Little Elk Lake

Sub-Watershed Assessment

December 2021

Prepared by:

Sherburne Soil & Water Conservation District

In partnership with

Baldwin Township, MN

CLEAN WATER LAND & LEGACY AMENDMENT

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Executive Summary

At 362 acres and with 4.94 miles of shoreline, Little Elk Lake (DNR ID 710055) is one of the largest developed recreation lake in Sherburne County, MN. Though it is large, the lake is almost entirely within the littoral (vegetated) zone with an average depth of 7 ft and a maximum depth of 15 ft. The lake is moderately to well developed with both year-long and seasonal homes lining the south, east and west shores of the lake. Several homes line the lake's northern end along with by a large wetland complex which ushers in Battle Brook, a relatively small stream that originates in the southeast corner of Benton County and runs through Mille Lacs County before entering Sherburne County. Little Elk Lake is mostly enclosed within Baldwin Township in Sherburne County.

Little Elk Lake has been known to exhibit abundant plant growth and mid / late summer algae blooms which can reduce the water clarity of the lake. In 2011, following two years of water quality monitoring through the Minnesota Pollution Control Agency's Intensive Watershed Monitoring program, the lake was found to not be meeting water quality standards and was listed on the State of Minnesota's impaired waterbodies list for excessive nutrient content. The Little Elk Lake Improvement Association works diligently to encourage conservation along the shores of the lake and within its watershed. Additionally, Baldwin Township has overseen numerous projects to protect the lake including working with the Sherburne SWCD in past years to complete several stormwater control projects within adjacent residential neighborhoods. In 2022, the lake will be focus of a Total Maximum Daily Load (TMDL) study in which a nutrient budget will be calculated for external and internal sources of phosphorus to the lake. This study will quantify both the phosphorus sources and the reductions needed to meet water quality standards.

In late 2020, staff from Sherburne SWCD met with the Baldwin Township board regarding completion of a Sub-Watershed Assessment (SWA) which would identify priority rural and urban areas in the lake's watershed as well as determine appropriate conservation practices for these areas. With that, the project was set to begin in spring 2021.

A SWA is intended to identify potential projects within a target area to improve the water quality of a defined receiving waterbody. These potential projects are often practices that are needed to be retrofit into existing developed landscapes. In this study, instead of aiming for a certain number of projects or achieving a certain cost budget, the focus is to identify feasible practices in specific locations then examine their cost efficiency compared to pollutant reduction. In this report, both the costs to install the practice and the estimated pollutant reduction are compared to determine the cost effectiveness (amount of pollutant removed per dollar spent).

The Little Elk Lake watershed was delineated using a combination of Department of Natural Resources spatial information along with on-the-ground examinations of culvert locations and elevations. The 22,578 acre watershed was further delineated into more manageable sized 36 sub-watersheds. Seventeen of these sub-watersheds were deemed "urban" based upon dwelling density and the remaining nineteen sub-watersheds described here as "rural". In urban sub-watersheds, stormwater runoff pollutant estimates were estimated using the environmental modeling program WinSLAMM, the Source Loading and Management Model for Windows. The model first was run using baseline conditions, which included existing stormwater or other Best Management Practices (BMPs). To minimize costs with the study, the model was not calibrated so can only be used as an estimation tool to provide relative information. Specific model inputs are detailed in Appendix A. For the rural sub-watersheds, the Chisago

County SWCD's protocol, "Rural Sub-watershed Analysis Protocol" was used to examine land characteristics and ultimately determine priority rural sub-watersheds to focus attention.

Following the initial computer modeling seven urban and seven rural sub-watersheds were determined priority areas for further analysis due to their high pollutant or water volume annual load, high load per acre, proximity to the receiving waterbody, and overall condition of the sub-watershed. Baldwin Township Supervisors and Sherburne SWCD staff visited the urban sub-watersheds located around the lake and, using aerial maps and on-the-ground observations, identified potential BMP locations. Sherburne SWCD conducted separate visits to rural watershed areas, one visit to examine Sherburne County focused priority sites and one visit with Mille Lacs SWCD staff to examine conditions within Mille Lacs County focus sub-watersheds. In total, 55 potential projects were identified (Figure 1).

Costs associated with project design, administrative duties, construction, and operation and maintenance associated with these BMP types were estimated based upon the best available information. Cost data were assumed over a 30-year lifespan and compared against the model benefits (pollutant reduction) to rank projects according to a cost-benefit variable (cost-effectiveness). Although the highest ranked projects in this analysis should be considered for potential retrofit projects, it is acknowledged that other variables must be considered before implementation. Considerations for funding limitations, landowner interest, educational opportunity / visibility, site-specific feasibility and construction timing or other factors must be weighed prior to determining which retrofit projects to pursue.

Table 1 displays the findings of this study, including the applicable potential stormwater and rural runoff retrofit options within the priority areas along with the BMP types, their pollutant reduction potential, overall cost and cost effectiveness. Table 1 lists each potential project in order of cost-effectiveness with respect to phosphorus, the pollutant of highest concern for Little Elk Lake. The most cost-effective options are listed first, while lesser cost-effective options fall lower on the list.

Based upon the study results modeling, implementing all potential BMP practices within the 14 priority sub-watersheds would result in an estimated reduction of 319 lbs of phosphorus and 13,948 lbs of sediment. However, it is recognized that installing all these recommendations is not feasible due to funding availability, site-specific detailed conditions, and participation of willing landowners. Instead, it is recommended that projects be pursued in order of cost effectiveness according to Table 1 to achieve the greatest pollution reduction for the smallest amount of cost. Installation of projects in series will result in lower total treatment than the simple sum of treatment achieved by the individual projects due to treatment train effects. Reported treatment levels are depending upon optimal site selection and sizing. More detail about each project can be found in the catchment profile page of this report.

Finally, it should be noted that the cost estimates and pollution reduction estimates in this report are fine-tuned to be as accurate as possible; however, costs are estimated conservatively and pollutant reduction numbers may change based upon more detailed investigation. Site specific conditions, final BMP designs, fluctuations in material costs and bids from contractors will vary with any installed work. Users of this report should recognize that final numbers may vary from reported estimates here, but a scalable approach can be used when determining priority projects to pursue. In other words, in the priority ranking tables below the project costs and pollution reduction estimates may all be higher or lower, however the end costs should impact each project similarly so the higher-ranking projects should still rank high given a different cost or pollutant reductions structure. Thus, this report should be considered a guidance tool for informed decision making on potential BMP retrofit projects.

Table 1. Ranked BMP summary from an assessment of Little Elk Lake sub-watersheds. Table sorted by 30-year cost / lb. removal of total phosphorus.

Project Rank	Sub-watershed	Project ID	BMP Type	Volume Reduction (acft/yr)	TSS Reduction (lbs/yr)	TP Reduction (lbs/yr)	Project Cost	30-yr Avg Cost/1,000lb-TSS	30-yr Avg Cost/lb-TP
1	U007	LEL_U007_04	Shoreline Buffer Strip	-	400.0	2.6	$5,750	$504	$77
2	U007	LEL_U007_05	750 sqft RG	0.85	884.0	5.1	$11,100	$515	$90
3	R010	LEL_R010_01	Filter Strip	-	2.3	4.2	$441	$191	$104
4	U007	LEL_U007_03	250 sqft RG	0.41	338.0	3.7	$11,100	$1,346	$123
5	R010	LEL_R010_04	Filter Strip	-	3.9	6.4	$800	$204	$126
6	U017	LEL_U017_02	Shoreline Buffer Strip	-	309.0	1.3	$5,530	$629	$149
7	U007	LEL_U007_02	50 ' grass swale	0.37	365.0	1.5	$5,020	$678	$171
8	R004	LEL_R004_04	Filter Strip	-	4.6	7.6	$1,658	$363	$217
9	U007	LEL_U007_01	750 sqft RG	0.37	404.0	4.0	$26,100	$2,364	$238
10	U001	LEL_U001_02	50 ' grass swale	0.34	383.0	0.9	$5,020	$646	$288
11	U009	LEL_U009_03	50 ' grass swale	0.48	1,127.0	0.8	$5,020	$219	$298
12	R005	LEL_R005_04	Filter Strip	-	15.7	20.7	$6,238	$398	$301
13	U015	LEL_U015_03	Shoreline Buffer Strip	-	105.9	1.0	$8,500	$2,770	$303
14	U005	LEL_U005_04	1000 ' infiltration basin	2.16	843.0	3.5	$33,600	$1,429	$349
15	U002	LEL_U002_01	750 sqft RG	1.91	1,244.0	2.7	$26,100	$768	$352
16	R004	LEL_R004_02	Filter Strip	-	12.4	17.8	$6,848	$552	$384
17	U005	LEL_U005_01	50 ' grass swale	0.51	283.0	0.6	$5,020	$874	$399
18	U001	LEL_U001_03	250 sqft RG	0.58	509.0	1.1	$11,100	$894	$406
19	U005	LEL_U005_02	750 sqft RG	1.70	1,002.0	2.2	$26,100	$953	$438
20	R011	LEL_R011_03	Conservation Tillage	-	16.2	27.0	$11,976	$739	$443
21	U017	LEL_U017_01	8' HD	0.19	746.0	3.0	$29,400	$1,796	$445
22	U005	LEL_U005_03	750 sqft RG	1.87	986.0	2.1	$26,100	$969	$453
23	R010	LEL_R010_06	Conservation Tillage	-	11.2	19.0	$8,784	$787	$462
24	R005	LEL_R005_02	Filter Strip	-	8.9	14.8	$6,848	$766	$463
25	U009	LEL_U009_04	50 ' grass swale	0.37	237.0	0.5	$5,020	$1,044	$467
26	U017	LEL_U017_03	750 sqft RG	1.50	881.0	1.9	$26,100	$1,084	$497
27	R013	LEL_R013_01	Conservation Tillage	-	1.4	2.4	$1,224	$893	$506
28	U002	LEL_U002_02	250 sqft RG	0.48	401.0	0.9	$11,100	$1,135	$511
29	U009	LEL_U009_05	50 ' grass swale	0.32	204.0	0.4	$5,020	$1,212	$550
30	R005	LEL_R005_03	Filter Strip	-	18.1	24.3	$14,306	$790	$590
31	R013	LEL_R013_06	Cover Crop	-	5.2	7.8	$4,810	$934	$616
32	U009	LEL_U009_02	250 sqft RG	0.57	336.0	0.7	$11,100	$1,354	$623
33	R010	LEL_R010_07	Conservation Tillage	-	4.8	7.6	$4,812	$1,007	$637
34	U015	LEL_U015_01	250 sqft RG	0.55	320.0	0.7	$11,100	$1,422	$650
35	U017	LEL_U017_04	250 sqft RG	0.51	301.0	0.6	$11,100	$1,512	$700
36	U015	LEL_U015_02	250 sqft RG	0.48	284.0	0.6	$11,100	$1,602	$734
37	R010	LEL_R010_03	Cover Crop	-	12.3	17.5	$12,900	$1,050	$737
38	U001	LEL_U001_01	250 sqft RG	0.18	273.0	0.6	$11,100	$1,667	$746
39	R010	LEL_R010_02	Pasture / Manure Mgmt	-	12.4	10.0	$7,500	$603	$750
40	U002	LEL_U002_03	250 sqft RG	0.24	257.0	0.6	$11,100	$1,770	$784
41	R013	LEL_R013_03	Filter Strip	-	6.1	7.3	$6,034	$994	$824
42	U009	LEL_U009_01	250 sqft RG	0.39	234.0	0.5	$11,100	$1,944	$892
43	R011	LEL_R011_02	Cover Crop	-	13.7	20.6	$18,900	$1,378	$917
44	R010	LEL_R010_05	Cover Crop	-	3.2	4.9	$4,590	$1,421	$939
45	R013	LEL_R013_05	Cover Crop	-	1.4	2.2	$2,490	$1,779	$1,132
46	R003	LEL_R003_01	Wascob	-	10.2	8.7	$13,088	$1,286	$1,513
47	R004	LEL_R004_03	Wascob	-	9.9	8.4	$15,000	$1,518	$1,786
48	R003	LEL_R003_02	Wascob	-	6.4	5.4	$9,804	$1,534	$1,806
49	R011	LEL_R011_01	Pasture / Manure Mgmt	-	2.7	4.0	$7,500	$2,799	$1,875
50	R004	LEL_R004_01	Wascob	-	7.1	6.0	$13,088	$1,849	$2,178
51	R006	LEL_R006_02	Wascob	-	8.3	7.0	$16,000	$1,932	$2,273
52	R005	LEL_R005_01	Wascob	-	5.5	4.7	$13,088	$2,388	$2,809
53	R013	LEL_R013_02	Pasture / Manure Mgmt	-	2.0	2.5	$7,500	$3,676	$3,000
54	R013	LEL_R013_04	Pasture / Manure Mgmt	-	1.7	2.0	$7,500	$4,545	$3,750
55	R006	LEL_R006_01	Wascob	-	3.9	3.6	$19,044	$4,858	$5,246

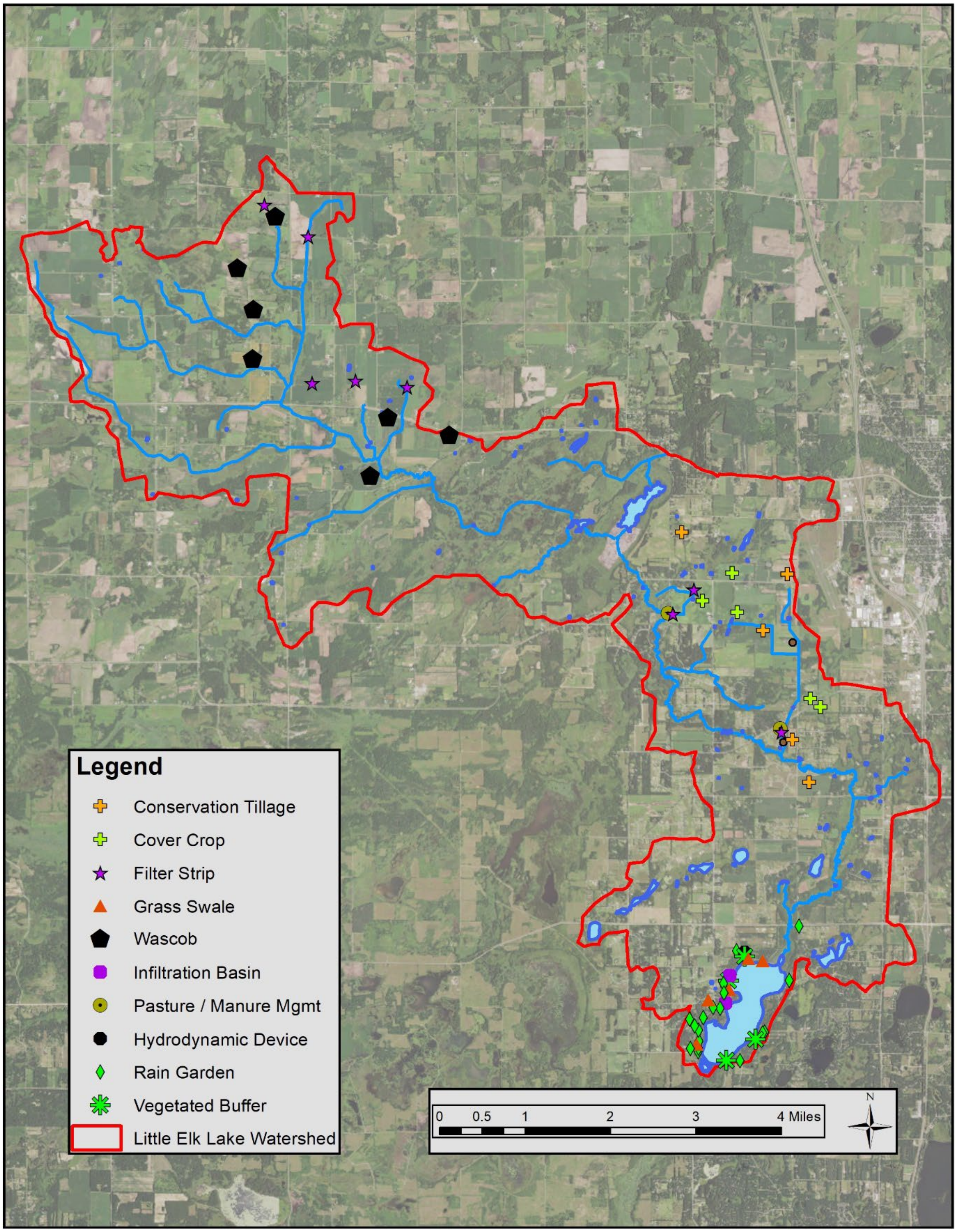


Figure 1. Map of BMP options identified and modeled within the Little Elk Lake SWA.

Introduction

Many factors are considered when choosing which sub-watersheds to analyze for BMP retrofits. Water quality monitoring data, non-degradation report modeling, and TMDL studies are just a few of the resources available to help determine which water bodies are a priority. Sub-watershed analyses supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data, etc.) to greater facilitate the process also rank highly. For some communities a sub-watershed analysis complements their Municipal Separate Storm Sewer System (MS4) stormwater permit. The focus is always on a high priority waterbody.

Little Elk Lake is one of the largest waterbodies in Sherburne County, Minnesota at approximately 362 acres in size. The lake is relatively shallow with an average depth of 7 feet and maximum of 15 feet. The watershed that drains to the lake consists of 22,578 acres of and includes the headwaters in Benton County (2,791 acres), a portion of Mille Lacs County (10,079 acres) and ends in Sherburne County (12,948 acres). The stream draining this watershed is called Battle Brook. Battle Brook continues at the lake's southern outlet and travels further downstream to the St. Francis River.

Little Elk Lake was included on the State of Minnesota's 2011 impaired waterbodies list for holding excessive nutrient content which feeds abundant plant growth as well as mid and late summer algae blooms. Recently collected data from 2019 and 2020 suggests the lake's nutrient content, algae abundance, and water clarity continues to exceed state water quality standards. However, long-term Secchi disk clarity monitoring conducted by Little Elk Lake Improvement Association volunteers indicates that there have been subtle improvements in the lake's clarity (LELIA annual meeting presentation, 2021).

Battle Brook is a small tributary stream that is currently listed by the State of Minnesota as being impaired for excessive e.coli bacteria as well as a poor fish and insect community. During 2019-2020 Intensive Watershed Monitoring, the collected data suggests that the phosphorus being transported via Battle Brook is on the higher side (two year mean of 75 ug/L, range of 39-122 ug/L) but still falling underneath the Central Stream standard threshold of 100 ug/L at this time.

At the time of this writing, internal sources of phosphorus to Little Elk Lake have not been quantified or studied. However, in 2022 the lake will be focus of a Total Maximum Daily Load (TMDL) study in which a nutrient budget will be calculated for external and internal sources of phosphorus to the lake. This study will quantify both the phosphorus sources and the reductions needed to meet water quality standards.

Completing this assessment allows for a formal process to be completed in identifying the best areas to complete conservation work within. It also provided an opportunity to discuss conservation with area stakeholders and managers. Finally, as this report identifies the best locations for conservation work and the most cost-effective practices to install in these locations, this analysis will be helpful for future pursuit of funding to help bring these practices to fruition.

About This Document

This Sub-Watershed Assessment is a watershed management tool to help prioritize urban and rural conservation projects by performance and cost effectiveness. This process helps maximize the value of each dollar spent.

Urban Catchments:
Urban sub-watersheds (catchments) are defined as being adjacent to and directly draining to the lake. These areas are largely built-out residential. Modeling of existing conditions and pollutant reductions for each project was completed with the environmental model WinSLAMM.

Urban catchments are noted on the maps in this report with a lake identifier code, the letter "U", followed by the sub-watershed name. Individual BMP projects are further noted after the sub-watershed code with a number value. An example is provided below:

LEL_U001_01

LEL = Little Elk Lake

U001 = Urban sub-watershed 001

01 = Project #01 in this sub-watershed

Rural Catchments:
Rural sub-watersheds (catchments) are defined as areas not adjacent to Little Elk Lake, but within the lake's drainage area and contributing drainage to the lake's primary inlet stream, Battle Brook. The Chisago SWCD protocol "Rural Sub-watershed Analysis Protocol Part 1- Targeting" was used to highlight the areas with the highest potential for contributing sediment and nutrients to the Lake.

Rural catchments are noted on the maps in this report with a lake identifier code, the letter "R", followed by the sub-watershed name. Individual BMP projects are further noted after the sub-watershed code with a number value. An example is provided below:

LEL_R001_01

LEL = Little Elk Lake

R001 = Rural sub-watershed 001

01 = Project #01 in this sub-watershed

Analytical Process and Elements

This sub-watershed analysis is a management tool that can help to identify and prioritize potential BMP retrofit projects by performance and cost-effectiveness. This tool helps to maximize the value of each dollar spent. The process used for this analysis is outlined in the following pages and was modified from the Center for Watershed Protection's Urban Stormwater Retrofit Practices, Manuals 2 and 3 (Schueler & Kitchell, 2005 and Schueler et al. 2007) as well as a protocol developed by Chisago SWCD (Rural Sub-watershed Analysis Protocol, 2015). Locally relevant design considerations were also incorporated into the process (Technical Documents, Minnesota Stormwater Manual, 2014).

Scoping includes determining the objectives of the retrofits (volume reduction, target pollutant, etc.) and the level of treatment desired. It involves meeting with local land decision-makers and other partners to determine the issues in the watershed. This step also helps to define preferred retrofit treatment options and retrofit performance criteria. To create a manageable area to analyze in large sub-watersheds, a focus area may be determined.

In this analysis, the focus areas first consisted of the 36 sub-watersheds draining towards Little Elk Lake. Following additional research into these areas, the list was paired back to 14 sub-watersheds that were determined to have higher modeled pollutant loads as well as capacity for improvement. These watersheds include primarily urban lakeshore residence areas, suburban parcels, and rural agricultural or pasture and animal lots. Existing stormwater infrastructure maps, topography data, and direct observations of flow following rain events were used to determine drainage boundaries for the sub-watersheds included in this analysis.

The targeted pollutants for this study were TP and TSS, though volume was also estimated and reported as it is necessary for pollutant loading calculations and potential retrofit project considerations. Table 2 describes the target pollutants and their role in water quality degradation. Projects that effectively reduce loading of multiple target pollutants can provide greater immediate and long-term benefits.

It should be noted that although chloride is an emerging stormwater pollutant of concern, particularly in urban areas, this report does little to address it. Chloride dissolves readily in stormwater and is unable to be "treated" using traditional stormwater practices. To reduce chloride from reaching Little Elk Lake, resources are best spent investigating ways to utilize "Smart Salting" technology and techniques which result in less road salt on area roads and less chemical fertilizer on farming fields. Residential water softeners are an additional source of chloride to groundwater, so education and outreach on how to use these machines as efficiently as possible is encouraged.

Table 2: Target Pollutants

Total Phosphorus (TP)	Phosphorus is a nutrient essential to plant growth and is commonly the factor that limits the growth of plants in surface water bodies. TP is a combination of particulate phosphorus (PP), which is bound to sediment and organic debris, and dissolved phosphorus (DP), which is in solution and readily available for plant growth (active).
Total Suspended Solids (TSS)	Very small mineral and organic particles that can be dispersed into the water column due to turbulent mixing. TSS loading can create turbid and cloudy water conditions and carry with it TP. As such, reductions in TSS will also result in TP reductions.
Volume	Higher runoff volumes and velocities can carry greater amounts of TSS and TP to receiving water bodies. It can also exacerbate soil erosion, thereby increasing TSS and TP loading. As such, reductions in volume may reduce TSS loading and, by extension, TP loading.

Desktop analysis involves computer-based scanning of the sub-watershed for potential retrofit catchments and/or specific sites. This step also identifies areas that do not need to be analyzed because of existing stormwater treatment or disconnection from the target water body. Accurate GIS data are extremely valuable in conducting the desktop retrofit analysis. Some of the most important GIS layers include: 2-foot or finer topography (Light Detection and Ranging [LiDAR] was used for this analysis), surface hydrology, soils, watershed/sub-watershed boundaries, parcel boundaries, high-resolution aerial photography, and the stormwater drainage infrastructure.

Field investigation is conducted after potential retrofits are identified in the desktop analysis to evaluate each site and identify additional opportunities. During the investigation, the drainage area and surface stormwater infrastructure mapping data were verified. Site constraints were assessed to determine the most feasible retrofit options as well as eliminate sites from consideration. The field investigation may have also revealed additional retrofit opportunities that could have gone unnoticed during the desktop search. Finally, where needed a small-scale culvert inventory may be completed to verify drainage pathways and sub-watershed boundaries.

Modeling involves assessing multiple scenarios to estimate pollutant loading and potential reductions by proposed retrofits. WinSLAMM (version 10.4.0), which allows routing of multiple catchments and stormwater treatment practices, was used for the urban analysis. WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. Therefore, the volume and pollutant estimates in this report are not waste load allocations, nor does this report serve as a TMDL for the study area. The WinSLAMM model was not calibrated and was only used as an estimation tool to provide relative ranking across potential projects. Soils throughout the study area were predominantly sandy based on the information available in the Sherburne County soil survey.

The initial step was to create a "base" model which estimates pollutant loading from each catchment in its present-day state without taking into consideration any existing stormwater treatment. To accurately model the land uses in each catchment, a full watershed delineation was completed using the watershed ArcGIS Spatial Analysis tools and modified manually as necessary using stormwater infrastructure data. The drainage areas were then consolidated into catchments using ArcGIS Spatial Analysis. Land use data were used to calculate acreages of each land use type within each catchment. Soil types throughout the sub-watershed were modeled in this analysis based on the information available in the NRCS Web Soil Survey. Entering the acreages, land use, and soil data into WinSLAMM ultimately resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment. After "base" models were completed, an "existing" conditions model was run using any current stormwater treatment such as street cleaning, stormwater treatment ponds, etc.

For the rural analysis, the Revised Universal Soil Loss Equation 2 (RUSLE2) software was used to determine pollutant reductions from prospective BMPs. "Base" conditions were determined first, all fields were assumed to utilize a corn / soybean rotation (RUSLE setting Corn FC Disk Fld Cult-Soybeans FC Disk Fld Cult) and contouring was assumed at a middle value for the absolute row grade. Field export estimates were input to the Board of Water and Soil Resources' (BWSR) Pollution Reduction Estimator spreadsheet to determine the level of phosphorus and sediment reduction on a given BMP practice. MinnFarm (Schmidt and Wilson, 2008) was used for animal feedlot modeling. Table 3 displays the most common BMPs selected for Priority Zone catchments and the modeling procedures that were utilized for each one. Note that nutrient management is currently believed to be utilized by all agricultural operators in the watershed so this was not an option included in the study.

Table 3. Rural catchment modeling programs for Little Elk Lake Sub-Watershed Assessment.

Parameter / BMP	Model
Wascob	BWSR Spreadsheet - Gully
Grassed Waterway	BWSR Spreadsheet - Gully
Filter Strip	BWSR Spreadsheet - Filter Strip; RUSLE2
Gully Stabilization	BWSR Spreadsheet - Gully
Permanent Vegetation	BWSR Spreadsheet - Sheet and Rill; RUSLE2
Cover Crops	BWSR Spreadsheet - Sheet and Rill; RUSLE2
Conservation Tillage	BWSR Spreadsheet - Sheet and Rill; RUSLE2
Pasture / Manure Mgmt	MinnFarm; RUSLE2

Finally, each proposed BMP practice was added individually to the "existing conditions" model and pollutant reductions were estimated. Because neither a detailed design of each practice nor in-depth site investigation was completed, a generalized design for each practice was used. Whenever possible, site-specific parameters were included. Design parameters were modified to obtain various levels of treatment. It is worth noting that each practice was modeled individually, and the benefits of projects may not be additive, especially if serving the same area (i.e. treatment train effects). Reported treatment levels are dependent upon optimal site selection and sizing. Additional information on modeling procedures can be found in Appendix A.

Cost estimating is essential for the comparison and ranking of projects, development of work plans, and pursuit of grants and other funds. Costs throughout this report were estimated using a multitude of sources, including The Center for Watershed Protection's Urban SubWatershed Restoration Manuals (Schueler & Kitchell, 2005 and Schueler et al. 2007), recent project installation quotes, and cost estimates provided to the Sherburne SWCD by personal contacts. Cost estimates were annualized costs that incorporated the elements listed below over a 10 (rural projects) and 30 (urban projects) year period.

<u>Project promotion and administration</u> includes local staff efforts to reach out to landowners, administer related grants, and complete necessary administrative tasks.

<u>Design</u> includes site surveying, engineering, and construction oversight.

<u>Land or easement acquisition</u> cover the cost of purchasing property or the cost of obtaining necessary utility and access easements from landowners.

<u>Construction</u> calculations are project specific and may include all or some of the following; grading, erosion control, vegetation management, structures, mobilization, traffic control, equipment, soil disposal, and rock or other materials.

<u>Maintenance</u> includes annual inspections and minor site remediation such as vegetation management, structural outlet repair and cleaning, and washout repair.

In cases where promotion to landowners is important, such as rain gardens, those costs were included as well. In cases where multiple, similar projects are proposed in the same locality, promotion and administration costs were estimated using a non-linear relationship that accounted for savings with scale. Design assistance from an engineer is assumed for practices in-line with the stormwater conveyance system, involving complex stormwater treatment interactions, or posing a risk for upstream flooding. No site-specific construction investigations were done as part of this stormwater retrofit analysis, and therefore cost estimates account for only general site considerations. Detailed feasibility analyses may be necessary for some projects. Generalized cost estimates are provided in Appendix B.

Project ranking is essential to identify which projects could be pursued to achieve water quality goals. The intent of this analysis is to provide the information necessary to enable local natural resource managers to successfully secure funding for the most cost-effective projects to achieve water quality goals. This analysis ranks potential projects by cost-effectiveness to facilitate project selection. There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point. Local resource management professionals will be responsible to select projects to pursue. Several considerations in addition to project cost-effectiveness for prioritizing installation are included.

If all identified practices were installed, significant pollution reduction could be accomplished. However, funding limitations and landowner interest will likely be limiting factors for implementation. The tables on the following pages rank all modeled projects by cost-effectiveness.

Projects were ranked in terms of the 30 year cost per pound of total phosphorus removed (Table 1), but could be ranked with respect to the cost per 1,000 pound of total suspended solids removed as well.

Project selection involves considerations other than project ranking. The combination of projects selected for pursuit could strive to achieve TSS and TP reductions in the most cost-effective manner possible. Several other factors affecting project installation decisions should be weighed by resource managers when selecting projects to pursue. These factors include but are not limited to the following:

- Total project costs
- Cumulative treatment
- Availability of funding
- Economies of scale
- Landowner willingness
- Project combinations with treatment train effects
- Non-target pollutant reductions
- Timing coordination with other projects to achieve cost savings
- Stakeholder input
- Number of parcels (landowners) involved
- Project visibility
- Educational value
- Long-term impacts on property values and public infrastructure

Additional Conservation Considerations

The intent of this study was to examine the existing conditions and mitigation potential for surface water flow ("stormwater") related pollution, with a specific receiving waterbody (Little Elk Lake) in mind. Other conservation-minded activities were noted during this study which were out of the original scope but are included below for the reader's general information.

Shoreline erosion: Erosion along shoreline can unfortunately be common as waves, wind, and ice batter the shorelines, vegetation management changes, and developmental pressure increases. As a shoreline erodes, it can deposit sediment and nutrients into a lake which may lead to algae proliferation and habitat alteration. It also can be frustrating to a landowner to see their property "washing away". Of course, shoreline erosion occurs in various degrees and so the remedy for a degrading shoreline changes with the extent of the issue present. The best proven methods for shoreline erosion control are 1) increasing native vegetation on the toe, slope, and upland areas of the shoreline, 2) combatting serious erosion situations with bioengineered products or rock rip rap (in extreme cases or steep slopes), 3) altering the grade of the slope or 4) a combination of all techniques. Each shoreline is different and so a unique approach may need to be considered depending on the slope, soils, cause of disturbance, position on the lake, etc. Sherburne SWCD provides technical assistance to landowners through our shoreline management program – for more information visit: https://www.sherburneswcd.org/water-management.html.

Hobby farm and animal waste: Sherburne County hosts numerous small animal operations, sometimes called small farms or hobby farms. Consisting of small operations with chickens, goats, sheep, alpacas, horses or cows these farms offer rich recreational experiences for families. Resource concerns related to animal waste may or may not occur on these farms related to the quality of soils, vegetation management, waste management and proximity to surface or ground water. As Battle Brook is currently listed by the Minnesota Pollution Control Agency as holding excessive e.coli bacteria, improvements on animal feedlots may help to reduce bacteria content in the stream and connected waterways.

Sherburne SWCD has staff with expertise in small farm operations and animal waste management and can offer free technical assistance through a Small Farms Program for county residents. Visit the SWCD's website for more information on soil health, pasture management, nutrient management and more: https://www.sherburneswcd.org/rural-resource-management.html.

Study Area

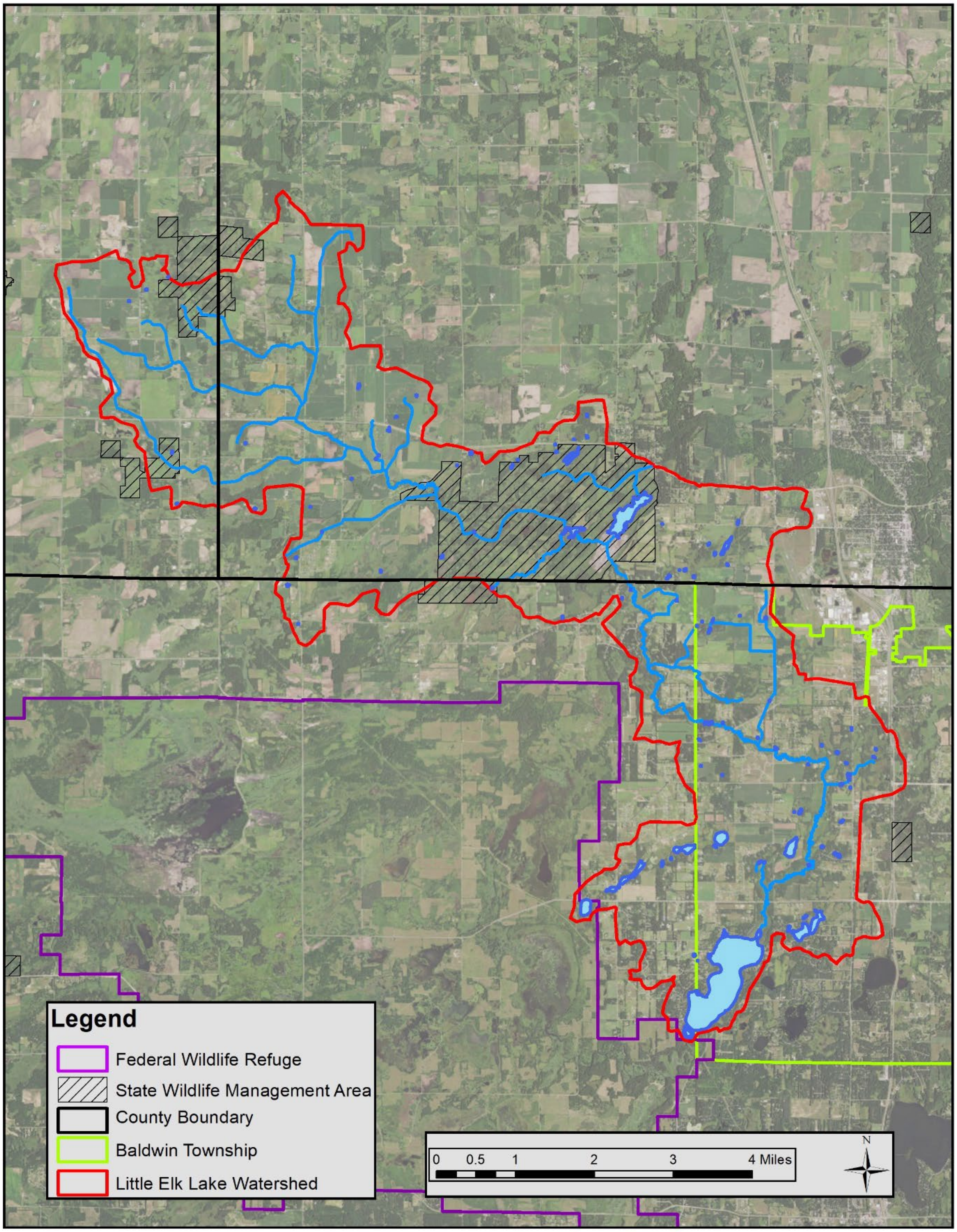


Figure 2: Little Elk Lake watershed.

Geographic Setting

Little Elk Lake lies mostly within Baldwin Township and a portion of Blue Hill Township, Sherburne County, Minnesota (Figure 2). Its watershed spans 22,578 acres, nearly 13,000 of which (50%) lies in Sherburne County. Roughly 39% of the watershed falls within Mille Lacs County and the remaining small portion can be found in Benton County. The area has been historically noted for agricultural as well as several large portions of public land including several Wildlife Management Areas and the nearby Sherburne National Wildlife Refuge. However, this watershed has seen development pressure as suburbs span outwards from both Princeton and Zimmerman.

Soils

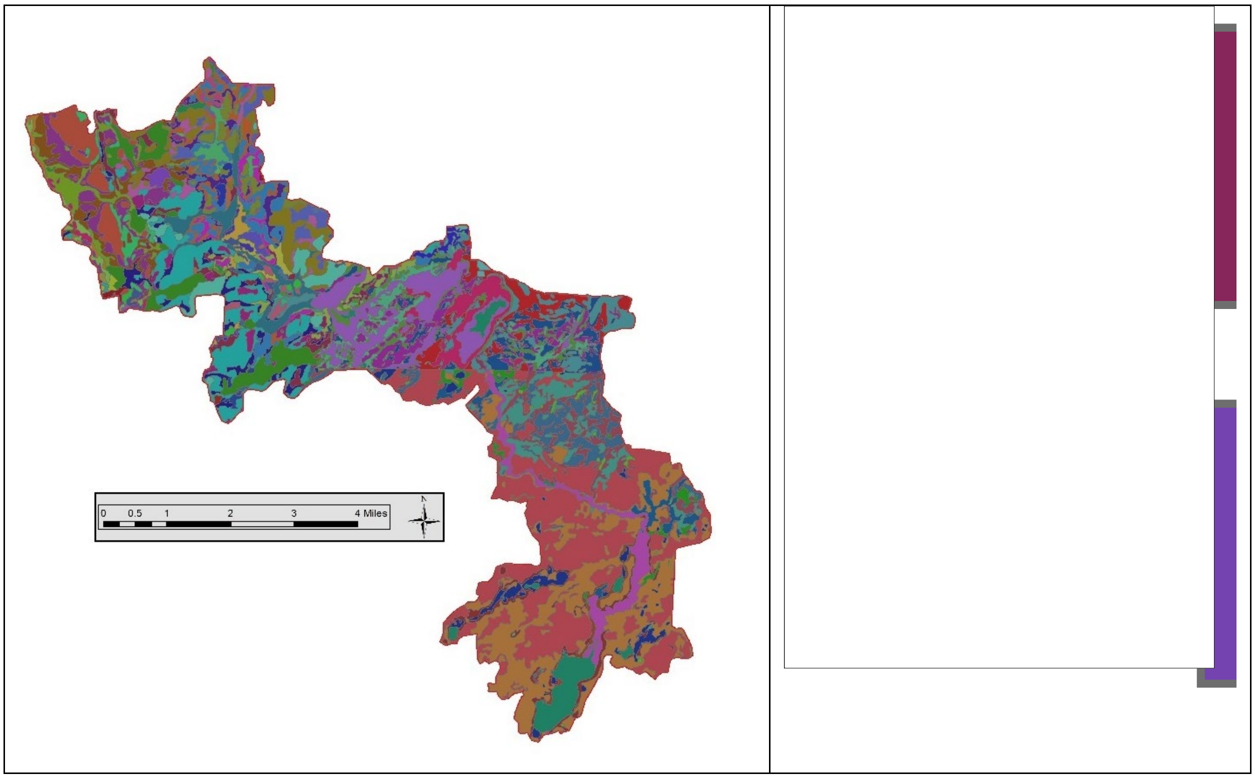


Figure 3: Little Elk Lake watershed area soils.

Most of Sherburne County lies within the Anoka Sand Plains, a broad area that years ago was lake bottom (Figure 3). Sand dunes, kettle lakes and tunnel valleys are prominent features in the region and are associated with glacial activity. These sandy soils are excessively drained, making for high infiltration rates and relatively low organic matter. While bedrock in the western portion of the county underlie the topsoil at depths of 0-100 feet, the eastern areas of the county where Little Elk Lake is located hold sedimentary rocks under topsoil with bedrock being found 50-300 feet below the soil. These soils make for high movement conditions, so infiltration-based practices are most suitable. However, sandy soils need to be carefully managed due to the potential for leaching of pollutants with groundwater.

Watershed Delineation and Priority Setting

In determining the applicable study area for this exercise, a number of resources were utilized including previous available watershed delineations, aerial photography, LIDAR information, observations of surface flow in relation to culvert locations, etc. These resources were compiled into a GIS databased and used to create the map depicted on Figure 2, which represents the watershed, or contributing catch-basin for Little Elk Lake. Following this exercise several questionable existed which required further examination. SWCD staff completed a culvert inventory of key areas of the watershed and examined flow characteristics in several ditches to assist delineating the full watershed as well as sub-watersheds as described in the text that follows.

These resources were used within a GIS database to delineate 36 sub-watershed catchments within the Little Elk Lake watershed. 17 of these watersheds were deemed “urban”, while the remaining 19 sub-watersheds placed in a “rural” category. Following sub-watershed delineation, the stormwater modeling program WinSLAMM was used to estimate current stormwater pollutant contributions from each of the urban sub-watersheds. The current pollution load from each sub-watershed was estimated and ranked in terms of most phosphorus and solids produced per acre basis. The result was the determination of seven priority basins which, due to their unique conditions, were estimated to have higher pollutant loads per area and thus should be approached first for pollution reduction (Figure 4). Local knowledge of conditions and the opportunity to retrofit during upcoming construction played a role in priority area selection as well.

For rural sub-watersheds, the Chisago County SWCD’s protocol, “Rural Sub-watershed Analysis Protocol” was followed to determine priority focus zones. This GIS-based protocol utilizes soil, slope, precipitation, land management, hydrology, and other information sources to identify areas most likely to contribute phosphorus and sediment to a receiving waterbody. Land areas are thus identified in terms of their potential for phosphorus and sediment delivery. In Figure 5, areas in orange / red coloring are assumed to have a higher pollutant delivery than areas shaded in green or light yellow. Figure 6 depicts the resulting rural sub-watershed focus areas because of the rural assessment protocol.

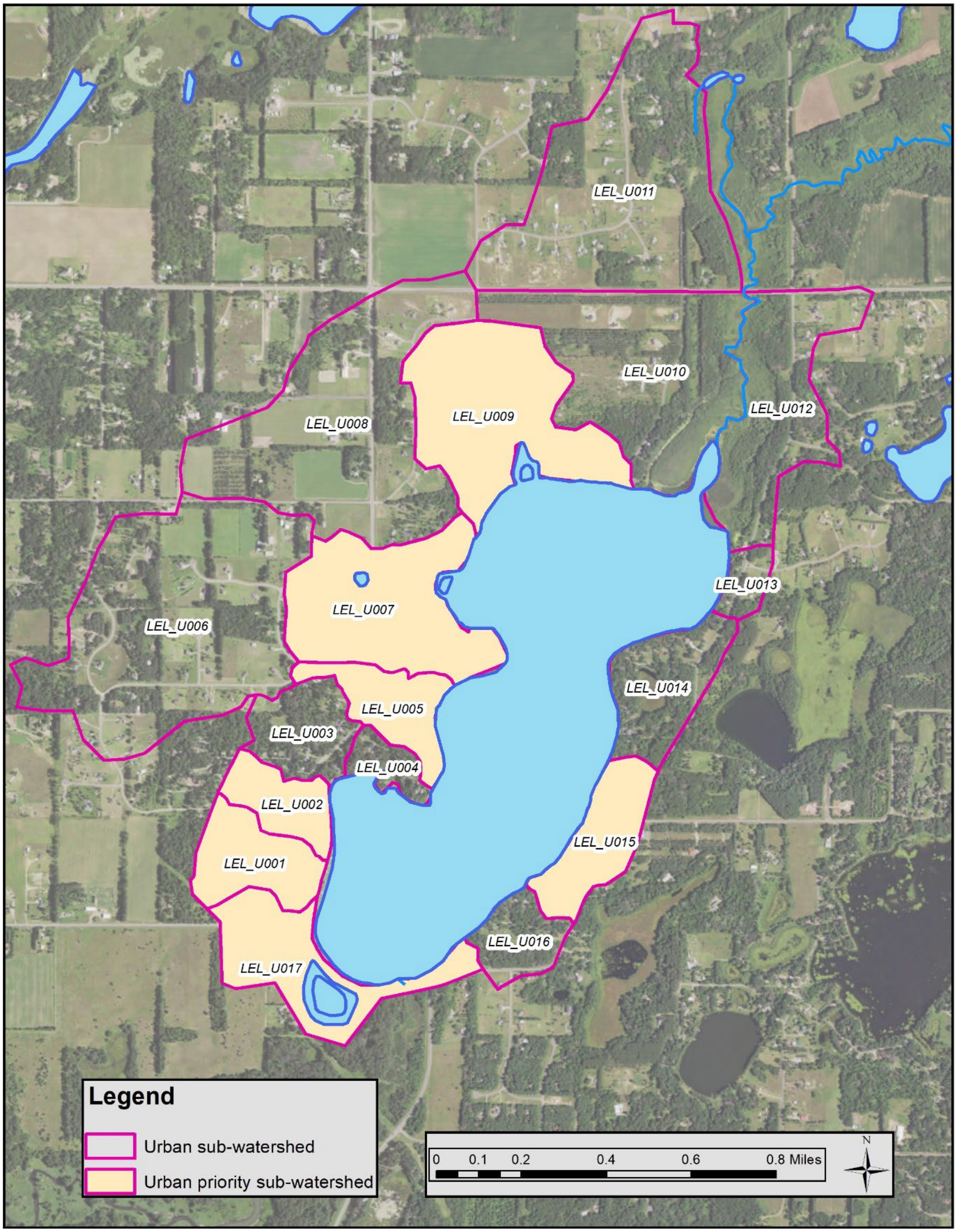


Figure 4: Little Elk Lake urban priority and non-priority sub-watersheds.

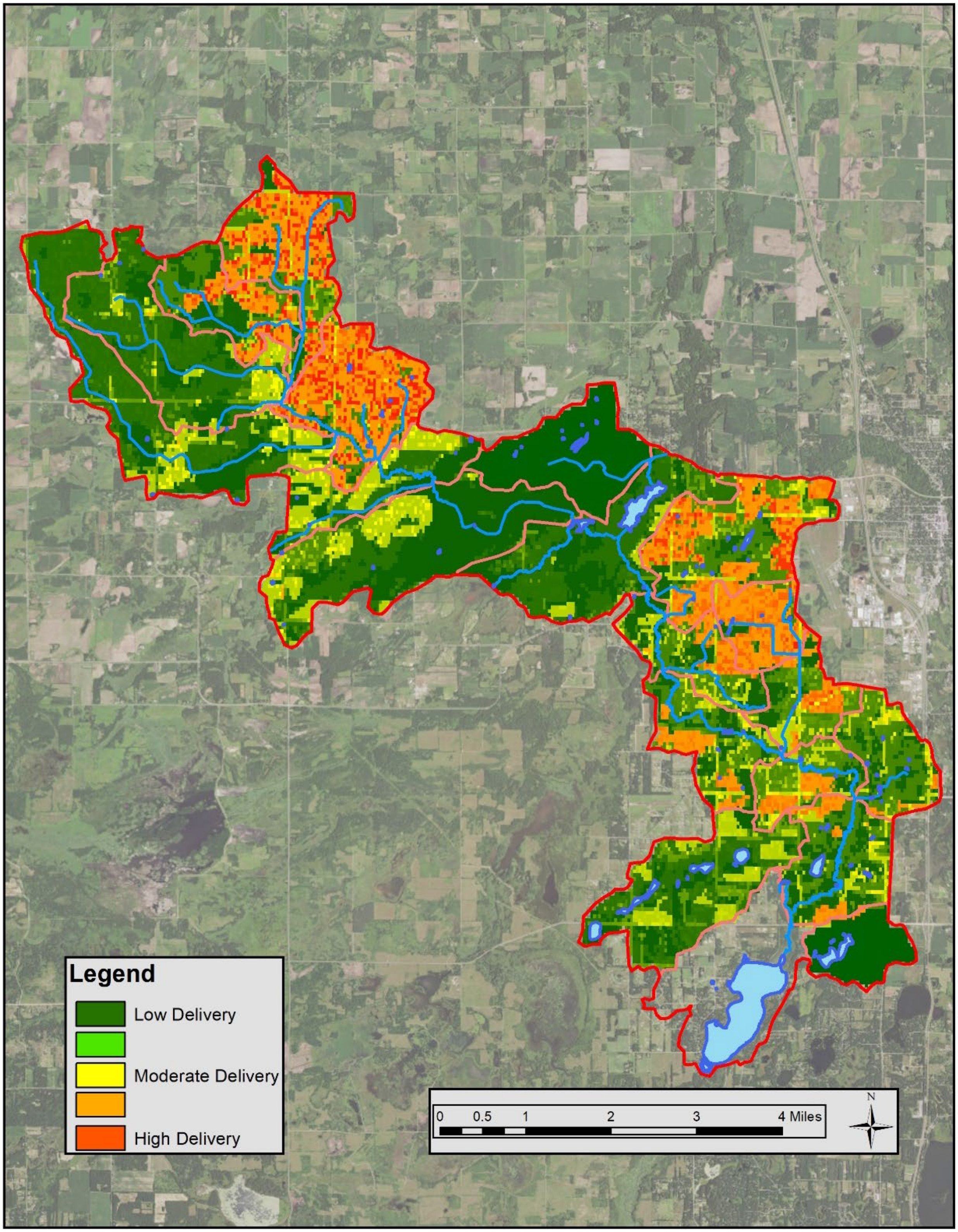


Figure 5: Little Elk Lake rural land analysis results.

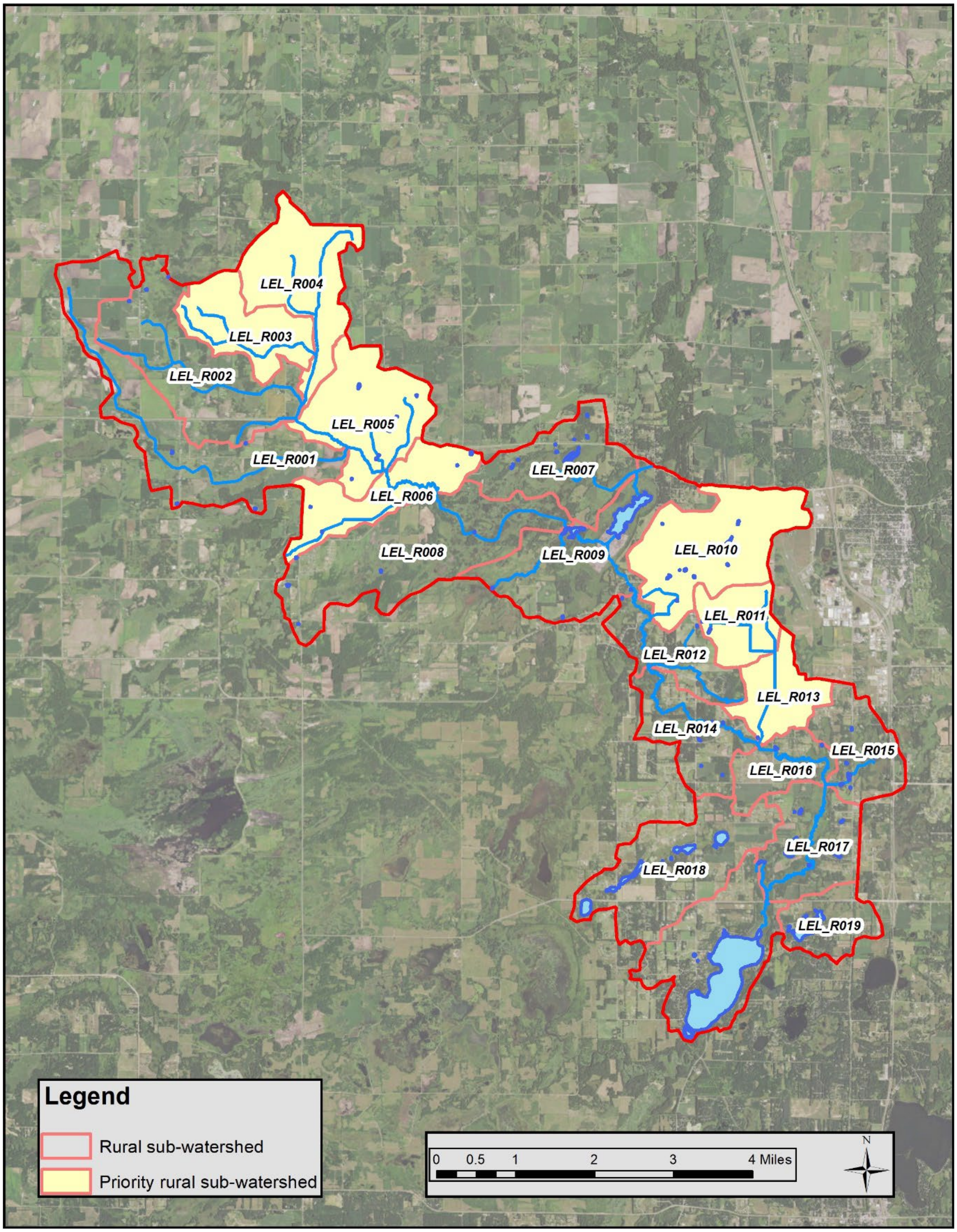


Figure 6: Little Elk Lake rural priority and non-priority sub-watersheds.

BMP Identification Process Note

As previously noted, potential BMPs were identified through several resources including aerial map reviews, on the ground observations and conversations with Baldwin Township Supervisors and Mille Lacs SWCD staff. Several conversations were had with private landowners in the watershed. This section of the report is included to review some of the discoveries and challenges involved with this process.

Urban / lakeshore sub-watersheds: The western and northern side of Little Elk Lake includes numerous relatively small parcels. Smaller practices such as rain gardens require a certain footprint, but must also meet setback requirements from wells, structures, groundwater table, etc. In this environment obstacles such as trees, tree roots, mailboxes, pavement, and other items can present a challenge as well. Finally, as you near the lakeshore area the distance from the surface to groundwater table decreases. The Minnesota Stormwater Manual requires a minimum a three-foot separation between the bottom of an infiltration practice and the groundwater, and in some cases a potential infiltration BMP had to be removed from consideration due to this requirement. When possible, alternatives such as vegetative swales were considered.

Rural sub-watersheds: As the watershed extends to the north, lot sizes increase. Suburban home parcels from 1-5 acres in size dot the landscape north of Little Elk Lake, and on the west side of the City of Princeton. Gradually, lot sizes increase to accommodate agriculture and animal pastures.

The larger lot sizes here offer opportunities for BMP placement. However, the hydrology of the landscape and the land use often dictate if BMPs are feasible and which types would work best. Some of the glacial outwash areas in the watershed have very little relief, so a single “edge-of-field” BMP would do little to capture and treat water runoff. Numerous areas would require field-scale BMPs such as cover crop or conservation tillage to be effective.

Sub-Watershed Profiles

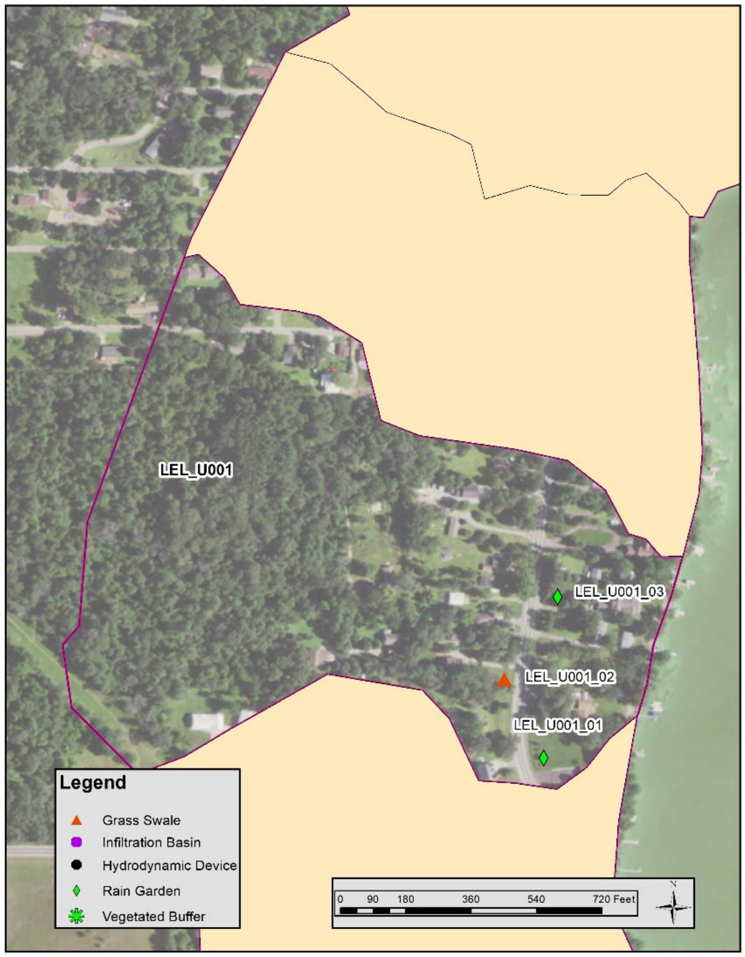
The pages that follow outline each of the priority urban and rural sub-watersheds. The urban sub-watersheds are presented first, followed by the rural sub-watersheds. For each, the following information is provided:

- Baseline pollution modeling (urban only)
- The potential BMPs that could be incorporated in the landscape
- The estimated pollution reductions from these BMPs
- The estimated cost of these BMPs
- The pollution reduction relative to cost ($ per lb of reduction)

Priority Sub-watershed U001

Sub-watershed Characteristics	
Acres	33.7
Dominant Land Cover	Med Dense Urban

This sub-watershed lies on the southwest side of Little Elk Lake and is steeply sloped. BMPs were selected near the higher density lakeside regions of the sub-watershed.



	Existing Conditions	**Base Loading**	**Treatment**	**Net Treatment %**	**Existing Loading**
Treatment	**Number of BMPs**	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	18.8	1.7	9%	**17.1**
	TSS (lb/yr)	8,504	730.0	9%	**7,774**
	Volume (acre-feet/yr)	13.5	0.0	0%	**13.5**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 4: Sub-watershed U001 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

LEL_U001_01

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.61	3.6%
	TSS (lb/yr)	273	3.5%
	Volume (acre-feet/yr)	0.18	1.3%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$746**	
	30-yr Average Cost/1,000lb-TSS	**$1,667**	
	30-yr Average Cost/ac-ft Vol.	**$2,520**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U001_02

Vegetated Swale

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	50	ln-ft
	TP (lb/yr)	0.86	5.0%
	TSS (lb/yr)	383	4.9%
	Volume (acre-feet/yr)	0.34	2.5%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$3,220	
	Total Estimated Project Cost	**$5,020**	
	Annual O&M***	$80	
Efficiency	30-yr Average Cost/lb-TP	**$288**	
	30-yr Average Cost/1,000lb-TSS	**$646**	
	30-yr Average Cost/ac-ft Vol.	**$738**	

*Indirect Cost: (30 hours at $60/hour)

**Direct Cost: ($50/sqft materials & labor) + 12 hours/BMP at $60/hour design)

***Per BMP: ($150/year at year 10) + ($75/year for routine maintenance)

LEL_U001_03

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	1.12	6.6%
	TSS (lb/yr)	509	6.5%
	Volume (acre-feet/yr)	0.58	4.3%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$406**	
	30-yr Average Cost/1,000lb-TSS	**$894**	
	30-yr Average Cost/ac-ft Vol.	**$789**	

*Indirect Cost: (30 hours at $60/hour base cost)

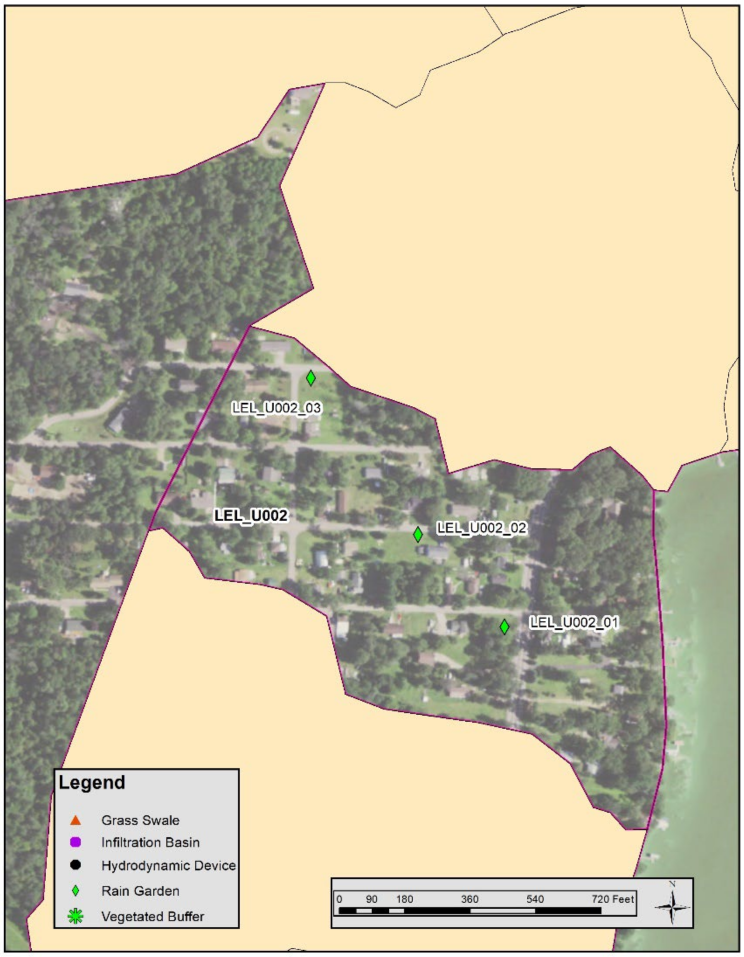
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

Priority Sub-watershed U002

Sub-watershed Characteristics	
Acres	23.3
Dominant Land Cover	Med Dense Urban

This sub-watershed lies along the western edge of Little Elk Lake and includes rolling topography and housing in medium density.



	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	13.0	1.2	9%	**11.8**
	TSS (lb/yr)	5,880	505.0	9%	**5,375**
	Volume (acre-feet/yr)	9.3	0.0	0%	**9.3**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 5: Sub-watershed U002 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

LEL_U002_01

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	750	sq-ft
	TP (lb/yr)	2.71	23.0%
	TSS (lb/yr)	1,244	23.1%
	Volume (acre-feet/yr)	1.91	20.5%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$24,300	
	Total Estimated Project Cost	**$26,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$352**	
	30-yr Average Cost/1,000lb-TSS	**$768**	
	30-yr Average Cost/ac-ft Vol.	**$499**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U002_02

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.89	7.5%
	TSS (lb/yr)	401	7.5%
	Volume (acre-feet/yr)	0.48	5.2%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$511**	
	30-yr Average Cost/1,000lb-TSS	**$1,135**	
	30-yr Average Cost/ac-ft Vol.	**$944**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U002_03

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.58	4.9%
	TSS (lb/yr)	257	4.8%
	Volume (acre-feet/yr)	0.24	2.6%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$784**	
	30-yr Average Cost/1,000lb-TSS	**$1,770**	
	30-yr Average Cost/ac-ft Vol.	**$1,879**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

Sub-watershed U005

Sub-watershed Characteristics	
Acres	29.8
Dominant Land Cover	Med Dense Urban

Along the west side of Little Elk Lake, sub-watershed U005 includes numerous residential small lots as well as a public access owned by Baldwin Township.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Wetland Pond			
	TP (lb/yr)	18.9	2.6	14%	**16.3**
	TSS (lb/yr)	8,652	1136.0	13%	**7,516**
	Volume (acre-feet/yr)	14.5	0.2	1%	**14.3**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 6: Sub-watershed U005 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

LEL_U005_01

Vegetated Swale

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	50	ln-ft
	TP (lb/yr)	0.62	3.8%
	TSS (lb/yr)	283	3.8%
	Volume (acre-feet/yr)	0.51	3.5%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$3,220	
	Total Estimated Project Cost	**$5,020**	
	Annual O&M***	$80	
Efficiency	30-yr Average Cost/lb-TP	**$399**	
	30-yr Average Cost/1,000lb-TSS	**$874**	
	30-yr Average Cost/ac-ft Vol.	**$487**	

*Indirect Cost: (30 hours at $60/hour)
**Direct Cost: ($50/sqft materials & labor) + 12 hours/BMP at $60/hour design)
***Per BMP: ($150/year at year 10) + ($75/year for routine maintenance)

LEL_U005_02

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	750	sq-ft
	TP (lb/yr)	2.18	13.4%
	TSS (lb/yr)	1,002	13.3%
	Volume (acre-feet/yr)	1.70	11.9%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$24,300	
	Total Estimated Project Cost	**$26,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$438**	
	30-yr Average Cost/1,000lb-TSS	**$953**	
	30-yr Average Cost/ac-ft Vol.	**$561**	

*Indirect Cost: (30 hours at $60/hour base cost)
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)
***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U005_03

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	750	sq-ft
	TP (lb/yr)	2.11	13.0%
	TSS (lb/yr)	986	13.1%
	Volume (acre-feet/yr)	1.87	13.0%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$24,300	
	Total Estimated Project Cost	**$26,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$453**	
	30-yr Average Cost/1,000lb-TSS	**$969**	
	30-yr Average Cost/ac-ft Vol.	**$512**	

*Indirect Cost: (30 hours at $60/hour base cost)
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)
***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U005_04

Infiltration Basin

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	1,000	sq-ft
	TP (lb/yr)	3.45	21.2%
	TSS (lb/yr)	843	11.2%
	Volume (acre-feet/yr)	2.16	15.1%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$31,800	
	Total Estimated Project Cost	**$33,600**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$349**	
	30-yr Average Cost/1,000lb-TSS	**$1,429**	
	30-yr Average Cost/ac-ft Vol.	**$558**	

*Indirect Cost: (30 hours at $60/hour base cost)
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)
***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

Sub-watershed U007

Sub-watershed Characteristics	
Acres	84.0
Dominant Land Cover	Med Dense Urban

Sub-watershed U007 includes a number of residential parcels and a single business. A single stormwater pond currently exists and is maintained by the County.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	Street Cleaning, Wetland Pond			
	TP (lb/yr)	49.1	2.4	5%	**46.7**
	TSS (lb/yr)	22,329	2362.0	11%	**19,967**
	Volume (acre-feet/yr)	36.2	0.1	0%	**36.1**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 7: Sub-watershed U007 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

_LEL_U007_01_

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
Treatment	Total Size of BMPs	750	sq-ft
Treatment	TP (lb/yr)	4.01	8.6%
Treatment	TSS (lb/yr)	404	2.0%
Treatment	Volume (acre-feet/yr)	0.37	1.0%
Cost	Administration & Promotion Costs*	$1,800	
Cost	Design & Construction Costs**	$24,300	
Cost	Total Estimated Project Cost	**$26,100**	
Cost	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$238**	
Efficiency	30-yr Average Cost/1,000lb-TSS	**$2,364**	
Efficiency	30-yr Average Cost/ac-ft Vol.	**$2,600**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

_LEL_U007_02_

Vegetated Swale

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
Treatment	Total Size of BMPs	50	ln-ft
Treatment	TP (lb/yr)	1.45	3.1%
Treatment	TSS (lb/yr)	365	1.8%
Treatment	Volume (acre-feet/yr)	0.37	1.0%
Cost	Administration & Promotion Costs*	$1,800	
Cost	Design & Construction Costs**	$3,220	
Cost	Total Estimated Project Cost	**$5,020**	
Cost	Annual O&M***	$80	
Efficiency	30-yr Average Cost/lb-TP	**$171**	
Efficiency	30-yr Average Cost/1,000lb-TSS	**$678**	
Efficiency	30-yr Average Cost/ac-ft Vol.	**$673**	

*Indirect Cost: (30 hours at $60/hour)

**Direct Cost: ($50/sqft materials & labor) + 12 hours/BMP at $60/hour design)

***Per BMP: ($150/year at year 10) + ($75/year for routine maintenance)

_LEL_U007_03_

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
Treatment	Total Size of BMPs	250	sq-ft
Treatment	TP (lb/yr)	3.71	7.9%
Treatment	TSS (lb/yr)	338	1.7%
Treatment	Volume (acre-feet/yr)	0.41	1.1%
Cost	Administration & Promotion Costs*	$1,800	
Cost	Design & Construction Costs**	$9,300	
Cost	Total Estimated Project Cost	**$11,100**	
Cost	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$123**	
Efficiency	30-yr Average Cost/1,000lb-TSS	**$1,346**	
Efficiency	30-yr Average Cost/ac-ft Vol.	**$1,101**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

_LEL_U007_04_

Shoreline Buffer Strip

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
Treatment	Total Size of BMPs	2,000	sqft
Treatment	TP (lb/yr)	2.62	5.6%
Treatment	TSS (lb/yr)	400	2.0%
Treatment	Volume (acre-feet/yr)	n/a	n/a
Cost	Administration & Promotion Costs*	$1,800	
Cost	Design & Construction Costs**	$3,950	
Cost	Total Estimated Project Cost	**$5,750**	
Cost	Annual O&M***	$10	
Efficiency	30-yr Average Cost/lb-TP	**$77**	
Efficiency	30-yr Average Cost/1,000lb-TSS	**$504**	
Efficiency	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (30 hours at $60/hour)

**Direct Cost: ($1.10/sqft for materials and labor + $1,750 design and oversight)

***Per BMP: ($10/year)

LEL_U007_05			
Curb-Cut Rain Garden			
Cost/Removal Analysis		**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	5.06	10.8%
	TSS (lb/yr)	884	4.4%
	Volume (acre-feet/yr)	0.85	2.4%
Cost	**Administration & Promotion Costs***	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	**30-yr Average Cost/lb-TP**	**$90**	
	30-yr Average Cost/1,000lb-TSS	**$515**	
	30-yr Average Cost/ac-ft Vol.	**$536**	

*Indirect Cost: (30 hours at $60/hour base cost)

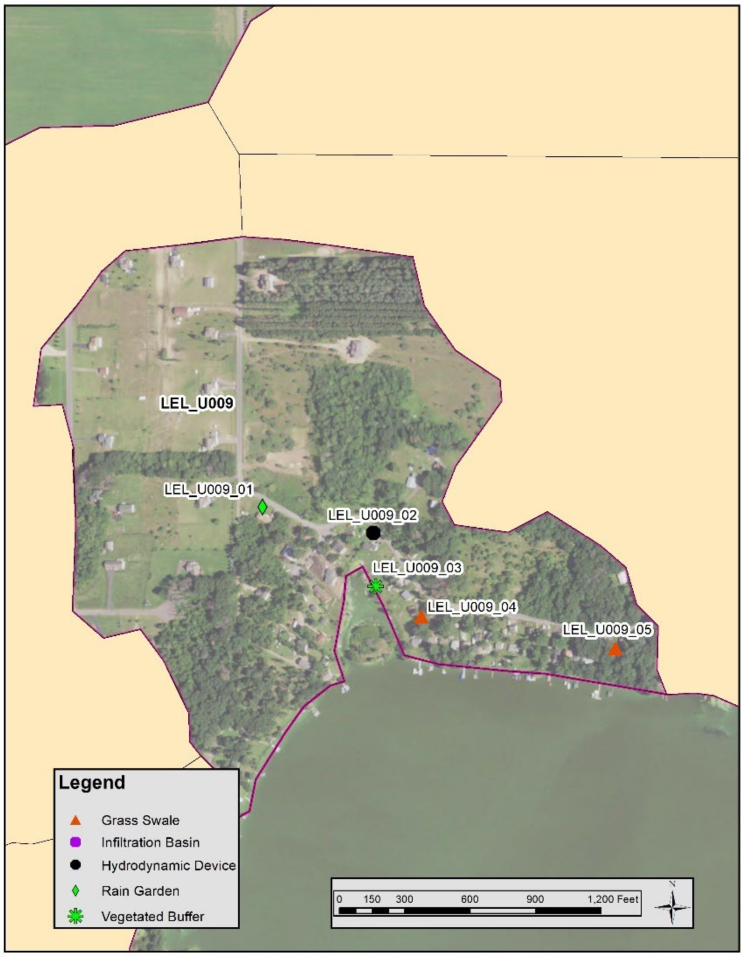
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

Sub-watershed U009

Sub-watershed Characteristics	
Acres	94.1
Dominant Land Cover	Med Dense Urban

This sub-watershed lies on the north end of Little Elk Lake. The shoreline area is quite densely populated with numerous structures, balancing out the sparse areas to the north.



	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	52.4	5.8	11%	**46.6**
	TSS (lb/yr)	23,747	2515.0	11%	**21,232**
	Volume (acre-feet/yr)	37.7	0.0	0%	**37.7**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 8: Sub-watershed U009 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

LEL_U009_01 — Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.51	1.1%
	TSS (lb/yr)	234	1.1%
	Volume (acre-feet/yr)	0.39	1.0%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$892**	
	30-yr Average Cost/1,000lb-TSS	**$1,944**	
	30-yr Average Cost/ac-ft Vol.	**$1,166**	

*Indirect Cost: (30 hours at $60/hour base cost)
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)
***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U009_02 — Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.73	1.6%
	TSS (lb/yr)	336	1.6%
	Volume (acre-feet/yr)	0.57	1.5%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$623**	
	30-yr Average Cost/1,000lb-TSS	**$1,354**	
	30-yr Average Cost/ac-ft Vol.	**$793**	

*Indirect Cost: (30 hours at $60/hour base cost)
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)
***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U009_03 — Vegetated Swale

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	50	ln-ft
	TP (lb/yr)	0.83	1.8%
	TSS (lb/yr)	1,127	5.3%
	Volume (acre-feet/yr)	0.48	1.3%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$3,220	
	Total Estimated Project Cost	**$5,020**	
	Annual O&M***	$80	
Efficiency	30-yr Average Cost/lb-TP	**$298**	
	30-yr Average Cost/1,000lb-TSS	**$219**	
	30-yr Average Cost/ac-ft Vol.	**$513**	

*Indirect Cost: (30 hours at $60/hour)
**Direct Cost: ($50/sqft materials & labor) + 12 hours/BMP at $60/hour design)
***Per BMP: ($150/year at year 10) + ($75/year for routine maintenance)

LEL_U009_04 — Vegetated Swale

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	50	ln-ft
	TP (lb/yr)	0.53	1.1%
	TSS (lb/yr)	237	1.1%
	Volume (acre-feet/yr)	0.37	1.0%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$3,220	
	Total Estimated Project Cost	**$5,020**	
	Annual O&M***	$80	
Efficiency	30-yr Average Cost/lb-TP	**$467**	
	30-yr Average Cost/1,000lb-TSS	**$1,044**	
	30-yr Average Cost/ac-ft Vol.	**$673**	

*Indirect Cost: (30 hours at $60/hour)
**Direct Cost: ($50/sqft materials & labor) + 12 hours/BMP at $60/hour design)
***Per BMP: ($150/year at year 10) + ($75/year for routine maintenance)

LEL_U009_05			
Vegetated Swale			
Cost/Removal Analysis		**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMPs	50	ln-ft
	TP (lb/yr)	0.45	1.0%
	TSS (lb/yr)	204	1.0%
	Volume (acre-feet/yr)	0.32	0.9%
Cost	**Administration & Promotion Costs***	$1,800	
	Design & Construction Costs**	$3,220	
	Total Estimated Project Cost	**$5,020**	
	Annual O&M***	$80	
Efficiency	**30-yr Average Cost/lb-TP**	**$550**	
	30-yr Average Cost/1,000lb-TSS	**$1,212**	
	30-yr Average Cost/ac-ft Vol.	**$770**	

*Indirect Cost: (30 hours at $60/hour)

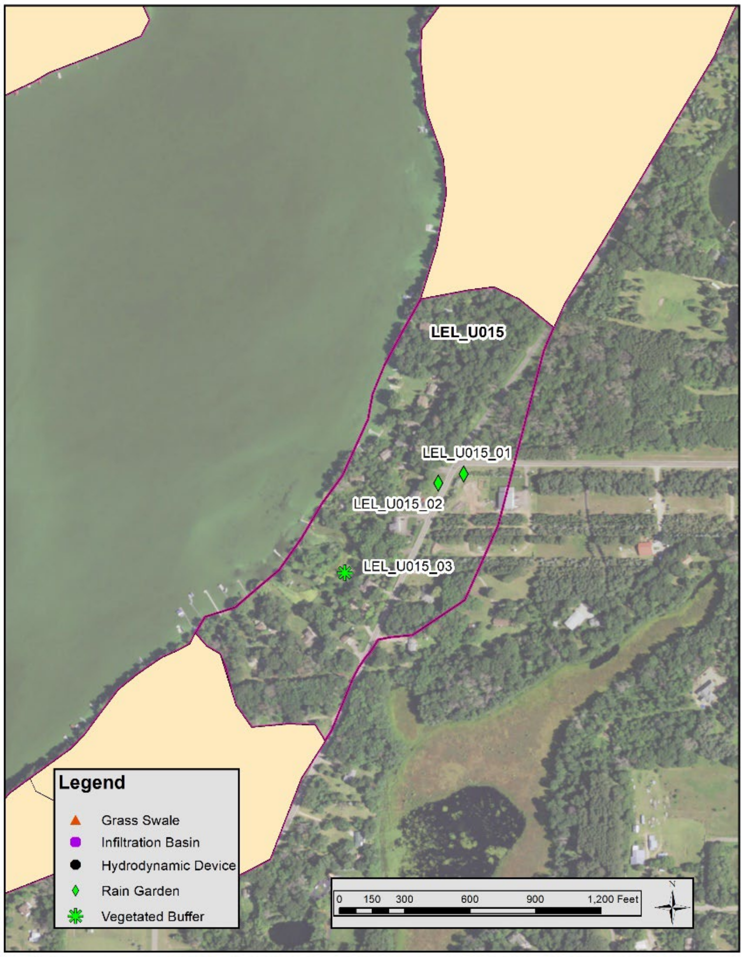
**Direct Cost: ($50/sqft materials & labor) + 12 hours/BMP at $60/hour design)

***Per BMP: ($150/year at year 10) + ($75/year for routine maintenance)

Sub-watershed U015

Sub-watershed Characteristics	
Acres	34.4
Dominant Land Cover	Med Dense Urban

Sub-watershed U015 lies along the eastern side of Little Elk Lake and includes medium density residential lots and rolling terrain.



Existing Conditions		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	19.2	2.1	11%	**17.0**
	TSS (lb/yr)	8,681	919.0	11%	**7,762**
	Volume (acre-feet/yr)	13.8	0.0	0%	**13.8**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 9: Sub-watershed U015 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

LEL_U015_01

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.70	4.1%
	TSS (lb/yr)	320	4.1%
	Volume (acre-feet/yr)	0.55	4.0%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$650**	
	30-yr Average Cost/1,000lb-TSS	**$1,422**	
	30-yr Average Cost/ac-ft Vol.	**$828**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U015_02

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.62	3.6%
	TSS (lb/yr)	284	3.7%
	Volume (acre-feet/yr)	0.48	3.5%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$734**	
	30-yr Average Cost/1,000lb-TSS	**$1,602**	
	30-yr Average Cost/ac-ft Vol.	**$942**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U015_03

Shoreline Buffer Strip

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	4,500	sqft
	TP (lb/yr)	0.97	5.7%
	TSS (lb/yr)	106	1.4%
	Volume (acre-feet/yr)	n/a	n/a
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$6,700	
	Total Estimated Project Cost	**$8,500**	
	Annual O&M***	$10	
Efficiency	30-yr Average Cost/lb-TP	**$303**	
	30-yr Average Cost/1,000lb-TSS	**$2,770**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (30 hours at $60/hour)

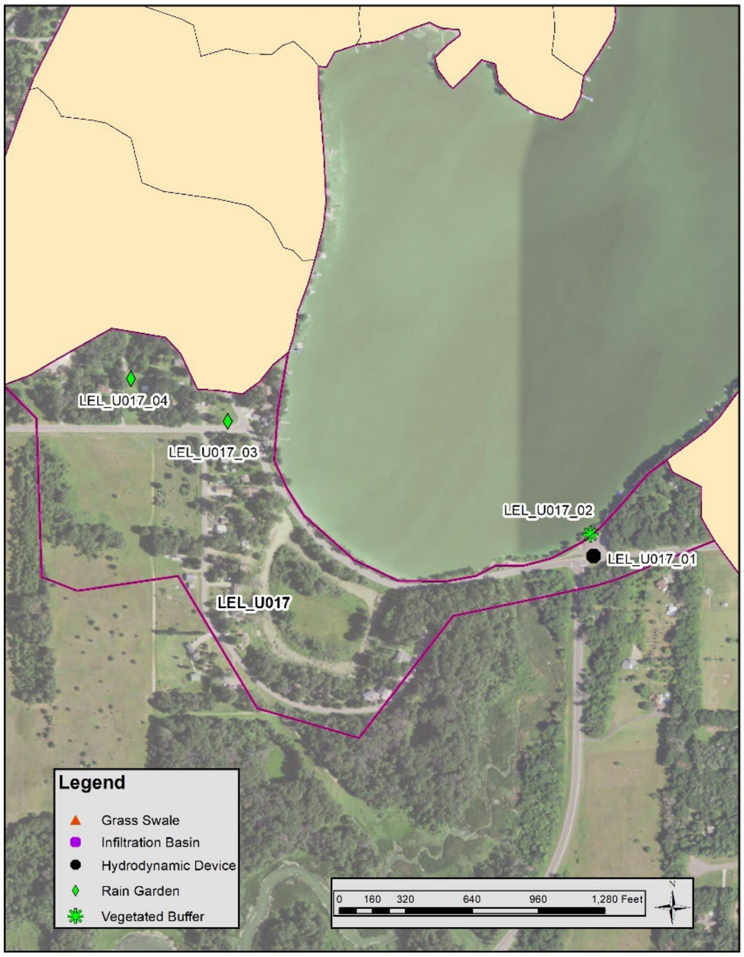
**Direct Cost: ($1.10/sqft for materials and labor + $1,750 design and oversight)

***Per BMP: ($10/year)

Sub-watershed U017

Sub-watershed Characteristics	
Acres	54.3
Dominant Land Cover	Med Dense Urban

Sub-watershed U017 is at the south end of the lake. Some residential areas exist, but it also includes a good portion of a county road and a DNR public lake access.



	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	30.2	3.3	11%	**26.9**
	TSS (lb/yr)	13,703	1451.0	11%	**12,252**
	Volume (acre-feet/yr)	21.8	0.0	0%	**21.8**

Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 10: Sub-watershed U017 potential BMP projects. Pollutant estimates based upon standard WinSLAMM and RUSLE2 parameters. Costs based upon conservative estimates from The Center for Watershed Protection's Urban Subwatershed Restoration Manuals and local project experience.

LEL_U017_01

6' Hydrodynamic Device

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	6	ft dia
	TP (lb/yr)	3.01	11.2%
	TSS (lb/yr)	746	6.1%
	Volume (acre-feet/yr)	0.19	0.9%
Cost	Administration & Promotion Costs*	$2,400	
	Design & Construction Costs**	$27,000	
	Total Estimated Project Cost	**$29,400**	
	Annual O&M***	$360	
Efficiency	30-yr Average Cost/lb-TP	**$445**	
	30-yr Average Cost/1,000lb-TSS	**$1,796**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (24 hours at $100/hr)

**Direct Cost: ($18,000 HD materials) + ($9,000 labor & construction)

***Per BMP: (2 cleanings/year)*(3 hrs/cleaning)*$60/hr)

LEL_U017_02

Shoreline Buffer Strip

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	1,800	sqft
	TP (lb/yr)	1.30	4.8%
	TSS (lb/yr)	309	2.5%
	Volume (acre-feet/yr)	n/a	n/a
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$3,730	
	Total Estimated Project Cost	**$5,530**	
	Annual O&M***	$10	
Efficiency	30-yr Average Cost/lb-TP	**$149**	
	30-yr Average Cost/1,000lb-TSS	**$629**	
	30-yr Average Cost/ac-ft Vol.	**n/a**	

*Indirect Cost: (30 hours at $60/hour)

**Direct Cost: ($1.10/sqft for materials and labor + $1,750 design and oversight)

***Per BMP: ($10/year)

LEL_U017_03

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	750	sq-ft
	TP (lb/yr)	1.92	7.1%
	TSS (lb/yr)	881	7.2%
	Volume (acre-feet/yr)	1.50	6.9%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$24,300	
	Total Estimated Project Cost	**$26,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$497**	
	30-yr Average Cost/1,000lb-TSS	**$1,084**	
	30-yr Average Cost/ac-ft Vol.	**$637**	

*Indirect Cost: (30 hours at $60/hour base cost)

**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

LEL_U017_04

Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	250	sq-ft
	TP (lb/yr)	0.65	2.4%
	TSS (lb/yr)	301	2.5%
	Volume (acre-feet/yr)	0.51	2.4%
Cost	Administration & Promotion Costs*	$1,800	
	Design & Construction Costs**	$9,300	
	Total Estimated Project Cost	**$11,100**	
	Annual O&M***	$85	
Efficiency	30-yr Average Cost/lb-TP	**$700**	
	30-yr Average Cost/1,000lb-TSS	**$1,512**	
	30-yr Average Cost/ac-ft Vol.	**$887**	

*Indirect Cost: (30 hours at $60/hour base cost)

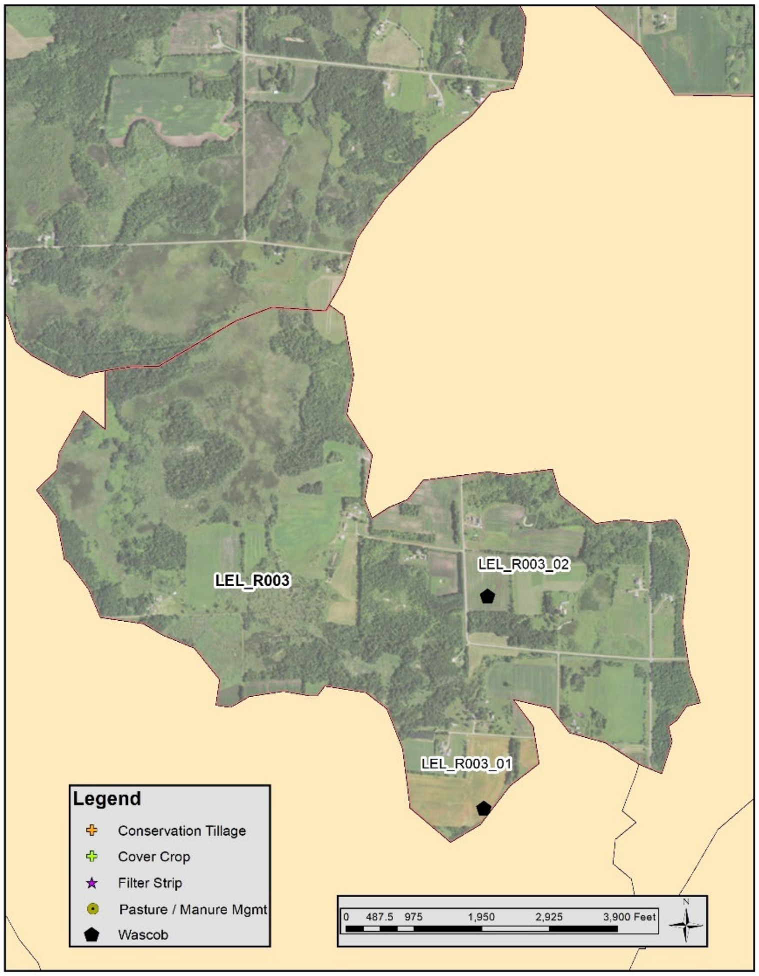
**Direct Cost: ($30/sqft materials & labor) + 30 hours/BMP at $60/hour design)

***Per BMP: ($150/year at years 10 and 20) + ($75/year routine maintenance)

Sub-watershed R003

Sub-watershed Characteristics	
Acres	857.0
Dominant Land Cover	Agriculture

Sub-watershed R003 sits near the headwaters of Battle Brook, in Mille Lacs County. A number of agricultural fields dot the landscape and the rolling terrain is well suited for WASCOBs.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 11: Sub-watershed R003 potential BMP projects. Pollutant estimates based upon standard RUSLE2 and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

LEL_R003_01

Wascob			
	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
Treatment	BMP catchment area	19	acres
Treatment	TP (lb/yr)	8.7	
Treatment	TSS (lb/yr)	10.2	
Cost	Administration & Promotion Costs*	$1,125	
Cost	Design & Construction Costs**	$11,863	
Cost	Total Estimated Project Cost	**$13,088**	
Cost	Annual O&M***	$100	
	Average Cost/lb-TP	**$1,513**	
	Average Cost/1,000lb-TSS	**$1,286**	

*Indirect Cost: (15 hours at $75/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R003_02

Wascob			
	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
Treatment	BMP catchment area	7.9	acres
Treatment	TP (lb/yr)	5.4	
Treatment	TSS (lb/yr)	6.4	
Cost	Administration & Promotion Costs*	$844	
Cost	Design & Construction Costs**	$8,860	
Cost	Total Estimated Project Cost	**$9,804**	
Cost	Annual O&M***	$100	
	Average Cost/lb-TP	**$1,806**	
	Average Cost/1,000lb-TSS	**$1,534**	

*Indirect Cost: (11 hours at $75/hr)

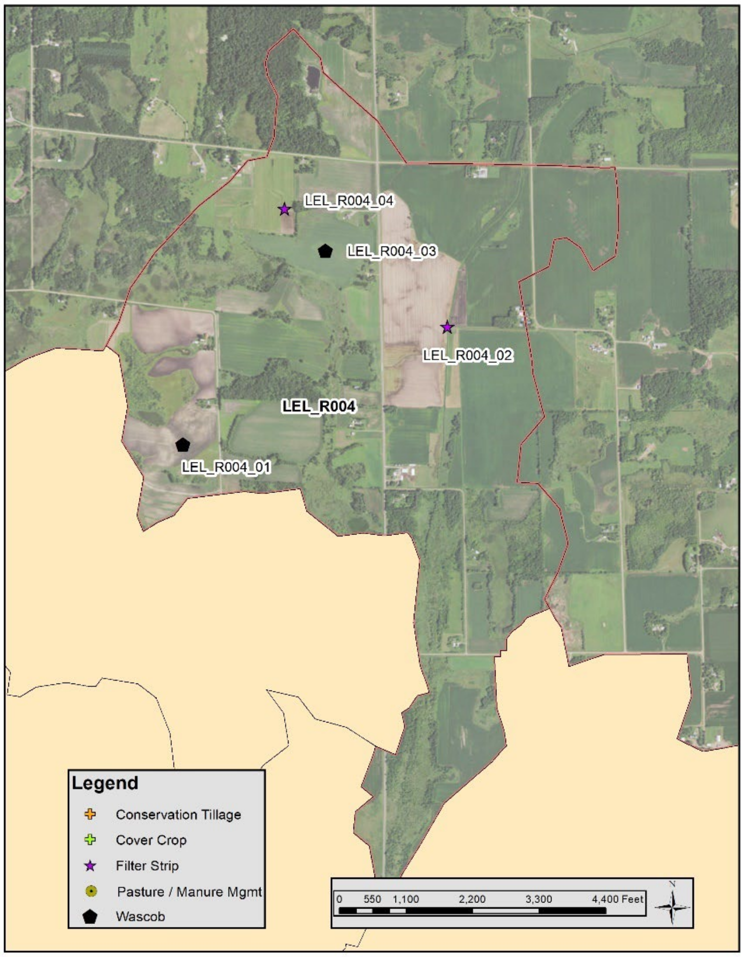
**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

Sub-watershed R004

Sub-watershed Characteristics	
Acres	1188.0
Dominant Land Cover	Agriculture

R004 sits next to R003 at the headwaters of Battle Brook in Mille Lacs County. The sub-watershed largely consists of agriculture land, primarily producing corn and soybeans.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 13: Sub-watershed R004 potential BMP projects. Pollutant estimates based upon standard RUSLE2 and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

LEL_R004_01

Wascob

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	15.4	acres
	TP (lb/yr)	8.7	
	TSS (lb/yr)	10.2	
Cost	Administration & Promotion Costs*	$1,125	
	Design & Construction Costs**	$11,863	
	Total Estimated Project Cost	**$13,088**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$2,178**	
	Average Cost/1,000lb-TSS	**$1,849**	

*Indirect Cost: (15 hours at $75/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R004_02

Filter Strip

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	190.0	acres
	TP (lb/yr)	17.8	
	TSS (lb/yr)	12.4	
Cost	Administration & Promotion Costs*	$1,120	
	Design & Construction Costs**	$5,560	
	Total Estimated Project Cost	**$6,780**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$384**	
	Average Cost/1,000lb-TSS	**$552**	

*Indirect Cost: (16 hours at $70/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R004_03

Wascob

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	22.3	acres
	TP (lb/yr)	8.4	
	TSS (lb/yr)	9.9	
Cost	Administration & Promotion Costs*	$1,125	
	Design & Construction Costs**	$11,863	
	Total Estimated Project Cost	**$13,088**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$1,786**	
	Average Cost/1,000lb-TSS	**$1,518**	

*Indirect Cost: (15 hours at $75/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R004_04

Filter Strip

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	25.9	acres
	TP (lb/yr)	7.6	
	TSS (lb/yr)	4.6	
Cost	Administration & Promotion Costs*	$1,120	
	Design & Construction Costs**	$5,560	
	Total Estimated Project Cost	**$6,780**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$301**	
	Average Cost/1,000lb-TSS	**$398**	

*Indirect Cost: (16 hours at $70/hr)

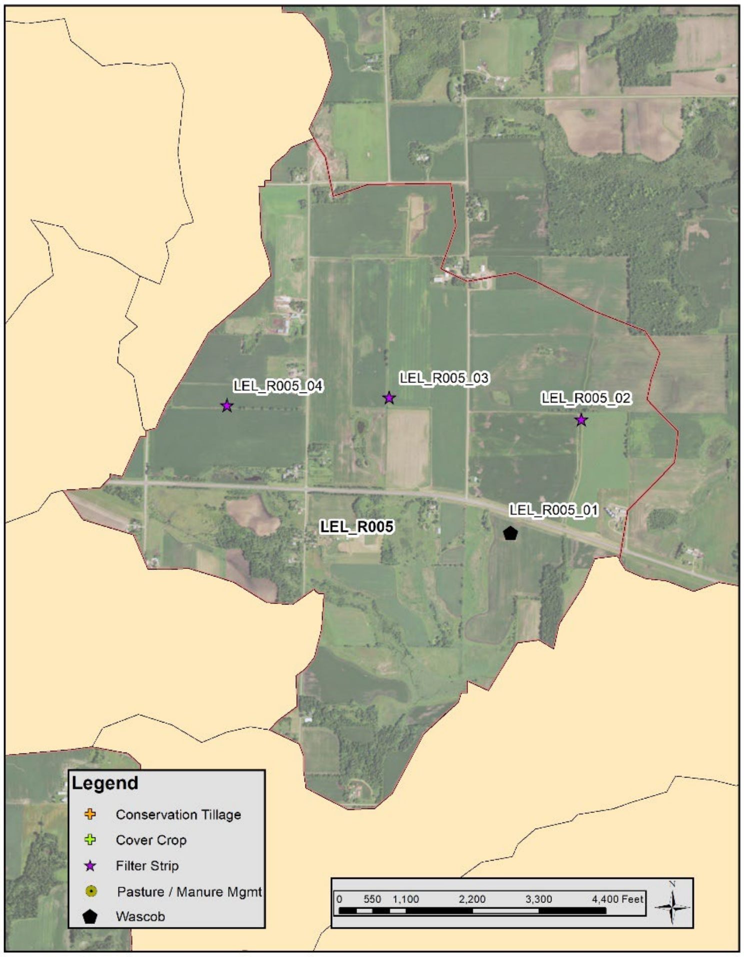
**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

Sub-watershed R005

Sub-watershed Characteristics	
Acres	1268.0
Dominant Land Cover	Agriculture

Sub-watershed R005 is largely dominated by agriculture. The area includes many small ditches which could integrate the use of filter strips for water quality protection.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 13: Sub-watershed R005 potential BMP projects. Pollutant estimates based upon standard RUSLE2 and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

LEL_R005_01

Wascob			
	Cost/Removal Analysis	**New Treatment**	
Treatment	Number of BMPs	1	
	BMP catchment area	17.3	acres
	TP (lb/yr)	4.7	
	TSS (lb/yr)	5.5	
Cost	Administration & Promotion Costs*	$1,125	
	Design & Construction Costs**	$11,863	
	Total Estimated Project Cost	**$13,088**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$2,809**	
	Average Cost/1,000lb-TSS	**$2,388**	

*Indirect Cost: (15 hours at $75/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

LEL_R005_02

Filter Strip			
	Cost/Removal Analysis	**New Treatment**	
Treatment	Number of BMPs	1	
	BMP catchment area	265.3	acres
	TP (lb/yr)	14.8	
	TSS (lb/yr)	8.9	
Cost	Administration & Promotion Costs*	$1,120	
	Design & Construction Costs**	$5,560	
	Total Estimated Project Cost	**$6,780**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$463**	
	Average Cost/1,000lb-TSS	**$766**	

*Indirect Cost: (16 hours at $70/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

LEL_R005_03

Filter Strip			
	Cost/Removal Analysis	**New Treatment**	
Treatment	Number of BMPs	1	
	BMP catchment area	291.6	acres
	TP (lb/yr)	24.3	
	TSS (lb/yr)	18.1	
Cost	Administration & Promotion Costs*	$1,120	
	Design & Construction Costs**	$5,560	
	Total Estimated Project Cost	**$6,780**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$590**	
	Average Cost/1,000lb-TSS	**$790**	

*Indirect Cost: (16 hours at $70/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

LEL_R005_04

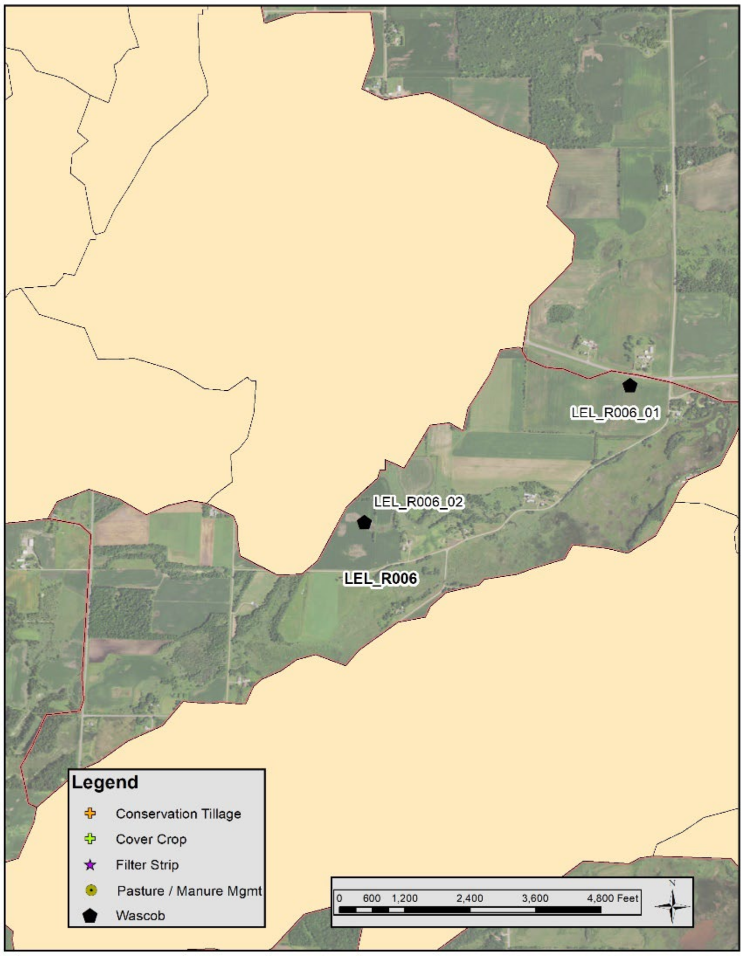
Filter Strip			
	Cost/Removal Analysis	**New Treatment**	
Treatment	Number of BMPs	1	
	BMP catchment area	70.9	acres
	TP (lb/yr)	20.7	
	TSS (lb/yr)	15.7	
Cost	Administration & Promotion Costs*	$1,120	
	Design & Construction Costs**	$5,560	
	Total Estimated Project Cost	**$6,780**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$301**	
	Average Cost/1,000lb-TSS	**$398**	

*Indirect Cost: (16 hours at $70/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

Sub-watershed R006

Sub-watershed Characteristics	
Acres	883.0
Dominant Land Cover	Agriculture

R006 is a strip of agricultural land that sits near the Mille Lacs / Sherburne County line. Several WASCOB opportunities were identified in this SWA.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 14: Sub-watershed R006 potential BMP projects. Pollutant estimates based upon standard RUSLE2 and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

	Cost/Removal Analysis	LEL_R006_01 Wascob New Treatment	LEL_R006_02 Wascob New Treatment
Treatment	Number of BMPs	1	1
Treatment	BMP catchment area	37.0 acres	26.9 acres
Treatment	TP (lb/yr)	3.6	7.0
Treatment	TSS (lb/yr)	3.9	8.3
Cost	Administration & Promotion Costs*	$1,125	$1,125
Cost	Design & Construction Costs**	$17,719	$17,719
Cost	Total Estimated Project Cost	**$19,044**	**$19,044**
Cost	Annual O&M***	$200	$200
	Average Cost/lb-TP	**$5,246**	**$2,273**
	Average Cost/1,000lb-TSS	**$4,858**	**$1,932**

*Indirect Cost: (15 hours at $75/hr)

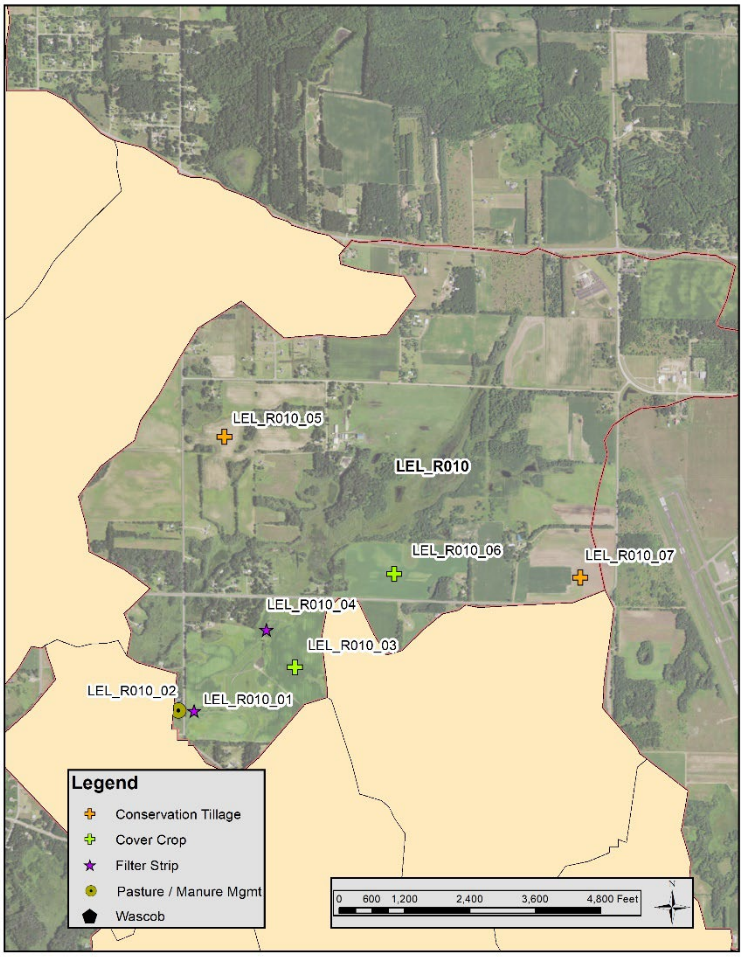
**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

Sub-watershed R010

Sub-watershed Characteristics	
Acres	1502.0
Dominant Land Cover	Agriculture

This sub-watershed holds both agricultural and animal operations and is located entirely within Sherburne County, just outside of the City of Princeton.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 15: Sub-watershed R010 potential BMP projects. Pollutant estimates based upon standard RUSLE2, MinnFarm and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

LEL_R010_01 — Filter Strip

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
Treatment	BMP catchment area	33.1	acres
Treatment	TP (lb/yr)	4.2	
Treatment	TSS (lb/yr)	2.3	
Cost	Administration & Promotion Costs*	$1,120	
Cost	Design & Construction Costs**	$5,560	
Cost	Total Estimated Project Cost	**$6,780**	
Cost	Annual O&M***	$100	
	Average Cost/lb-TP	**$104**	
	Average Cost/1,000lb-TSS	**$191**	

*Indirect Cost: (16 hours at $70/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

LEL_R010_02 — Pasture / Manure Mgmt

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
Treatment	BMP catchment area	10.0	acres
Treatment	TP (lb/yr)	10.0	
Treatment	TSS (lb/yr)	12.4	
Cost	Administration & Promotion Costs*	$1,200	
Cost	Design & Construction Costs**	$6,200	
Cost	Total Estimated Project Cost	**$7,500**	
Cost	Annual O&M***	$100	
	Average Cost/lb-TP	**$750**	
	Average Cost/1,000lb-TSS	**$603**	

*Indirect Cost: (16 hours at $75/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

LEL_R010_03 — Cover Crop

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
Treatment	BMP catchment area	129.3	acres
Treatment	TP (lb/yr)	17.5	
Treatment	TSS (lb/yr)	12.3	
Cost	Administration & Promotion Costs*	$640	
Cost	Design & Construction Costs**	$12,260	
Cost	Total Estimated Project Cost	**$12,900**	
Cost	Annual O&M	-	
	Average Cost/lb-TP	**$737**	
	Average Cost/1,000lb-TSS	**$1,050**	

*Indirect Cost: ($5 / acre)
**Direct Cost: ($95 / acre)

LEL_R010_04 — Filter Strip

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
Treatment	BMP catchment area	30.1	acres
Treatment	TP (lb/yr)	6.4	
Treatment	TSS (lb/yr)	3.9	
Cost	Administration & Promotion Costs*	$1,120	
Cost	Design & Construction Costs**	$5,560	
Cost	Total Estimated Project Cost	**$6,780**	
Cost	Annual O&M***	$100	
	Average Cost/lb-TP	**$126**	
	Average Cost/1,000lb-TSS	**$204**	

*Indirect Cost: (16 hours at $70/hr)
**Direct Cost: (Estimated labor and construction costs)
***Per BMP: ($100 / yr)

LEL_R010_05

Cover Crop

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	45.9	acres
	TP (lb/yr)	4.9	
	TSS (lb/yr)	3.2	
Cost	Administration & Promotion Costs*	$230	
	Design & Construction Costs**	$4,361	
	Total Estimated Project Cost	**$4,590**	
	Annual O&M	-	
	Average Cost/lb-TP	**$939**	
	Average Cost/1,000lb-TSS	**$1,421**	

*Indirect Cost: ($5 / acre)

**Direct Cost: ($95 / acre)

LEL_R010_06

Conservation Tillage

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	73.2	acres
	TP (lb/yr)	19.0	
	TSS (lb/yr)	11.2	
Cost	Administration & Promotion Costs*	$366	
	Design & Construction Costs**	$8,418	
	Total Estimated Project Cost	**$8,784**	
	Annual O&M	-	
	Average Cost/lb-TP	**$462**	
	Average Cost/1,000lb-TSS	**$787**	

*Indirect Cost: ($5 / acre)

**Direct Cost: ($115 / acre)

LEL_R010_07

Conservation Tillage

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	40.1	acres
	TP (lb/yr)	7.6	
	TSS (lb/yr)	4.8	
Cost	Administration & Promotion Costs*	$201	
	Design & Construction Costs**	$4,612	
	Total Estimated Project Cost	**$4,812**	
	Annual O&M	-	
	Average Cost/lb-TP	**$637**	
	Average Cost/1,000lb-TSS	**$1,007**	

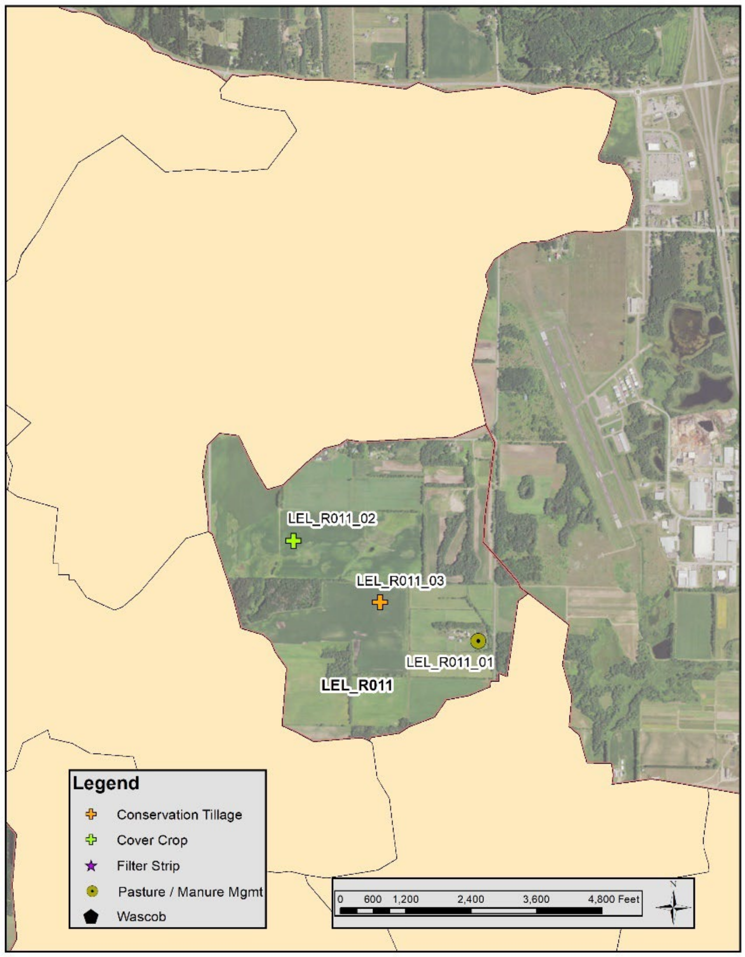
*Indirect Cost: ($5 / acre)

**Direct Cost: ($115 / acre)

Sub-watershed R011

Sub-watershed Characteristics	
Acres	560.0
Dominant Land Cover	Agriculture

Sub-watershed R011 sits outside of the City of Princeton, as the region transitions from suburbs to agriculture. Several fields and one hobby farm are located in this sub-watershed.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 16: Sub-watershed R011 potential BMP projects. Pollutant estimates based upon standard RUSLE2, MinnFarm and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

LEL_R011_01

Pasture / Manure Mgmt

	Cost/Removal Analysis	New Treatment
Treatment	Number of BMPs	1
	BMP catchment area	16.5 acres
	TP (lb/yr)	4.0
	TSS (lb/yr)	2.7
Cost	Administration & Promotion Costs*	$1,200
	Design & Construction Costs**	$6,200
	Total Estimated Project Cost	**$7,500**
	Annual O&M***	$100
	Average Cost/lb-TP	**$1,875**
	Average Cost/1,000lb-TSS	**$2,799**

*Indirect Cost: (16 hours at $75/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R011_02

Cover Crop

	Cost/Removal Analysis	New Treatment
Treatment	Number of BMPs	1
	BMP catchment area	189.1 acres
	TP (lb/yr)	20.6
	TSS (lb/yr)	13.7
Cost	Administration & Promotion Costs*	$946
	Design & Construction Costs**	$17,965
	Total Estimated Project Cost	**$18,900**
	Annual O&M	-
	Average Cost/lb-TP	**$917**
	Average Cost/1,000lb-TSS	**$1,378**

*Indirect Cost: ($5 / acre)

**Direct Cost: ($95 / acre)

LEL_R011_03

Conservation Tillage

	Cost/Removal Analysis	New Treatment
Treatment	Number of BMPs	1
	BMP catchment area	99.8 acres
	TP (lb/yr)	27.0
	TSS (lb/yr)	16.2
Cost	Administration & Promotion Costs*	$499
	Design & Construction Costs**	$11,477
	Total Estimated Project Cost	**$11,976**
	Annual O&M	-
	Average Cost/lb-TP	**$443**
	Average Cost/1,000lb-TSS	**$739**

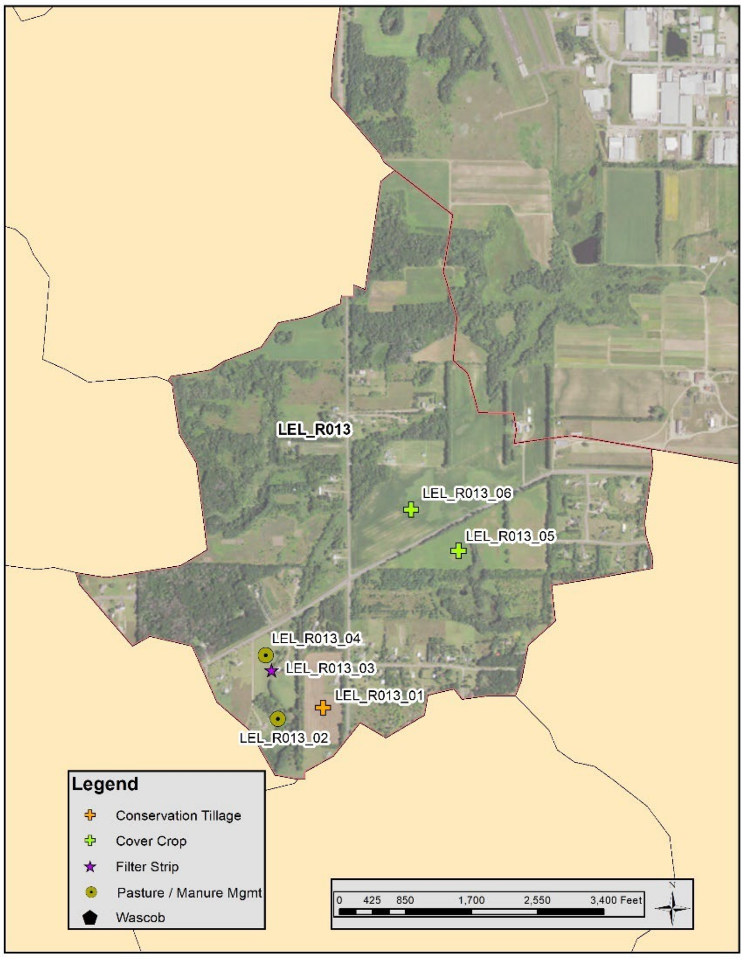
*Indirect Cost: ($5 / acre)

**Direct Cost: ($115 / acre)

Sub-watershed R013

Sub-watershed Characteristics	
Acres	613.0
Dominant Land Cover	Agriculture

Sub-watershed R013 includes agricultural land and two animal operations along a County ditch. BMPs installed here would prevent nutrients and bacteria from entering Battle Brook.



Treatment Calculations and Cost Analysis

As outlined in the tables below, several potential projects were identified for this sub-watershed. The tables that follow outline the project type, pollution parameters following installation of the project, the cost of the project and the cost per pound of pollutant reduction. Modeling results are independent of each other; that is, the reductions and costs are associated with each single project and do not reflect savings or additional pollutant reduction that would occur with multiple BMP installations.

Table 17: Sub-watershed R013 potential BMP projects. Pollutant estimates based upon standard RUSLE2, MinnFarm and BWSR pollution calculator estimates. Costs based upon conservative estimates from current literature research and local project experience.

LEL_R013_01

Conservation Tillage

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	10.2	acres
	TP (lb/yr)	2.4	
	TSS (lb/yr)	1.4	
Cost	Administration & Promotion Costs*	$51	
	Design & Construction Costs**	$1,173	
	Total Estimated Project Cost	**$1,224**	
	Annual O&M	-	
	Average Cost/lb-TP	**$506**	
	Average Cost/1,000lb-TSS	**$893**	

*Indirect Cost: ($5 / acre)

**Direct Cost: ($115 / acre)

LEL_R013_02

Pasture / Manure Mgmt

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	7.4	acres
	TP (lb/yr)	2.5	
	TSS (lb/yr)	2.0	
Cost	Administration & Promotion Costs*	$1,200	
	Design & Construction Costs**	$6,200	
	Total Estimated Project Cost	**$7,500**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$3,000**	
	Average Cost/1,000lb-TSS	**$3,676**	

*Indirect Cost: (16 hours at $75/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R013_03

Filter Strip

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	8.9	acres
	TP (lb/yr)	7.3	
	TSS (lb/yr)	6.1	
Cost	Administration & Promotion Costs*	$1,120	
	Design & Construction Costs**	$5,560	
	Total Estimated Project Cost	**$6,780**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$824**	
	Average Cost/1,000lb-TSS	**$994**	

*Indirect Cost: (16 hours at $70/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R013_04

Pasture / Manure Mgmt

	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	7.3	acres
	TP (lb/yr)	2.0	
	TSS (lb/yr)	1.7	
Cost	Administration & Promotion Costs*	$1,200	
	Design & Construction Costs**	$6,200	
	Total Estimated Project Cost	**$7,500**	
	Annual O&M***	$100	
	Average Cost/lb-TP	**$3,750**	
	Average Cost/1,000lb-TSS	**$4,545**	

*Indirect Cost: (16 hours at $75/hr)

**Direct Cost: (Estimated labor and construction costs)

***Per BMP: ($100 / yr)

LEL_R013_05

Cover Crop			
	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	24.9	acres
	TP (lb/yr)	2.2	
	TSS (lb/yr)	1.4	
Cost	Administration & Promotion Costs*	$125	
	Design & Construction Costs**	$2,366	
	Total Estimated Project Cost	**$2,490**	
	Annual O&M	-	
	Average Cost/lb-TP	**$1,132**	
	Average Cost/1,000lb-TSS	**$1,779**	

*Indirect Cost: ($5 / acre)

**Direct Cost: ($95 / acre)

LEL_R013_06

Cover Crop			
	Cost/Removal Analysis	New Treatment	
Treatment	Number of BMPs	1	
	BMP catchment area	48.1	acres
	TP (lb/yr)	7.8	
	TSS (lb/yr)	5.2	
Cost	Administration & Promotion Costs*	$241	
	Design & Construction Costs**	$4,570	
	Total Estimated Project Cost	**$4,810**	
	Annual O&M	-	
	Average Cost/lb-TP	**$616**	
	Average Cost/1,000lb-TSS	**$934**	

*Indirect Cost: ($5 / acre)

**Direct Cost: ($95 / acre)

Literature Cited

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Appendix A: Modeling Methods

The following section includes WinSLAMM model details for each type of best management practice modeled for this analysis.

WinSLAMM

Pollutant and volume reductions were estimated using the stormwater model Source Load and Management Model for Windows (WinSLAMM). WinSLAMM uses an abundance of stormwater data from the Upper-Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It has detailed accounting of pollutant loading from various land uses and allows the user to build a model "landscape". WinSLAMM uses rainfall and temperature data from a typical year (1959 data from Minneapolis for this analysis), routing stormwater through the user's model for each storm. WinSLAMM version 10.4.0 was used for this analysis to estimate volume and pollutant loading and reductions. Additional inputs for WinSLAMM are provided in Table 18.

Table 18: General WinSLAMM Model Inputs (i.e. Current File Data).

General WinSLAMM Model Inputs	
Parameter	***File or Method***
Land use acreage	ArcMap with 2015 Land Use
Precipitation / Temperature	Minneapolis 1959 (user preference, best approximates a typical year)
Winter Season	Included in model, 11-12 to 3-18
Pollutant probability distribution	WI_GE001.ppd
Runoff coefficient file	WI_SL06 Dec06.rsv
Particulate solids concentration file	WI_AVG01.psc
Particle residue delivery file	WI_DLV01.prr
Street delivery files	WI files for each land use
Street sweeping	2x annually

BMP model designs

The diagrams that follow represent the standard parameters defined for various BMPs used in the modeling process, including existing conditions as well as proposed BMPs.

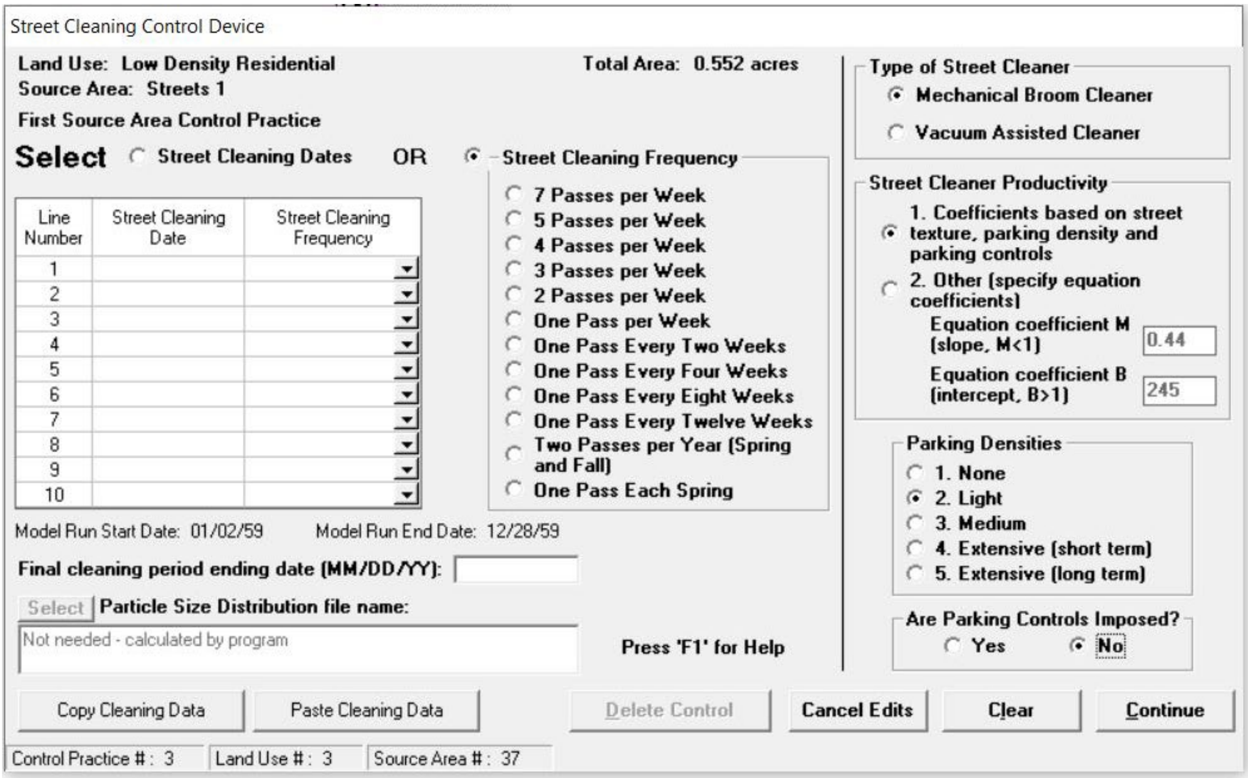

Figure 7: Street Sweeping. Street sweeping model inputs for the Little Elk Lake study.

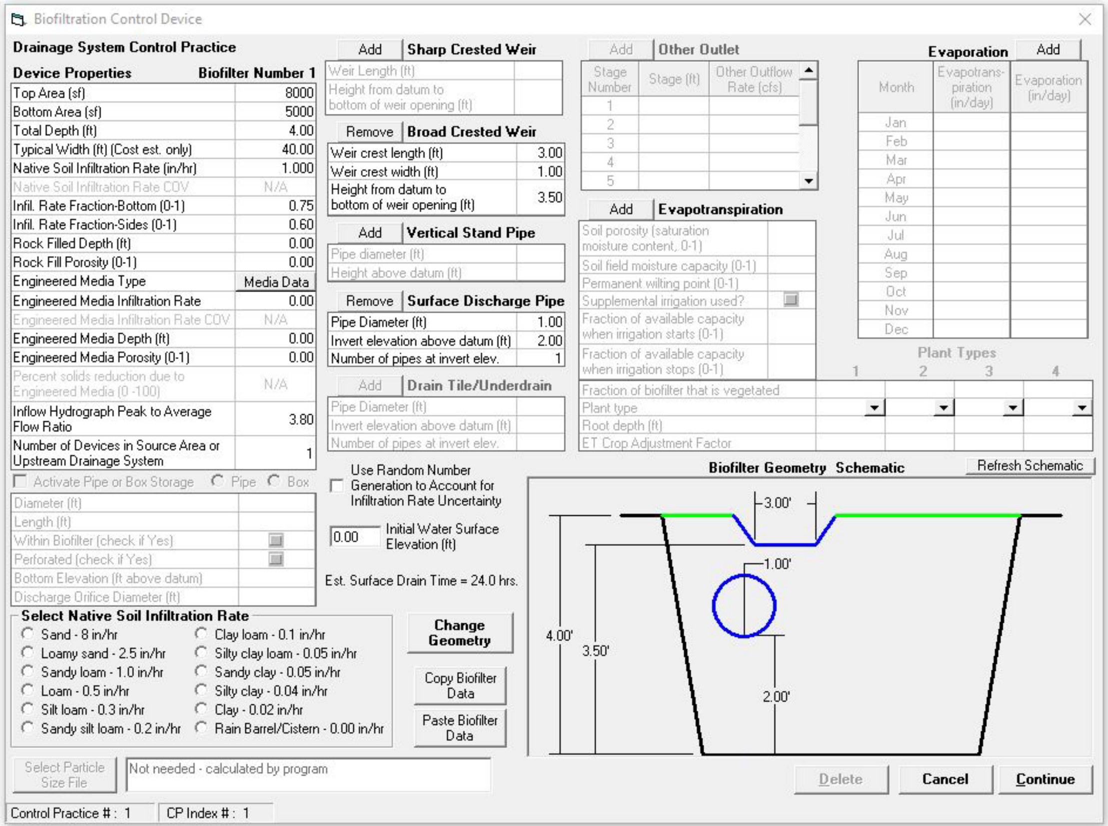

Figure 8: Infiltration Control Device. Model inputs will vary depending on site specific conditions.

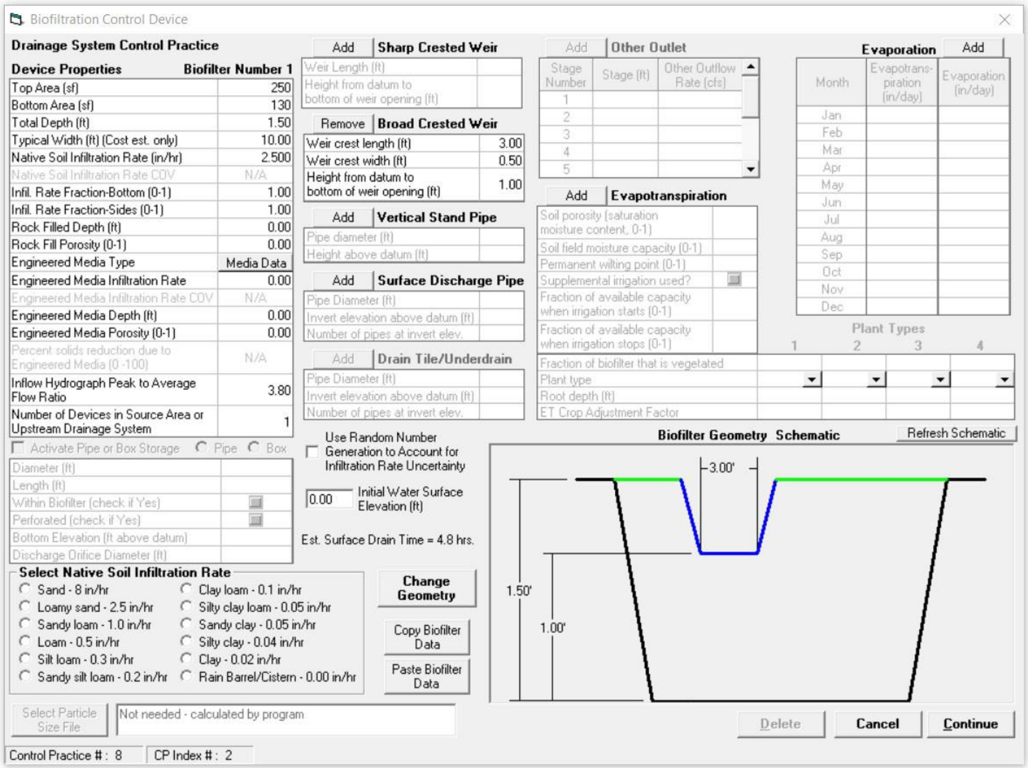

Figure 9: 250 sqft Rain Garden. Standard size used in most modeling applications.

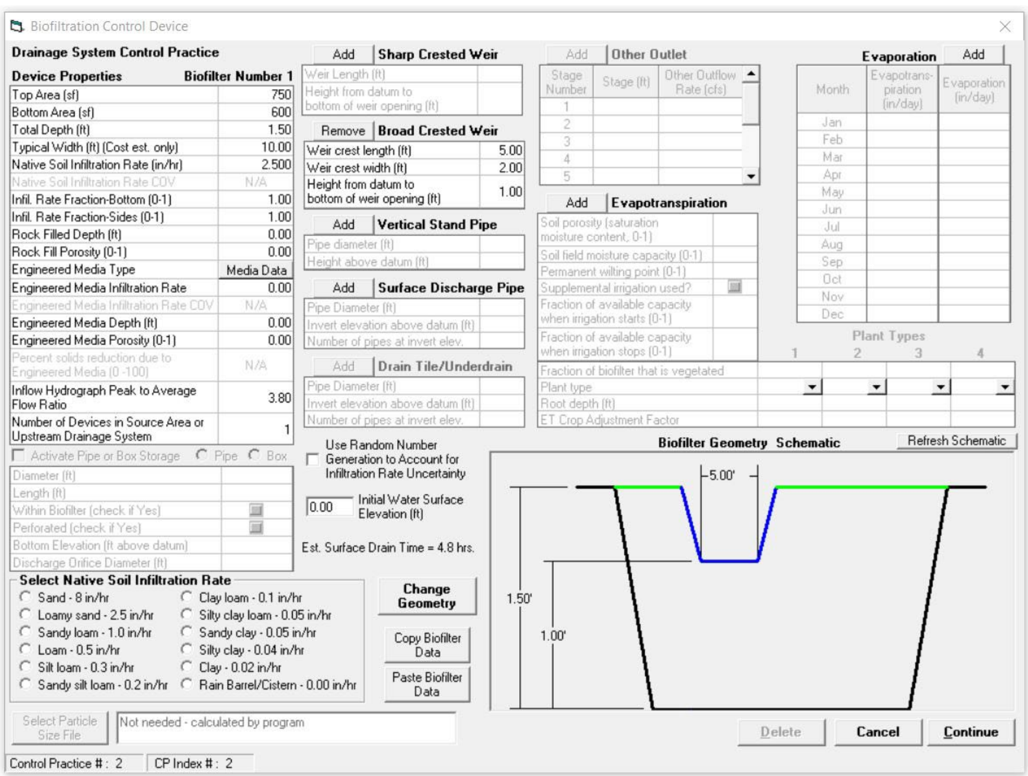

Figure 10: 750 sqft Rain Garden. Standard size used in several modeling scenarios.

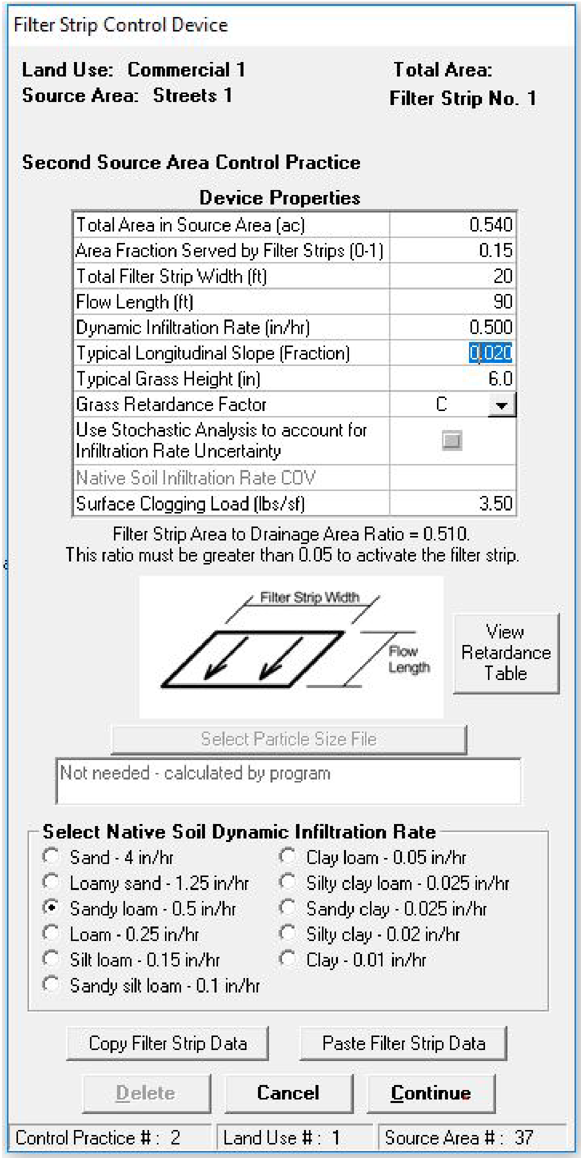

Figure 11: Filter strip. Some properties are standard, others customized given site-specific conditions.

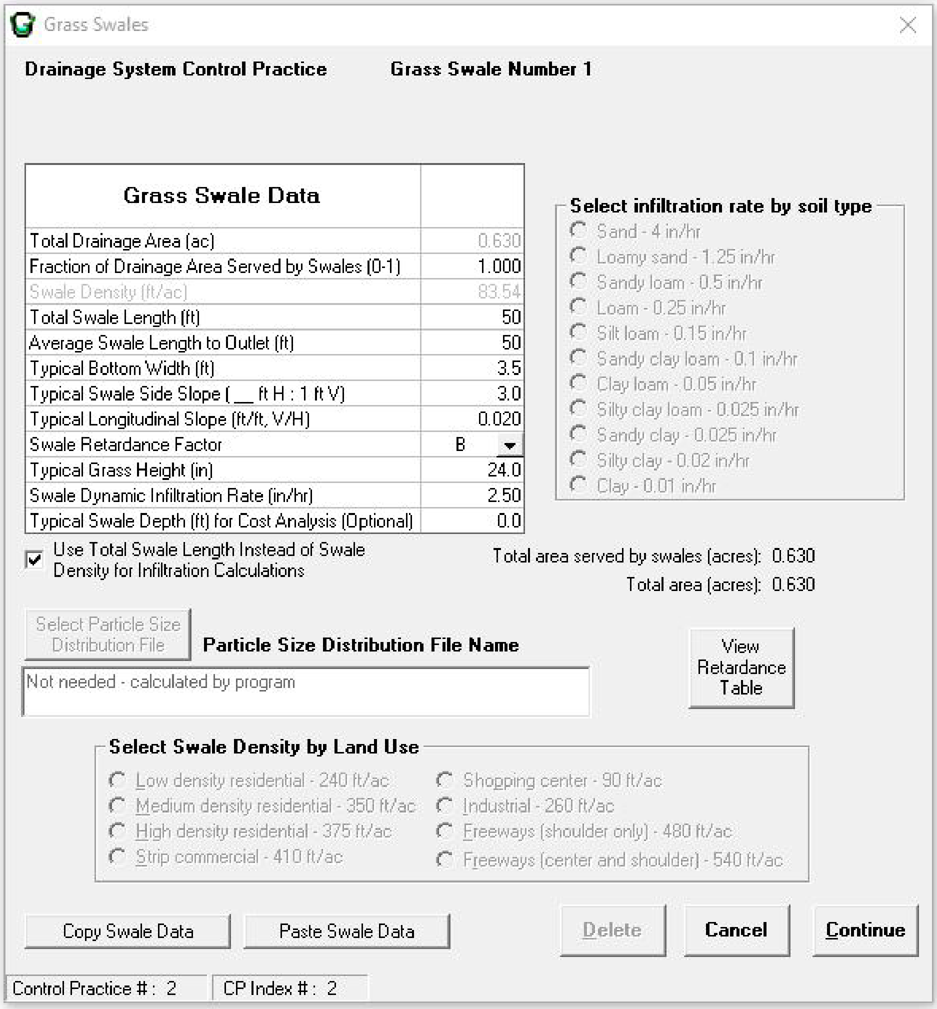

Figure 12: Vegetated Swale. Pictured is an example of a 50 ft swale.

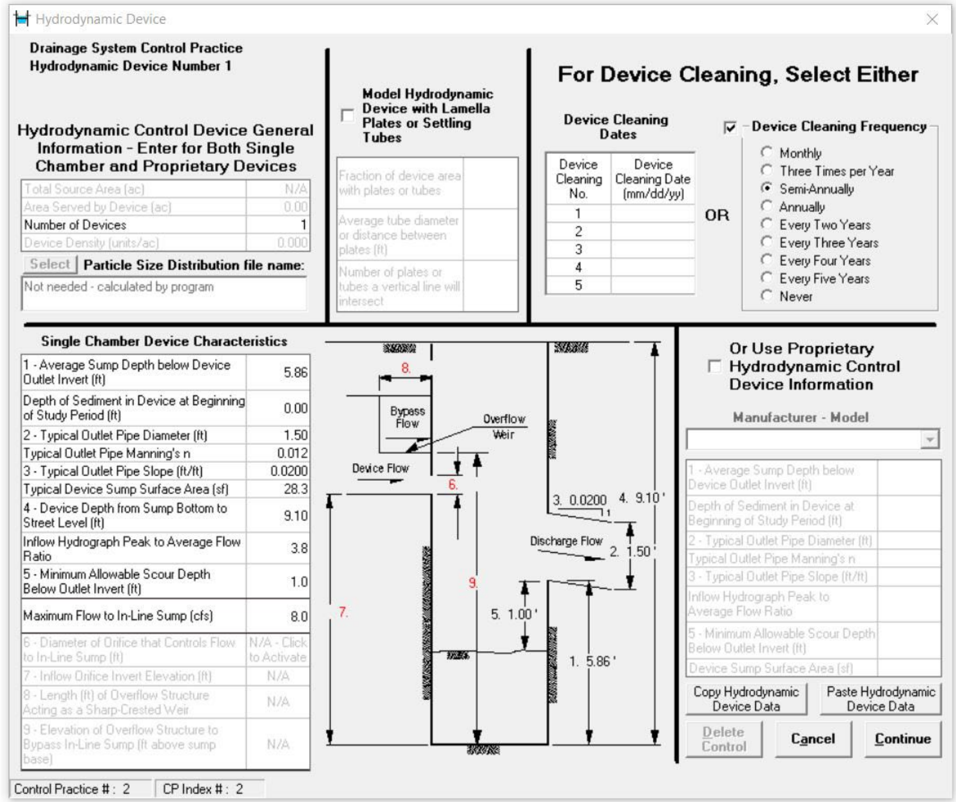

Figure 13: 4 ft Hydrodynamic Device.

Rural Modeling Procedures

Existing condition and BMP reduction conditions were estimated for rural areas using a combination of the RUSLE2 modeling program as well as the BWSR Pollution Reduction Calculator, per protocols outlined in the Chisago County SWCD's protocol, "Rural Sub-watershed Analysis Protocol". MinnFarm (Schmidt and Wilson, 2008) was utilized for animal pasture settings to estimate phosphorus conditions and, although not included in this report, e.coli outputs. RUSLE2 general inputs are provided in Table 19.

Table 19: General RUSLE Model Inputs.

Parameter	File or Method
Location	USA\Minnesota\Sherburne County OR Mille Lacs County
Soil	Location dependent
Slope	Location dependent
Avg Steepness, %	Location dependent
Base mgmt, conventional	managements\CMZ 04\b.Multi-year Rotation Templates\Corn-Soybeans\CB mulch till\Corn FC Disk Cult - Soybeans FC Disk Fld Cult
Base mgmt, No-till	managements\CMZ 04\b.Multi-year Rotation Templates\Corn-Soybeans\CB NT\corn grain;NT Soybeans, nr NT single disk openers z4
Base mgmt, Cover crop	managements\CMZ 04\b.Multi-year Rotation Templates\Cover Crops rotations\corn grain SC, disk afer w annual clover cover crop soybeans z4
Base mgmt, Filter strip	managements\CMZ 04\b.Multi-year Rotation Templates\Corn-Soybeans\CB mulch till\Corn FC Disk Cult - Soybeans FC Disk Fld Cult

Appendix B: BMP Cost Estimates

The following section includes estimates of BMPs evaluated in this report. Cost estimates were derived from a number of sources including The Center for Watershed Protection's Urban Sub-watershed Restoration Manuals, current literature research and local project experience.

Urban BMP Cost Profiles

250 sqft Rain Garden		**Assume**	
Administration & Promotion Costs	$1,800	Admin	Indirect Cost (30 hours at $60/hour base cost)
Design & Construction Costs	$9,300	Design/Const	Direct Cost ($30/sqft for materials and labor) + 30 hours/BMP at $60/hour for design)
Total Estimated Project Cost	$11,100	Annual O&M	Per BMP ($150/year for rehabilitation at years 10 and 20) + ($75/year for routine maintenance)
Annual O & M	$85		

500 sqft Rain Garden		**Assume**	
Administration & Promotion Costs	$1,800	Admin	Indirect Cost (30 hours at $60/hour base cost)
Design & Construction Costs	$16,800	Design/Const	Direct Cost ($30/sqft for materials and labor) + 30 hours/BMP at $60/hour for design)
Total Estimated Project Cost	$18,600	Annual O&M	Per BMP ($150/year for rehabilitation at years 10 and 20) + ($75/year for routine maintenance)
Annual O & M	$85		

750 sqft Rain Garden		**Assume**	
Administration & Promotion Costs	$1,800	Admin	Indirect Cost (30 hours at $60/hour base cost)
Design & Construction Costs	$24,300	Design/Const	Direct Cost ($30/sqft for materials and labor) + 30 hours/BMP at $60/hour for design)
Total Estimated Project Cost	$26,100	Annual O&M	Per BMP ($150/year for rehabilitation at years 10 and 20) + ($75/year for routine maintenance)
Annual O & M	$85		

Vegetated Swale		**Assume**	
Administration & Promotion Costs	$1,800	Admin	Indirect Cost (30 hours at $60/hour)
Design & Construction Costs	$3,220	Design/Const	Direct Cost ($50/lnft for materials and labor) + 12 hours/BMP at $60/hour for design)
Total Estimated Project Cost	$5,020	Annual O&M	Per BMP ($150/year for rehabilitation at year 10) + ($75/year for routine maintenance)
Annual O & M	$80		

Shoreline Buffer Strip		**Assume**	
Administration & Promotion Costs	$1,800	Admin	Indirect Cost (30 hours at $60/hour)
Design & Construction Costs	$3,220	Design/Const	Direct Cost ($1.10/sqft materials and labor + $1750 design and oversight)
Total Estimated Project Cost	$5,020	Annual O&M	Per BMP ($150/year for rehabilitation at year 10) + ($75/year for routine maintenance)
Annual O & M	$80		

4' dia Hydrodynamic Device		**Assume**	
Administration & Promotion Costs	$1,752	Admin	Indirect Cost (24 hours at $60/hour)
Design & Construction Costs	$18,000	Design/Const	Direct Cost ($9,000 for materials) + ($9,000 for labor and installation costs)
Total Estimated Project Cost	$19,752	Annual O&M	Per BMP (2 cleanings/year)*(3 hours/cleaning)*($60/hour)
Annual O & M	$420		

6' dia Hydrodynamic Device		**Assume**	
Administration & Promotion Costs	$2,400	Admin	Indirect Cost (24 hours at $100/hour)
Design & Construction Costs	$27,000	Design/Const	Direct Cost ($18,000 for materials) + ($9,000 for labor and installation costs)
Total Estimated Project Cost	$28,752	Annual O&M	Per BMP (2 cleanings/year)*(3 hours/cleaning)*($60/hour)
Annual O & M	$420		

8' dia Hydrodynamic Device		**Assume**	
Administration & Promotion Costs	$2,400	Admin	Indirect Cost (24 hours at $100/hour)
Design & Construction Costs	$54,000	Design/Const	Direct Cost ($36,000 for materials) + ($18,000 for labor and installation costs)
Total Estimated Project Cost	$55,752	Annual O&M	Per BMP (2 cleanings/year)*(3 hours/cleaning)*($60/hour)
Annual O & M	$420		

10' dia Hydrodynamic Device		**Assume**	
Administration & Promotion Costs	$2,400	Admin	Indirect Cost (24 hours at $100/hour)
Design & Construction Costs	$108,000	Design/Const	Direct Cost ($72,000 for materials) + ($36,000 for labor and installation costs)
Total Estimated Project Cost	$109,752	Annual O&M	Per BMP (2 cleanings/year)*(3 hours/cleaning)*($60/hour)
Annual O & M	$420		

Rural BMP Cost Profiles

Grassed Waterway		**Assume**	
Administration & Promotion Costs	$1,752	Admin	Indirect Cost (24 hours at $60/hour)
Design & Construction Costs	$2,210	Design/Const	Direct Cost ($500 initial, $1,150 design, $560 install oversight)
Total Estimated Project Cost	$3,962		
Annual O & M	$100		

Wascob (0-10 acres drainage)		**Assume**	
Administration & Promotion Costs	$844	Admin	11 hours at $75/hr
Design & Construction Costs	$8,860	Design/Const	Estimated labor and construction costs
Total Estimated Project Cost	$9,804	O & M	$100 / year
Annual O & M	$100		

Wascob (10-20 acres drainage)		**Assume**	
Administration & Promotion Costs	$1,125	Admin	15 hours at $75/hr
Design & Construction Costs	$11,863	Design/Const	Estimated labor and construction costs
Total Estimated Project Cost	$13,088	O & M	$100 / year
Annual O & M	$100		

Wascob (20-40 acres drainage)		**Assume**	
Administration & Promotion Costs	$1,125	Admin	15 hours at $75/hr
Design & Construction Costs	$17,719	Design/Const	Estimated labor and construction costs
Total Estimated Project Cost	$19,044	O & M	$100 / year
Annual O & M	$200		

Filter Strip		**Assume**	
Administration & Promotion Costs	$1,120	Admin	16 hours at $70/hr
Design & Construction Costs	$5,560	Design/Const	Estimated labor and construction costs
Total Estimated Project Cost	$6,780	O & M	$100 / year
Annual O & M	$100		

Cover Crops (per acre)		**Assume**	
Administration & Promotion Costs	$5	Admin	$5 per acre
Design & Construction Costs	$95	Design/Const	$95 per acre
Total Estimated Project Cost	$100	O & M	$100 / year
Annual O & M			

Conservation Tillage (per acre)		**Assume**	
Administration & Promotion Costs	$5	Admin	$5 per acre
Design & Construction Costs	$115	Design/Const	$115 per acre
Total Estimated Project Cost	$120	O & M	$100 / year
Annual O & M			

Pasture / Manure Mgmt		**Assume**	
Administration & Promotion Costs	$1,200	Admin	16 hours at $75/hr
Design & Construction Costs	$6,200	Design/Const	Estimated labor and construction costs
Total Estimated Project Cost	$7,500	O & M	$100 / year
Annual O & M	$100		