESF			303,731	6,687	303,731	6,687	422,737	143.9	31,313	147	0.68	3
18b + 23a with IESF[a]	Multiple Structures							533,919[a]	158.4	35,985	169	0.74	4
2b expansion with IESF[b][c]	Pond Expansion	1	2,233	144,287	500	148,287	500	154,287	42.4	124	182	62.26	5
21 + 23a with IESF[a]	Multiple Structures	2						565,192[a]	155.6	35,548	182	0.79	6
18a + 23a with IESF[a]	Multiple Structures	2						577,340[a]	148.2	32,264	195	0.89	7
18b, 21, 23a with IESF[a]	Multiple Structures	3						676,374[a]	170.1	40,167	199	0.84	8
18a, 21, 23a with IESF[a]	Multiple Structures	3						719,795[a]	172.7	40,463	208	0.89	9
18a, 18b, 23a with IESF[a]	Multiple Structures	3						688,522[a]	149.3	32,669	231	1.05	10
18a, 18b, 21, 23a with IESF[a]	Multiple Structures	4						830,977[a]	173.8	40,840	239	1.02	11
42[c]	Constructed Wetland	1	4,821	133,736	4,012	133,736	4,012	210,797	33.6	17,789	314	0.59	12
21 alone	Dry Swale	1	2,000 linear feet	67,196	4,911	67,196	4,911	142,455	16.5	11,186	432	0.64	13
2a+2b expansion with IESF[a] [b] [c]	Multiple Structures	2						459,509[a]	44.7	1,321	514	17.40	14
18b + 21[a]	Multiple Structures	2						253,637[a]	24.6	14,391	516	0.88	15
18a + 21[a]	Multiple Structures	2						297,058[a]	27.1	14,110	548	1.05	16
18b alone[c]	Wet Pond	1	403	53,875	2,694	53,875	2,694	111,182	8.0	3,206	695	1.73	17
18a, 18b, 21[a]	Multiple Structures	3						408,240[a]	22.4	13,577	911	1.50	18
24a alone[c]	Infiltration Basin	1	303	102,570	3,487	102,570	3,487	141,587	6.2	977	1,142	7.25	19
5b[b]	Wet Pond	1	334	54,903	2,745	54,903	2,745	100,940	3.9	2,645	1,294	1.91	20
6[b] [c]	Wet Pond	1	834	102,843	4,114	102,843	4,114	161,285	5.3	3,168	1,522	2.55	21
18a alone[a] [c]	Rain Garden	1	339	118,360	3,906	118,360	3,906	154,603	4.6	1,488	1,680	5.19	22
24a + 25a[a]	Multiple Structures	2						421,171[a]	11.4	2,463	1,847	8.55	23

Table F-4. Cost Summary With Rankings (by Total Phosphorus Removal Cost) of All Best Management Practices, With Total Phosphorus and Total Suspended Solids Removal Rates (2015 Dollars) (Page 2 of 2)

Watershed	Structure	Quantity	Excavated Volume (cu yd)	Unit Cost		Total Cost		Total Present Cost ($)	Additional Pollutant Removal		Price per Pound TP (for 20 Years) ($)	Price per Pound TSS (for 20 Years) ($)	TP Removal Cost Ranking
				Construction Cost ($)	Annual O&M Cost ($)	Construction Cost	Annual O&M Cost ($)		TP (pounds per year)	TSS (pounds per year)			
18a + 18b[a] [c]	Multiple Structures	2						265,785[a]	5.9	2,391	2,252	5.56	24
25a alone	Wet Pond	1	2,443	175,683	5,622	175,683	5,622	279,584	5.9	1,708	2,369	8.19	25
5a+5b[a] [b]	Multiple Structures	2						635,313[a]	11.2	4,040	2,836	7.86	26
13a[b]	Rain Gardens	12	411	10,920	699	131,041	8,387	313,608	5.4	1,715	2,904	9.14	27
5a alone[b]	Rain Gardens	23	678	9,384	638	215,832	14,677	534,373	9.0	2,930	2,969	9.12	28
15a[b]	Rain Gardens	5	194	12,333	765	61,666	3,823	143,612	2.4	752	2,992	9.55	29
7a[b] [c]	Wetland Restoration	1	368	60,473	2,903	60,473	2,903	106,060	1.7	1,191	3,119	4.45	30
26	Pond Expansion	1	629	20,050	0 (existing structure)	20,050	0	20,050	0.3	64	3,342	15.66	31
14a[b]	Rain Gardens	4	109	8,672	598	34,687	2,393	87,413	1.3	403	3,362	10.84	32
2a alone[b] [c]	Wet Pond	1	2,899	184,691	5,910	184,691	5,910	305,222	2.3	1,206	6,635	12.66	33

Note: Practices highlighted in red are not recommended because of the availability of cheaper, more effective alternatives.
The thick line separates projects that are upstream of North Lake from those that are downstream

(a) Total present project cost was calculated as a sum of individual projects.

(b) Structure(s) located upstream of North Lake and may have a limited effect on the water quality of Two Rivers Lake

(c) Structures proposed by the City of Albany

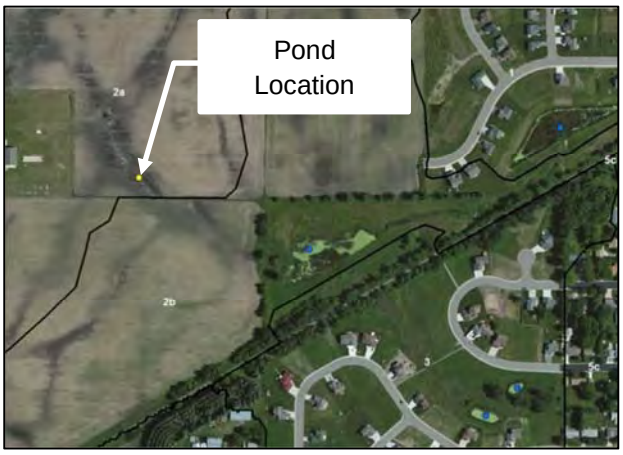
APPENDIX G

URBAN PROJECT PROFILES

Potential Project 2A-WP-1

Problem Description:	Total suspended solids (TSS) and total phosphorus (TP) loading from agricultural land
Potential Solution:	Wet pond
Location:	East of Albany Water Treatment Plant and upstream of existing Wet Pond 2b

TP Reduction	2.3 lbs/yr
TSS Reduction	1,206 lbs/yr
Project Installation Cost	$184,700
Maintenance Costs	$5,900
Cost per Pound Removal – TP	$6,600
Cost per Pound Removal – TSS	$13

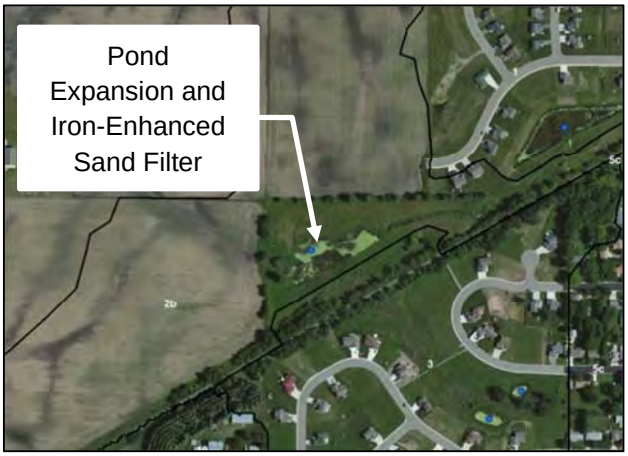


Notes: Subwatershed 2A consists of agricultural land that has severe erosion occurring. The proposed wet pond would be located in one parcel and it is believed that the landowner would be willing to allow the city to purchase right of way. The project could also incorporate a walking path or community trail that would be seen as a benefit to the community. However, this best management practice (BMP) is located upstream of several existing BMPs and North Lake, so while the proposed structure will capture pollutants and benefit North Lake, the actual cumulative effect downstream is diminished because of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 2B-WP-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from agricultural land
Potential Solution:	Wet pond expansion and iron-enhanced sand filter
Location:	East southeast of Albany Water Treatment Plant, north of northern section of Lake Wobegon Trail

TP Reduction	42.4 lbs/yr
TSS Reduction	124 lbs/yr
Project Installation Cost	$144,300
Maintenance Costs	$500
Cost per Pound Removal – TP	$180
Cost per Pound Removal – TSS	$62



Notes: Existing Wet Pond 2 receives direct runoff from agricultural land and outflow from Wet Pond 1. The existing permanent pool has a shallow-depth (1.1 feet) capacity and could benefit from increased depth (proposed depth of 3 feet). The project would also add an iron-enhanced sand filter to the pond for the treatment of dissolved phosphorus. TP removed by the iron-enhanced sand filter is estimated to be 42 pounds per year (lbs/year), while the pond expansion would remove an additional 0.4 lbs/year of TP and 124 lbs/year of TSS. The proposed improvements would not require new ROW. The iron-enhanced sand filter would capture dissolved phosphorus that is not treated by existing best management practices (BMPs), and contributes greatly to a relatively low TP removal cost. However, the benefit from an expanded permanent pool is minimal because of treatment by downstream BMPs.

Iron-Enhanced Sand Bench, Prior Lake, Minnesota.
Photograph from the Minnesota Stormwater Manual, courtesy of Mr. Ross Bintner.

Potential Project 5A-BIO-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	23 residential bioretention structures (rain gardens)
Location:	5th Street between Soo Line Avenue and 2nd Avenue

TP Reduction	9.0 lbs/yr
TSS Reduction	2,930 lbs/yr
Project Installation Cost	$215,800
Maintenance Costs	$14,700
Cost per Pound Removal – TP	$3,000
Cost per Pound Removal – TSS	$9

Notes: Subwatershed 5 is a residential neighborhood on the northwest corner of North Lake. Fifth Street is slated to be reconstructed in the next 10 years, which provides an opportunity to incorporate best management practices (BMPs) and reduce the overall costs by incorporating them into the project. The proposed 23 residential rain gardens would each be on separate lots and account for 67 percent of the homes on the street. These BMPs would require a willingness from landowners to construct on their property and provide maintenance upkeep. It could also serve a large educational value by serving as an example project within the city and increase the likelihood of other homeowners to implement rain gardens on their property. However, these BMPs are located upstream of North Lake, so while they capture pollutants and benefit North Lake, the actual cumulative water quality improvement downstream of North Lake is diminished because of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 5B-WP-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Wet pond
Location:	Upstream of North Lake at 5th Street and Linden Avenue

TP Reduction	3.9 lbs/yr
TSS Reduction	2,645 lbs/yr
Project Installation Cost	$54,900
Maintenance Costs	$2,700
Cost per Pound Removal – TP	$1,300
Cost per Pound Removal – TSS	$2

Notes: The proposed wet pond would receive runoff from the residential neighborhood on 5th Street. Fifth Street is slated to be reconstructed in the next 10 years, which provides an opportunity to incorporate the wet pond and reduce the overall costs by incorporating it into the roadway project. The parcel for the wet pond is located on city property. However, this best management practice (BMP) is located upstream of North Lake, so while it captures pollutants and benefits North Lake, the actual cumulative water quality improvement downstream of North Lake is diminished because of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 6-WP-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban and agricultural areas
Potential Solution:	Wet pond
Location:	Immediately east of Albany Hospital, upstream of existing wetland and North Lake

TP Reduction	5.3 lbs/yr
TSS Reduction	3,168 lbs/yr
Project Installation Cost	$102,800
Maintenance Costs	$4,100
Cost per Pound Removal – TP	$1,500
Cost per Pound Removal – TSS	$3

Notes: The proposed wet pond would receive runoff from a mix of commercial, park, and agricultural land uses; outflow would flow into the existing wetland adjacent to North Lake. The parcel is located on city property and could be used for educational purposes. However, this best management practice (BMP) is located upstream of North Lake, so while it captures pollutants and benefits North Lake, the actual cumulative water quality improvement downstream of North Lake is diminished because of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 7A-WR-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from agricultural and park runoff
Potential Solution:	Wetland restoration
Location:	On east side of North Park

TP Reduction	1.7 lbs/yr
TSS Reduction	1,191 lbs/yr
Project Installation Cost	$60,500
Maintenance Costs	$2,900
Cost per Pound Removal – TP	$3,100
Cost per Pound Removal – TSS	$4

Notes: The proposed restored wetland would receive runoff from a mix of park and agricultural land uses. The proposed best management practice (BMP) is located on city property and could also be used for educational purposes. However, the proposed BMP is located upstream of North Lake so while it captures pollutants, the actual cumulative effect downstream is diminished because of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 13A-BIO-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	12 residential bioretention structures (rain gardens)
Location:	4th Street between Lake Avenue and Midland Avenue

TP Reduction	5.4 lbs/yr
TSS Reduction	1,715 lbs/yr
Project Installation Cost	$131,000
Maintenance Costs	$8,400
Cost per Pound Removal – TP	$2,900
Cost per Pound Removal – TSS	$9

Notes: Subwatershed 13 is a residential neighborhood on the southwest corner of North Lake. Lake Avenue is slated to be reconstructed in the next 10 years, which provides an opportunity to incorporate best management practices (BMPs) and reduce the overall costs by incorporating them into the project. The proposed 12 residential rain gardens would each be on separate lots and accounts for 67 percent of the homes in the subwatershed. These BMPs would require willingness from landowners to construct BMPs on their property and provide maintenance upkeep. It could also provide educational value and increased awareness within the city and could lead to further BMP implementation. However, these BMPs are located upstream of North Lake so while they capture pollutants, the actual cumulative effect downstream is diminished becuse of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 14A-BIO-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	4 residential bioretention structures (rain gardens)
Location:	4th and 5th Street between Lake Avenue and Forest Avenue

TP Reduction	1.3 lbs/yr
TSS Reduction	403 lbs/yr
Project Installation Cost	$34,700
Maintenance Costs	$2,400
Cost per Pound Removal – TP	$3,400
Cost per Pound Removal – TSS	$11

Notes: Subwatershed 14 is a residential neighborhood on the southwest corner of North Lake. Lake Avenue is slated to be reconstructed in the next 10 years, which provides an opportunity to incorporate best management practices (BMPs) and reduce the overall costs by incorporating them into the project. The proposed 4 residential rain gardens would each be on separate lots and account for 67 percent of the homes in the subwatershed. These BMPs would require willingness from landowners to construct on their property and provide maintenance upkeep. It could also provide educational value and increased awareness within the city and could lead to further BMP implementation. However, these BMPs are located upstream of North Lake so while they capture pollutants, the actual cumulative effect downstream is diminished because of the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 15A-BIO-1

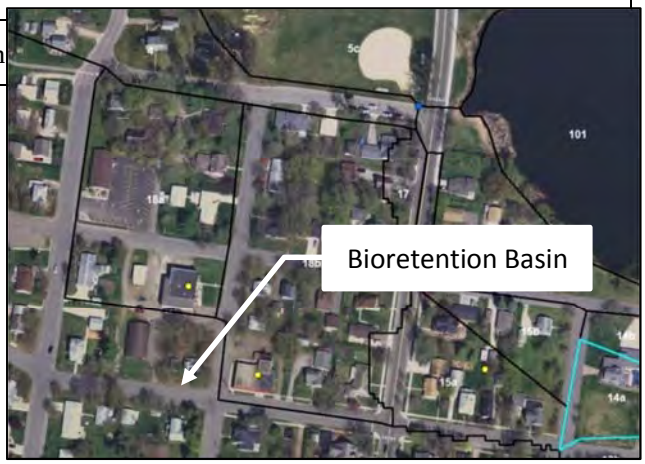
Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	5 residential bioretention structures (rain gardens)
Location:	5th and 6th Street between Lake Avenue and Forest Avenue

TP Reduction	2.4 lbs/yr
TSS Reduction	752 lbs/yr
Project Installation Cost	$61,700
Maintenance Costs	$3,800
Cost per Pound Removal – TP	$3,000
Cost per Pound Removal – TSS	$10

Notes: Subwatershed 15 is a residential neighborhood on the southwest corner of North Lake. Lake Avenue is slated to be reconstructed in the next 10 years, which provides an opportunity to incorporate best management practices (BMPs) and reduce the overall costs by incorporating them into the project. The proposed 5 residential rain gardens would each be on separate lots and accounts for 67 percent of the homes in the subwatershed. These BMPs would require willingness from landowners to construct on their property and provide maintenance upkeep. It could also provide educational value and increased awareness within the city and could lead to further BMP implementation. However, these BMPs are located upstream of North Lake so while they capture pollutants, the actual cumulative effect downstream is diminished due to the treatment train. This results in low effective pollutant removal in Two Rivers Lake and corresponding high pollutant removal costs.

Potential Project 18A-BIO-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Bioretention basin
Location:	Site of former apartmen



TP Reduction	4.6 lbs/yr
TSS Reduction	1,488 lbs/yr
Project Installation Cost	$118,400[(a)]
Maintenance Costs	$3,900
Cost per Pound Removal – TP	$1,700
Cost per Pound Removal – TSS	$5

(a) Project installation cost does not include cost to purchase lot and demolish remains of former building site. The project is dependent on action by the city of Albany.

Notes: The proposed bioretention basin will receive runoff from the residential neighborhood within Subwatershed 18A through overland flow. The vacant lot could be reasonably acquired by the city and other community benefits could be included within the acquired land. There are no existing best management practices (BMPs) are located downstream of the proposed project but this report proposes other BMPs, which may affect the performance of this project that should be evaluated when determining which projects to implement.

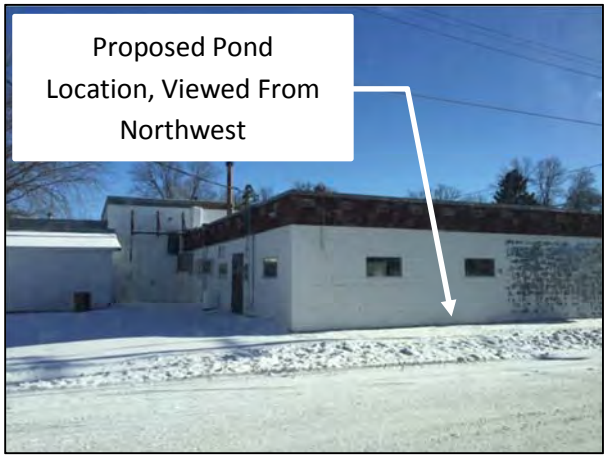
Potential Project 18B-WP-1

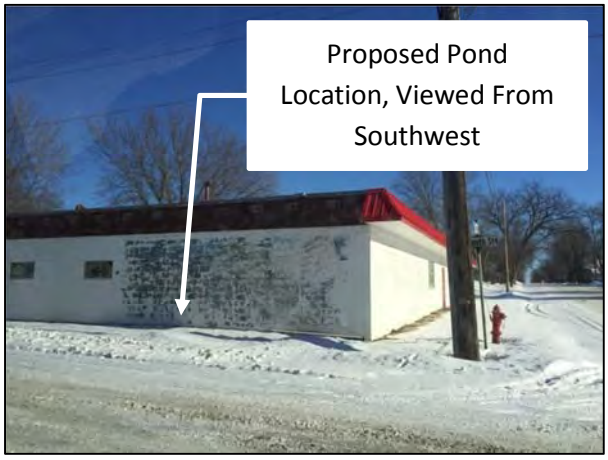
Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Wet pond
Location:	Forest Avenue and 7th Street

TP Reduction	8.0 lbs/yr
TSS Reduction	3,206 lbs/yr
Project Installation Cost	$53,900*
Maintenance Costs	$2,700
Cost per Pound Removal – TP	$700
Cost per Pound Removal – TSS	$2

(a) Project installation cost does not include cost to purchase lot and demolish remains of former building site. The project is dependent on action by the city of Albany.

Notes: The proposed wet pond will receive runoff from the residential neighborhood within Subwatershed 18 through overland flow and from a storm sewer within 7th Street. The abandoned building and land for the best management practice (BMP) could be reasonably acquired by the city, but the building would need to be demolished and it could present some environmental hazards such as asbestos. There are no existing BMPs downstream of the proposed project, but there are other proposed BMPs included that should be evaluated when determining which projects to implement.





Potential Project 21-DS-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Dry swale
Location:	Railroad Avenue and Lake Wobegon Trail from 9th Street to 13th Street

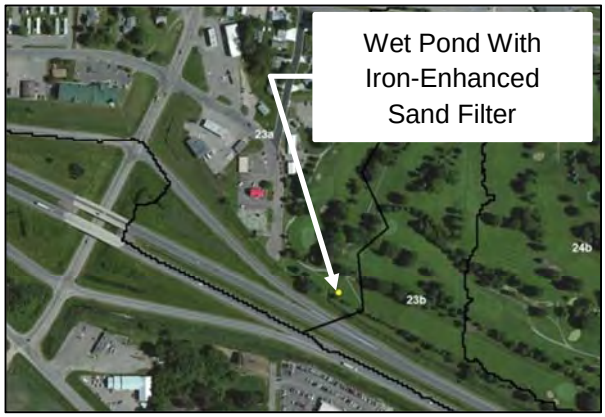
TP Reduction	16.5 lbs/yr
TSS Reduction	11,186 lbs/yr
Project Installation Cost	$67,200
Maintenance Costs	$4,900
Cost per Pound Removal – TP	$430
Cost per Pound Removal – TSS	$1

Notes: The proposed dry swale will receive runoff from the residential neighborhood and industrial area within Subwatersheds 20 and 21 through overland flow and from a storm sewer. The land is believed to be owned by MN/DOT, which would require an agreement between them and the city to implement the project. No existing best management practices (BMPs) are located downstream of the proposed project, but there are other proposed BMPs included that should be evaluated when determining which projects to implement.

Potential Project 23A-WP-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Wet pond and iron-enhanced sand filter
Location:	Southwest corner of Albany Golf Club between tee box and fairway

TP Reduction	143.9 lbs/yr
TSS Reduction	31,313 lbs/yr
Project Installation Cost	$303,700
Maintenance Costs	$6,700
Cost per Pound Removal – TP	$150
Cost per Pound Removal – TSS	$1



Notes: The proposed wet pond with an iron-enhanced sand filter will receive runoff from multiple subwatersheds downstream of North Lake to treat a mixture of residential, commercial and industrial development. Inclusion of an iron-enhanced sand filter will increase the annual TP removal from 34.2 pounds to 143.9 pounds by removing dissolved phosphorus. The proposed location is on the southwest edge of the golf course, which is owned by the city. There are severe limitations on land availability near the project site that led to a smaller wet pond than preferred, but this location offers great potential for treating runoff from the currently untreated older developed areas of Albany. No existing or proposed Best Management Practices downstream of the proposed project.

Iron-Enhanced Sand Bench, Prior Lake, Minnesota.
Photographs from the Minnesota Stormwater Manual, courtesy of Mr. Ross Bintner.

Potential Project 24A-INF-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Infiltration basin
Location:	Northern edge of Albany golf course at 4th Street

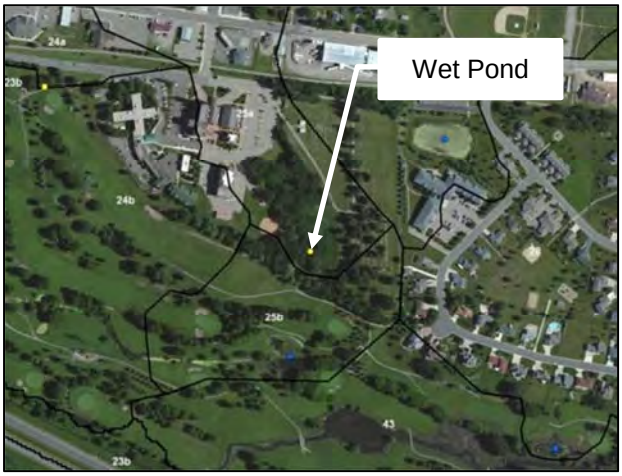
TP Reduction	6.2 lbs/yr
TSS Reduction	977 lbs/yr
Project Installation Cost	$102,600
Maintenance Costs	$3,500
Cost per Pound Removal – TP	$1,100
Cost per Pound Removal – TSS	$7

Notes: The proposed infiltration basin will receive runoff from a commercial area in Subwatershed 24A. An outfall is currently on the golf course with a riprap channel that could be modified to include the infiltration basin, although the available area is limited. The proposed best management practice (BMP) location is within the golf course which is owned by the city. There is an existing BMP downstream of the proposed project and other proposed BMPs included that should be evaluated when determining which projects to implement.

Potential Project 25A-WP-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Wet pond
Location:	Near the end of the ravine (north of Albany Golf Club) in Subwatershed 25A

TP Reduction	5.9 lbs/yr
TSS Reduction	1,708 lbs/yr
Project Installation Cost	$175,700
Maintenance Costs	$5,600
Cost per Pound Removal – TP	$2,400
Cost per Pound Removal – TSS	$8



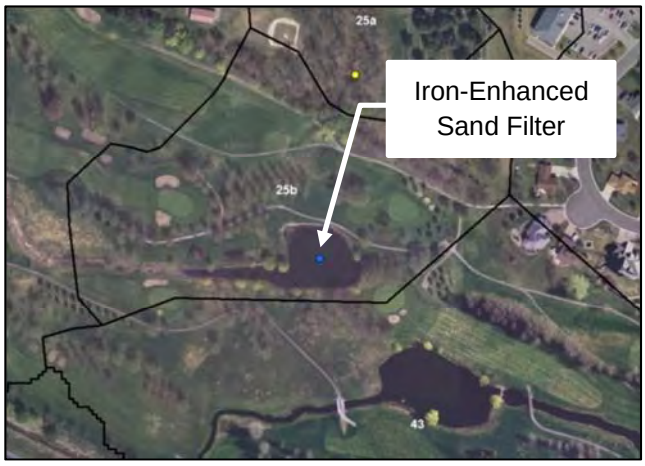
Notes: The proposed wet pond will receive runoff from a mix of commercial and residential development in Subwatershed 25A. The proposed location is in a steep channel upstream of the golf course. There is an existing best management practice (BMP) downstream of the proposed project and other proposed BMPs included that should be evaluated when determining which projects to implement.

Photograph from the Minnesota Stormwater Manual.

Potential Project 25B-IESF-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Construction of iron-enhanced sand filter within existing wet pond
Location:	Existing Wet Pond 25 within Albany Golf Club

TP Reduction	24.8 lbs/yr
TSS Reduction	0 lbs/yr
Project Installation Cost	$37,400
Maintenance Costs	$500
Cost per Pound Removal – TP	$100
Cost per Pound Removal – TSS	–



Notes: Existing Wet Pond 25 receives runoff from a large developed area in downtown Albany, as well as portions of Albany Golf Club. Wet Pond 25 is on land owned by the city of Albany. The construction of an iron-enhanced sand filter within the existing wet pond would specifically treat dissolved phosphorus. No best management practices (BMPs) currently exist that are designed to explicitly remove dissolved phosphorus.

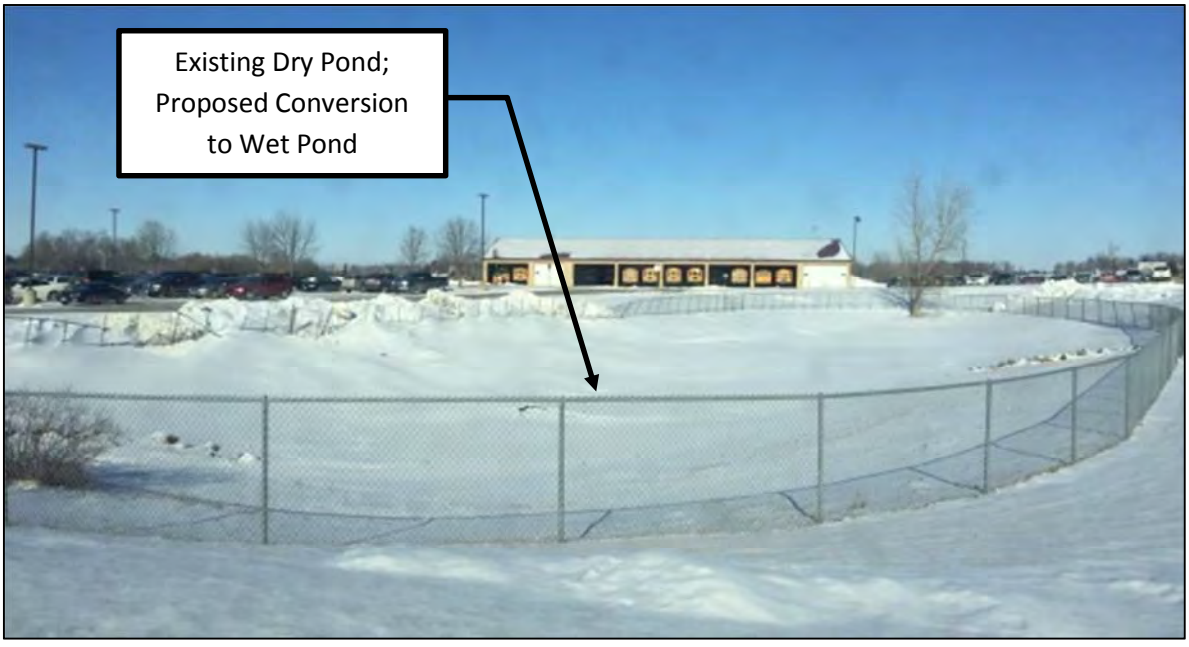
Iron-Enhanced Sand Bench, Prior Lake, Minnesota.
Photograph from the Minnesota Stormwater Manual, Courtesy of Mr. Ross Bintner.

Potential Project 26-WP-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from agricultural land
Potential Solution:	Pond improvement from dry pond to wet pond
Location:	Albany High School

TP Reduction	0.3 lbs/yr
TSS Reduction	64 lbs/yr
Project Installation Cost	$20,100
Maintenance Costs	$0
Cost per Pound Removal – TP	$3,300
Cost per Pound Removal – TSS	$16

Notes: Existing Dry Pond 26 receives direct runoff from parking lots and buildings at the school. The proposed pond improvement would create a 3-foot-deep permanent pool, thereby converting existing Dry Pond 26 to a wet pond. The proposed improvements would not require new ROW and could offer an opportunity for education and outreach to students with regard to stormwater management and water quality. However, the proposed project has a minimal benefit because of existing downstream Best Management Practices (BMPs). This effect is reflected in the low pollutant removal and cost/benefit analysis.



Potential Project 28-IESF-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from developed urban area
Potential Solution:	Construction of iron-enhanced sand filter within existing wet pond
Location:	Existing Wet Pond 28 within Albany Golf Club

TP Reduction	32.6 lbs/yr
TSS Reduction	0 lbs/yr
Project Installation Cost	$44,100
Maintenance Costs	$500
Cost per Pound Removal – TP	$80
Cost per Pound Removal – TSS	–

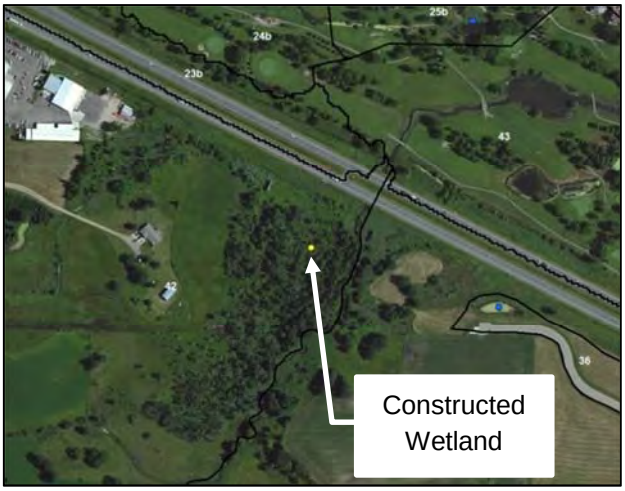
Notes: Existing Wet Pond 28 receives runoff from a large developed area, including Subwatersheds 26 and 27 that are treated by Dry Pond 26 and Wet Pond 27. The existing wet pond is on land owned by the city of Albany. The construction of an iron-enhanced sand filter within the existing wet pond would specifically treat dissolved phosphorus. No existing best management practices (BMPs) currently exist that are designed to explicitly remove dissolved phosphorus.

Iron-Enhanced Sand Bench, Prior Lake, Minnesota.
Photograph from the Minnesota Stormwater Manual, courtesy of Mr. Ross Bintner.

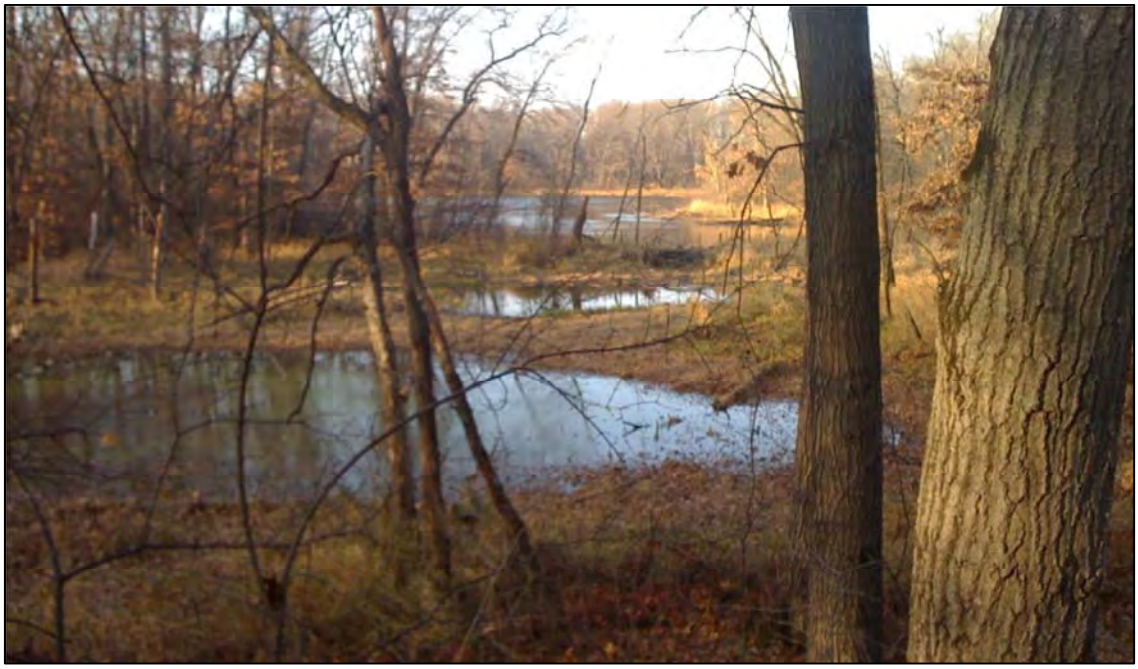
Potential Project 42-CW-1

Problem Description:	Total suspended solids (TSS) and Total phosphorus (TP) loading from commercial and agricultural land
Potential Solution:	Constructed wetland
Location:	Southwest corner of I-94 and Two Rivers Lake

TP Reduction	33.6 lbs/yr
TSS Reduction	17,789 lbs/yr
Project Installation Cost	$133,700
Maintenance Costs	$4,000
Cost per Pound Removal – TP	$310
Cost per Pound Removal – TSS	$1



Notes: The proposed constructed wetland will receive runoff from Subwatershed 42, which has a mixture of agricultural, commercial, and industrial development. The proposed location is upstream of Two River on a parcel of undeveloped land that is privately owned. No existing or proposed best management practices (BMPs) exist downstream of the proposed project.



Typical Constructed Wetland in a Forested Setting.