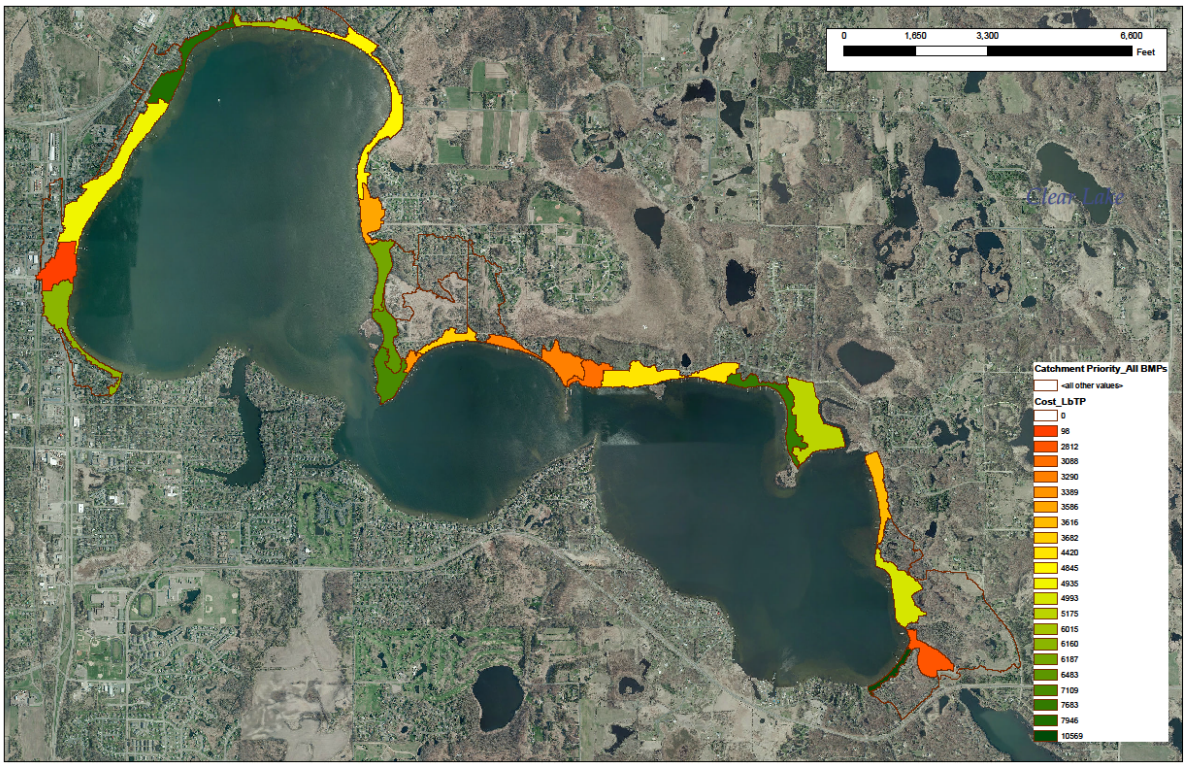
Forest Lake North Direct Stormwater Retrofit Analysis



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for the

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

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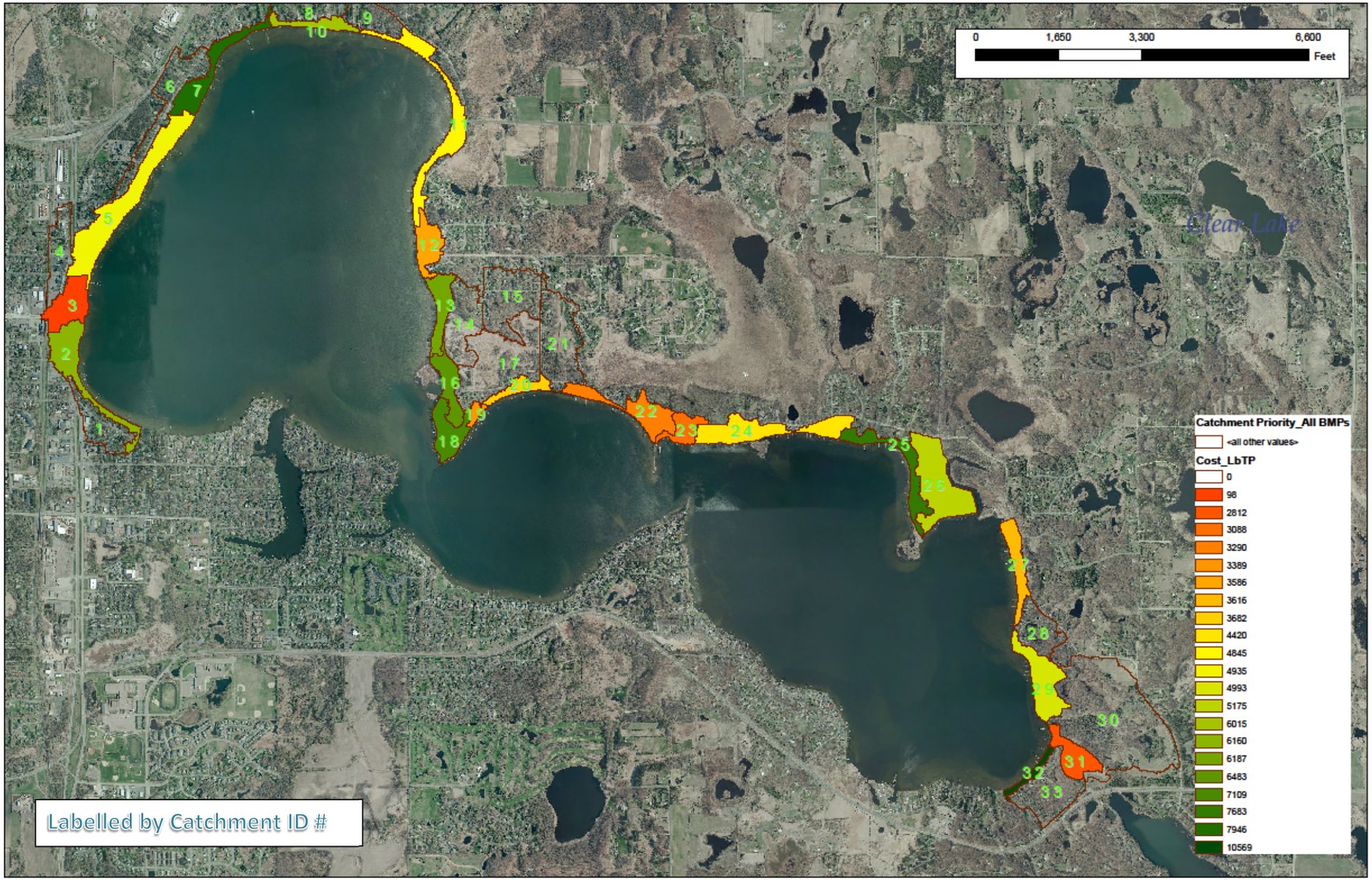
Prioritized Rankings by Catchment - rank of stormwater catchments referred to in this report

(prioritized by overall $Cost/Lb of TP removed over 10 years, if all proposed BMPs are implemented in each catchment).



Executive Summary

This analysis provides prioritized recommendations for improving treatment of stormwater from areas directly draining to Forest Lake along its northern boundary in the most cost-effective manner (herein described as Forest Lake North Direct Subwatershed Retrofit Analysis. This area is entirely located within the Comfort Lake Forest Lake Watershed District (CLFLWD) boundary as well as within the City of Forest Lake.

Although Forest Lake is not considered impaired, annual water monitoring reports reveal pollutant levels (namely phosphorus) are near thresholds for impairment in deep water lakes. The stormwater retrofits in this report will aid with alleviating existing water quality problems in Forest Lake.

For this analysis only, 33 sub-catchments were created within Catchment FL-01 in order to rank practices more effectively by geographic area (totaling 637 acres). Only twenty-one of these sub-catchments were analyzed for this report (totaling 300 acres) because the remaining 12 sub-catchments were either landlocked or were predominantly wetland and retrofit Best Management Practices (BMPs) were deemed ineffective. The existing stormwater management practices within each catchment were analyzed for annual pollutant loading - Total Phosphorus (TP), Total Suspended Solids (TSS) and Water Quality Volume (WQV) specifically. Observed existing BMPs and their load reductions were accounted for in the modeling process. The entire subwatershed was investigated via field reconnaissance. WinSLAMM was used for the water quality modeling. As modeled, Base Condition loading for the 21 analyzed catchments was 232.5 lbs/year of Total Phosphorus. Observed existing treatment (swales, street sweeping, bioretention areas, shoreline restorations) reduced the total phosphorus amount to 196.1 lbs/yr of TP (16% reduction). Stormwater practice options were compared for each sub-catchment, given their specific site constraints and characteristics. A stormwater practice was selected by weighing cost, ease of installation and maintenance, and ability to serve multiple functions. Given the difficulty in implementing bioinfiltration practices due to high water tables and lack of available space, it was decided to also document shoreline conditions of each property and prioritize them according to severity of erosion. Additional TP and TSS loads were factored in for shoreline erosion using the BWSR Pollution Reduction Estimator spreadsheet tool (BWSR tool only used in the Proposed Treatment Analysis). Details to this approach of modelling the Priority Shoreline Catchments are given in the Methods Section on page 13.

A variety of proposed stormwater BMP retrofit practices were identified totaling 72.85 lbs of total phosphorus reduction (37% reduction from Existing Conditions modelling). The single most cost-effective practice identified was to increase street sweeping of all major roads to 4x annually. Concept designs and cost estimates were drafted for individual BMP Projects identified throughout the analysis area and are included within each sub-catchment profile as well as Appendix C. See the table on the following page for a prioritized list of the 64 proposed Best Management Practices.

Identified BMPs include:
Street Sweeping (increased coverage and frequency)
Maintenance of, or alterations to, existing stormwater treatment practices
Residential curb-cut raingardens
Shoreline buffers (enhanced to pond 1” of water over 50% of each buffer footprint)
Iron-enhanced sand filters (IESFs)
Bioswales and filterstrips

Stormwater Retrofit Ranking by BMP Cost Effectiveness

The following table summarizes the assessment results, ascending in rank by $Cost per Lb of TP over 10 years. Reported treatment levels are dependent upon optimal siting and sizing. The recommended treatment levels/amounts summarized here are based on a subjective assessment of what can realistically be expected to be installed considering expected public participation and site constraints. See Map on page 9, individual Catchment Profiles, or Appendix D for BMP locations. See Methods Section for how rankings were determined.

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	# Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	$Cost/ lb-TP/year (10-year)
1	N2	Increased Street Sweeping to 4x per year	1	1.01	523	0.00	$469	$46
2	N5	Increased Street Sweeping to 4x per year	1	1.58	600	0.00	$812	$52
3	N26	Increased Street Sweeping to 4x per year	1	0.80	341	0.00	$750	$94
4	N7	Increased Street Sweeping to 4x per year	1	0.72	307	0.00	$694	$96
5	N22	Increased Street Sweeping to 4x per year	1	0.77	337	0.00	$745	$97
6	N3	Increased Street Sweeping to 4x per year	1	0.81	491	0.00	$790	$98
7	N24	Increased Street Sweeping to 4x per year	1	0.74	313	0.00	$748	$101
8	N13	Increased Street Sweeping to 4x per year	1	0.61	261	0.00	$646	$106
9	N18	Increased Street Sweeping to 4x per year	1	0.62	268	0.00	$711	$114
10	N12	Increased Street Sweeping to 4x per year	1	0.60	256	0.00	$692	$116
11	N11	Increased Street Sweeping to 4x per year	1	0.52	217	0.00	$701	$135
12	N27	Increased Street Sweeping to 4x per year	1	0.49	125	0.00	$667	$135
13	N25	Increased Street Sweeping to 4x per year	1	0.47	200	0.00	$657	$139
14	N16	Increased Street Sweeping to 4x per year	1	0.45	191	0.00	$675	$152
15	N23	Increased Street Sweeping to 4x per year	1	0.40	144	0.00	$653	$164
16	N20	Increased Street Sweeping to 4x per year	1	0.35	150	0.00	$657	$188
17	N19	Increased Street Sweeping to 4x per year	1	0.12	51	0.00	$625	$517
18	N23	BMP 15k - BioInfiltration Simple	1	0.71	102	0.20	$6,728	$1,399
19	N11	Priority Shoreline 102,103,104,105	15	8.69	15449	0.95	$96,850	$1,810
20	N7	BMP 2b - Vegetated Swale	1	0.14	53	0.04	$1,620	$2,085

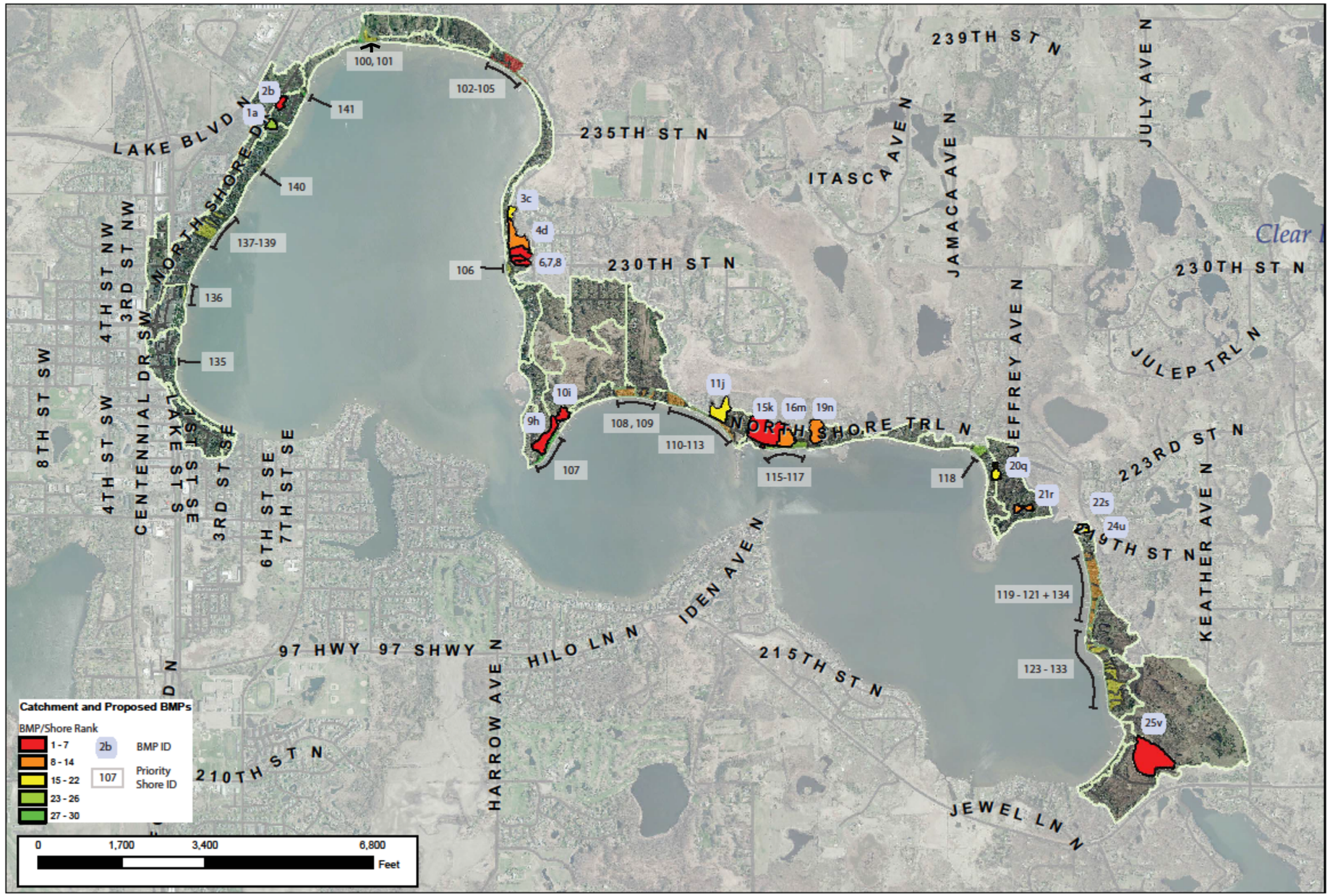
Stormwater Retrofit Ranking by BMP Cost Effectiveness

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	# Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	$Cost/ lb-TP/year (10-year)
21	N18	BMP 9h - BioInfiltration Simple	1	0.42	185	0.29	$4,567	$2,409
22	N19	BMP 10i - BioInfiltration Mod Complex	1	0.69	279	0.46	$15,026	$2,451
23	N31	BMP 25v - IESF Bench Retrofit	1	0.83	15	0.00	$18,339	$2,812
24	N12	BMP 6g,7f,8e - Retention Swales and BioInfiltration Mod Complex	3	1.14	455	0.61	$21,022	$2,831
25	N20	Priority Shoreline 108, 109	7	2.49	2588	0.86	$47,479	$3,094
26	N24	BMP 19n - BioInfiltration Simple	1	0.32	105	0.23	$5,432	$3,153
27	N12	BMP 4d- BioInfiltration Simple	1	0.45	182	0.33	$9,049	$3,322
28	N22	Priority Shoreline 110, 111, 112, 113	18	8.21	10892	1.65	$167,549	$3,334
29	N26	BMP 21r- BioInfiltration Simple	1	0.31	137	0.18	$7,026	$3,454
30	N24	BMP 16m - BioInfiltration Simple	1	0.27	109	0.23	$5,346	$3,620
31	N27	Priority Shoreline 119, 120,121,122,134	22	7.03	6914	2.00	$159,016	$3,683
32	N26	BMP 20q - BioInfiltration Simple	1	0.17	77	0.11	$4,481	$3,739
33	N27	BMP 24u - Swale Inlet and Raingarden Outfall Modification	1	0.07	46	0.05	$2,620	$3,743
34	N10	Priority Shoreline 101	3	1.12	1543	0.42	$29,489	$4,296
35	N5	Priority Shoreline 136-140	10	2.15	2735	1.05	$61,600	$4,655
36	N12	Priority Shoreline 106	3	0.97	1535	0.10	$27,704	$4,674
37	N22	BMP 11j - BioInfiltration Mod Complex	1	0.66	247	0.38	$18,113	$4,790
38	N29	Priority Shoreline 123 to 133	12	5.13	6106	1.75	$150,705	$4,822
39	N11	BMP 3c - BioInfiltration Mod Complex	1	0.36	152	0.16	$14,305	$4,951
40	N27	Shoreline Restorations-Typ Participation Rates	3	0.60	240	0.27	$16,698	$5,051
41	N7	Priority Shoreline 100 & 141	3	0.87	1243	0.33	$27,403	$5,138
42	N24	Priority Shoreline 115, 116, 117	11	2.04	1078	0.63	$70,523	$5,612
43	N25	Priority Shoreline 118	3	0.80	993	0.33	$27,704	$5,623
44	N7	BMP 1a - Parking Lot Retrofit	1	0.44	53	0.77	$22,506	$6,082

Stormwater Retrofit Ranking by BMP Cost Effectiveness

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	# Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	$Cost/ lb-TP/year (10-year)
45	N22	Shoreline Restorations-Typ Participation Rates	2	0.38	156	0.18	$12,967	$6,207
46	N24	Shoreline Restorations-Typ Participation Rates	4	0.68	288	0.23	$24,082	$6,453
47	N23	Priority Shoreline 114	3	0.62	376	0.17	$26,213	$6,884
48	N18	Priority Shoreline 107	10	1.51	1832	0.58	$84,206	$9,077
49	N20	Shoreline Restorations-Typ Participation Rates	3	0.48	156	0.22	$24,270	$9,275
50	N29	Shoreline Restorations-Typ Participation Rates	1	0.18	60	0.11	$9,697	$9,852
51	N2	Shoreline Restorations-Typ Participation Rates	15	1.50	600	1.31	$82,035	$9,969
52	N2	Priority Shoreline 135	1	0.12	74	0.13	$7,375	$10,064
53	N25	Shoreline Restorations-Typ Participation Rates	15	1.82	570	1.62	$104,526	$10,565
54	N32	Shoreline Restorations-Typ Participation Rates	8	1.12	344	0.52	$64,370	$10,569
55	N10	Shoreline Restorations-Typ Participation Rates	3	0.42	162	0.24	$24,270	$10,600
56	N5	Shoreline Restorations-Typ Participation Rates	15	1.35	540	1.31	$82,035	$11,077
57	N7	Shoreline Restorations-Typ Participation Rates	15	1.35	540	1.31	$82,035	$11,077
58	N26	Shoreline Restorations-Typ Participation Rates	6	0.78	330	0.30	$48,330	$11,388
59	N13	Shoreline Restorations-Typ Participation Rates	5	0.60	220	0.34	$40,310	$12,343
60	N16	Shoreline Restorations-Typ Participation Rates	4	0.48	160	0.28	$32,290	$12,352
61	N12	Shoreline Restorations-Typ Participation Rates	2	0.16	64	0.06	$14,116	$16,090
62	N27	BMP 22s - Swale with Ponding	1	0.03	31	0.05	$3,364	$16,213
63	N18	Shoreline Restorations-Typ Participation Rates	5	0.35	115	0.29	$32,102	$16,758
64	N11	Shoreline Restorations-Typ Participation Rates	10	0.80	320	1.05	$175,520	$40,806

Ranking map of locations of standalone projects referred to in this report. This map only includes BMP locations and Priority Shoreline Catchment Locations (ranking table on preceding pages 5-7). Street Sweeping and Typical Shoreline Restorations are excluded. The 'Catchment Profiles' section provides additional detail on these projects. See Appendix C for concept designs of all identified standalone projects.



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About this Document

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

Document Organization

This document is organized into three major sections, plus references and appendices. Each section is briefly described below.

Methods

The methods section outlines general procedures used when analyzing the subwatershed. It provides an overview of processes involved in retrofit scoping, desktop analysis, retrofit reconnaissance investigation, cost/treatment analysis and project ranking. See Appendix A for a detailed description of the methods for both the overall analysis as well as for how *Street Sweeping* and *Priority Shoreline Catchments* were factored into the modelling and reporting.

Catchment Profiles

Catchment ID numbers were provided by existing catchment delineation data that was provided by the CLFLWD and the City of Forest Lake. For this analysis only, 33 sub-catchments were created within the Forest Lake Catchment FL-01 (the catchment that is considered "direct drainage") in order to rank practices more effectively by geographic area (totaling 637 acres). Each sub-catchment was designated with the label FL01-Nx ('x' representing the new sub-catchment ID). Only 21 of these sub-catchments were analyzed for this report (totaling 300 acres) because the remaining 12 catchments were either landlocked or were predominantly wetland and retrofit BMPs were deemed ineffective. The existing stormwater management practices within each catchment were analyzed for annual pollutant loading - total phosphorus, total suspended solids and runoff volume specifically. See Appendix B for a guide to reading the catchment profiles. For each catchment, the following information is detailed:

Catchment Description

Within each catchment profile is a table that summarizes basic catchment information including acres, land cover, parcels, and estimated annual pollutant and volume loads. A brief description of the land cover, stormwater infrastructure, and any other important general information is also described. Existing stormwater practices are noted, and their estimated effectiveness presented.

Retrofit Recommendations

The recommendation section describes the conceptual retrofit(s) that were identified. It includes tables outlining the estimated pollutant removals by all practices proposed, as well as costs and overall cost-benefit ranking. Following this Retrofit Recommendations summary page, each practice has its own page which includes a map, individual cost-benefit analysis, and site specific comments on the individual proposed retrofit.

Retrofit Rankings (included in Appendix C and Appendix D)

This section ranks stormwater retrofit projects across all catchments to create a prioritized project list. The list is sorted by cost-per-pound of total phosphorus removed for each project over 10 years – typical contract obligation length for cost-share funded projects. The final cost-per-pound treatment value includes design, installation, and maintenance costs.

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

- Non-target pollutant reductions

- Timing projects to occur with other CIPs
- Project visibility
- Availability of funding
- Total project costs
- Educational value
- Additional ecological and habitat connectivity value

References

This section identifies various sources of information synthesized to produce the assessment protocol used in this analysis.

Appendices

This section provides supplemental information and/or data used at various points along the assessment protocol. It also includes Cost Estimates and Concepts for each proposed BMP.

Methods *(specific to this report only)*

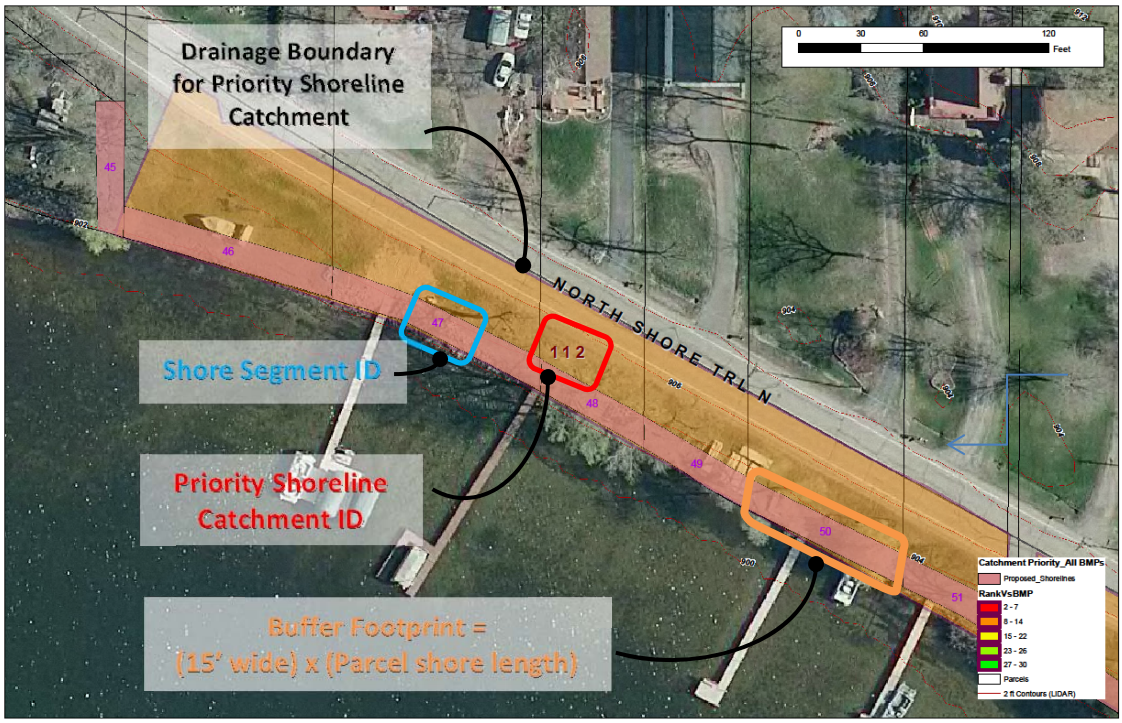
Priority Shoreline Catchments

Summary

The analysis utilized multiple resources in identifying and modelling BMPs mentioned in the report. Partway through the field investigations (and after the initial WinSLAMM base load modelling of 33 catchments was completed), it became very apparent that there was a lack of suitable area to implement traditional infiltration-based BMPs (eg, raingardens, curb-cut bioinfiltration basins, etc). This was mostly due to spatial constraints, soil permeability, and close proximity to the water table. It was decided at this point that a more comprehensive analysis and cost-benefit ranking of existing shoreline conditions on the lake would be a valuable addition to the report and that soil losses due to erosion should be incorporated into the modelling of proposed practices. Further, amendments were made to the typical design of a shoreline buffer strip to enhance its ability to capture pollutants before they reach the lake. This combination of factors has made some shoreline restorations much more representative of their true cost-benefit value as a BMP. Many eroding shorelines now rank higher than they have in the past when only the contributing land runoff was considered in the modelling.

Identification and Delineation of "Priority Shoreline Catchments"

A Priority Shoreline Catchment (PSC), as defined in this report, is a shoreline that was observed to be actively eroding, suffering from major ice heave, or was at risk to become an issue due to site-specific variables (such as proximity to critical infrastructure, steep slopes greater than 10%, near areas of intense ice heaving or other erosion, or high-traffic zones exhibiting heavy use). The identified shorelines were grouped by these similar site-specific variables and then sub-catchments were delineated for each grouping. The catchments were assigned a number 100-141. Further, each buffer footprint (or Shoreline Segment) was limited to a single parcel and was also labeled with a separate number on the maps in each Catchment Profile (based on the FID number 0-122 in the GIS file).



Methods *(specific to this report only)*

Priority Shoreline Catchments

Pollutant Loads from Erosion Losses

WinSLAMM modelling does not factor in soil losses due to erosion on shorelines and therefore may underestimate the TP and TSS being added to the lake. The BWSR Water Erosion Pollution Reduction Estimator tool was used as a way to account for these soil losses. The entire shoreline in the analysis area was observed by boat in the Fall of 2015. Each parcel's shoreline was photo documented and existing conditions such as shoreline composition (vegetation, riprap, lawn, or sand) and extent of shoreline erosion were noted. The values were input into the BWSR tool and these results were combined with the WinSLAMM results to create a composite value of TP and TSS that was then factored into the cost-benefit rankings.

The BWSR tool was only used for the Proposed Pollutant Reductions and the values were not factored into the Existing Conditions scenarios. Therefore, the resulting pollution reduction percentages sometimes were in excess of 100% (since it was being compared to WinSLAMM-only values from the base-load models). For the sake of this analysis, both values are presented in the catchment profiles so one can separate the pollution reduction values if they choose. All cost-benefit rankings in the report used these composite values. For future analyses, it would be recommended to use this composite method in the calculation of existing loads to eliminate any confusion in the final analysis. See example results below.

PRIORITY CATCHMENT 110 to 113 - SUMMARY											
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
110	2	0.544	6396	281	0.71	2560	1.280	6396	2841	1.99
111	4	2.031	27139	360	0.88	960	0.480	27139	1320	1.36
112	6	0.576	12174	313	0.76	2340	1.170	12174	2653	1.93
113	6	1.351	25975	458	1.13	3620	1.810	[illegible]	[illegible]	[illegible]
	TOTAL	4.502					TOTAL	71684	10892	8.21

COMPOSITE VALUE

Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N22*									
		BMP 11j - BioInfiltration Mod Complex		Priority Shoreline 110, 111, 112, 113		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.66	7%	8.21	84%	0.8	8%	0.4	4%	10.0	103%
	TSS (lb/yr)	247	7%	10,892	300%	337.0	9%	156.0	4%	11632	320%
	Volume (acre-feet/yr)	0.4	6%	1.6	24%	0.0	0%	0.2	3%	2.2	33%
	Number of BMP's	1		18		1		2		22	
	BMP Size/Description	1,800	sf	23,610	sf	0.788	curb miles	2,360	sf	All Practices	

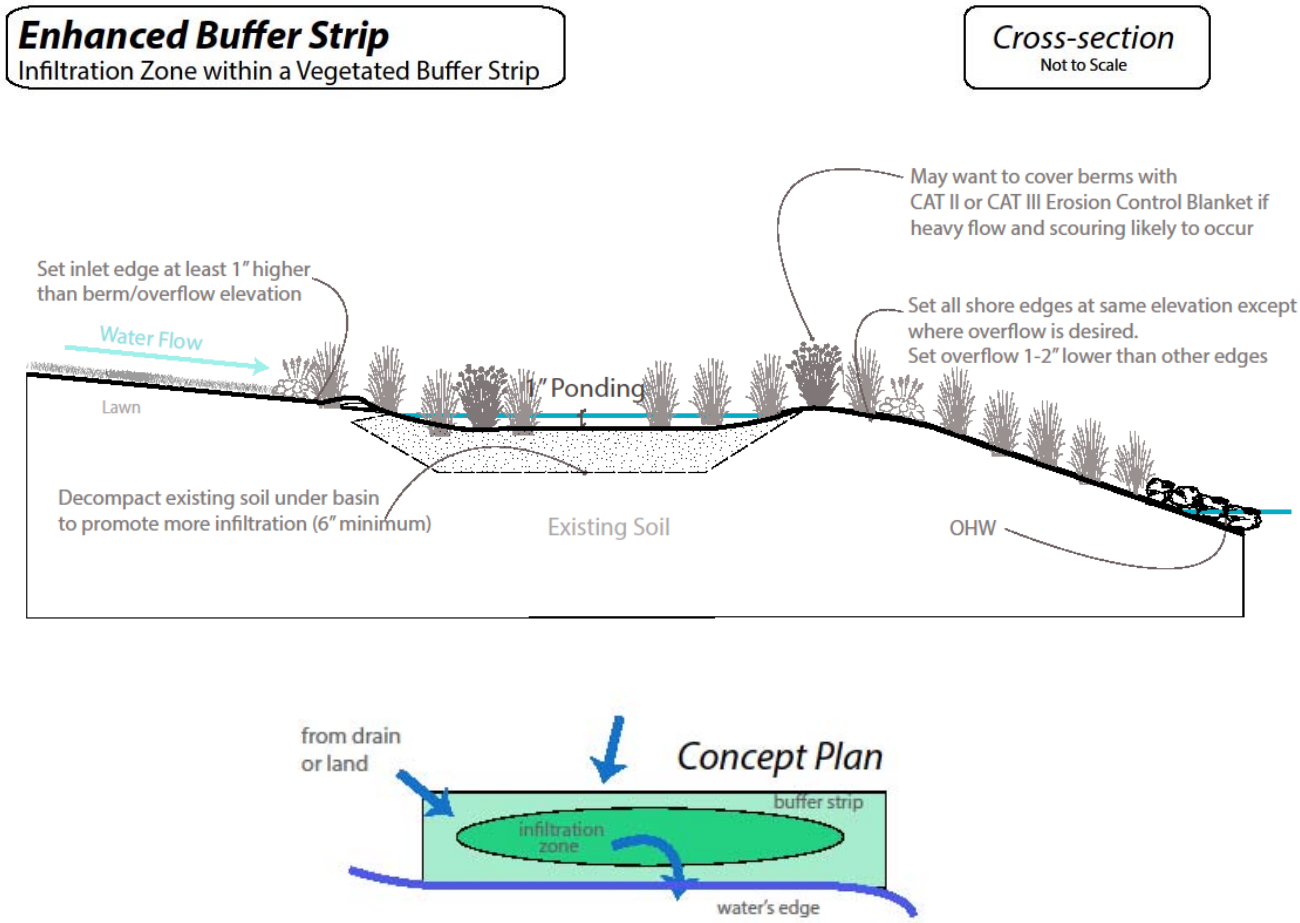
Methods *(specific to this report only)*

Enhanced Buffer Strip
(use for Priority Shoreline Catchments and Typ. Shoreline Restorations)

Typical Design

The WinSLAMM model inputs for a buffer were amended beyond what a traditional buffer strip would be input as. The typical cross-section of a buffer strip is only a planted strip of deep-rooted vegetation that is primarily used for filtration as water passes through the strip and it only incidentally infiltrates water as quickly as the soil media might provide. There is no ponding of water typically. Through field experience and modelling various scenarios, it was decided that an enhanced buffer strip (adding 1" of ponding storage) could be implemented for this analysis.

An Enhanced Buffer Strip is defined in this analysis as a buffer strip that can accommodate up to 1" of ponding over 50% of the proposed buffer area. This minor addition of ponding increases the ability of the buffer strip to reduce TP and TSS by both intercepting sediment as well as allow for soil infiltration and uptake by plants. Additionally, a ponding value of 1" deep is important because it is a safe design depth that is similar to many of the compacted lawn depressions that were observed throughout the watershed; all of which drained with a 48 hour period (which is a desired target for infiltration practices). All buffers were modelled at 15' wide and multiplied by the parcel shoreline length to get a total buffer area. Ponding area (of 1" depth) was modelled at 50% of the total buffer area for all shorelines proposed as Priority Shorelines.



Methods *(specific to this report only)*

Street Sweeping

Summary

The analysis utilized multiple resources in identifying and modelling BMPs mentioned in the report. The Forest Lake South Stormwater Retrofit Analysis (FLS report) had identified Street Sweeping as an existing BMP. The FLS report stated that street sweeping occurred in the area 10x annually on most major roads with the City of Forest Lake. For this North analysis, project scoping meetings revealed that most major roads were maybe swept twice annually; once in the Spring and once in the Fall. This is analysis assumed a 2x annual sweeping regime for all Existing Conditions modelling. An average cost of $150 per curb mile was assumed for the rankings. Street Sweeping as a Best Management Practice ranks as the most cost-effective BMP to implement in the analysis. Even if the cost per curb mile were more expensive than what was assumed in this report, it would not change the overall rankings. Street Sweeping would far and away be the most cost effective practice to implement to reduce TP and TSS loads to the lake.

Pollutant Loading

In proposing a street sweeping regime that would improve upon the current load reductions, numerous scenarios were run in WinSLAMM to view how effective street sweeping was if the frequency of sweeping were increased to 4x annually, 8x annually, and every two weeks. In WinSLAMM, it was shown that additional benefits in TP and TSS load reductions fell by roughly 50% when increasing from 2x to 4x annually, and after that the drop in load reductions was even greater. In order to provide a conservative estimate for street sweeping benefits and to strike a balance in cost effectiveness it was decided that a good target would be to increase street sweeping on all roads from 2x annually to 4x annually.

Model and Cost Assumptions

Various reports from local sources were reviewed to make our model assumptions (Prior Lake, RWMWD, MPCA, MNDOT). All assumptions were conservative values, so any benefits would not be over-exaggerated. It was assumed that the City of Forest Lake was using (and owned) a Mechanical Sweeper and sweeping was twice annually. Percent canopy cover of roads was not considered, as it is not a variable in WinSLAMM. If for budgetary reasons Street Sweeping as a practice had to be prioritized, it is recommended to consider tree canopy cover as a variable and to follow the prioritization methods presented in the following: Kalinosky, P., L.A. Baker, S. E. Hobbie, R. Bintner, and C. Buyarski. 2014. *User Support Manual: Estimating Nutrient Removal by Enhanced Street Sweeping.* Report to the Minnesota Pollution Control Agency, Sept. 2014

Overall cost per curb-mile was assumed to be $150 per curb mile. This was an intuitive composite of values given in the RWMWD report, the Prior Lake literature, and other values seen throughout past studies. Cost-per curb mile can range wildly based on a number of assumptions and it was decided that $150 per curb-mile was a fair estimate given the limited number of annual trips. Additionally, the analysis tables in each Catchment Profile show $0 for maintenance costs. This is because maintenance costs were directly accounted for in our cost per curb mile value and the $0 value in each table is so that these costs are not accounted for twice in our analysis. The final ranked Cost/Lb TP values appeared to be in line with estimates established in other reports. Even if the cost per curb mile were more expensive than what was assumed in this report, it would not change the overall rankings. Street Sweeping would far and away be the most cost effective practice to implement to reduce TP and TSS loads to the lake.

Methods *(specific to this report only)*

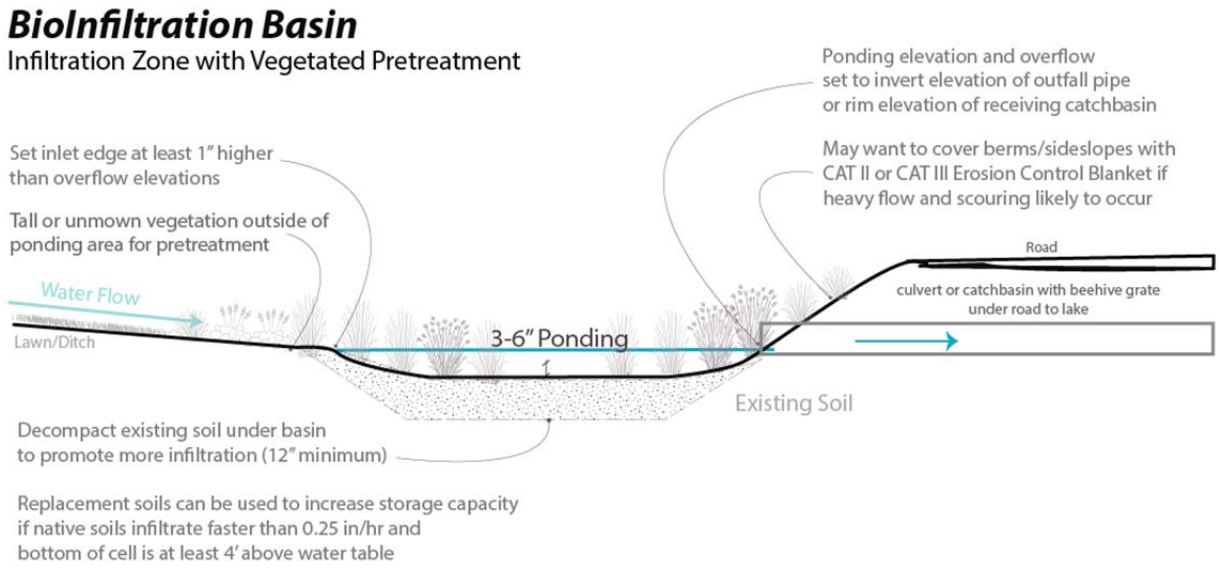
Typical Biofiltration, BioInfiltration, and Ponded Swale Design

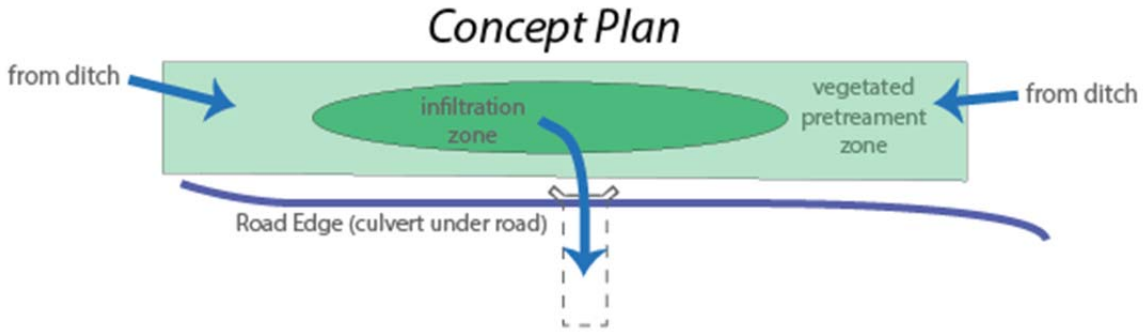
Summary

Biofiltration, BioInfiltration, and Ponded Swales were the three primary BMPs chosen throughout the analysis area. Typical cross-sections are included below and describe the design assumptions used in the cost estimation process.

BioInfiltration

BioInfiltration is a basin that infiltrates into the native soil fast enough to allow for a fully drained basin within 48 hours. There are no underdrains in a BioInfiltration Basin. All basins of either type in the analysis do not have pretreatment devices to limit gross solid accumulation and rely on additional tall vegetation upstream to capture sediment prior to entering the basin.





Methods *(specific to this report only)*

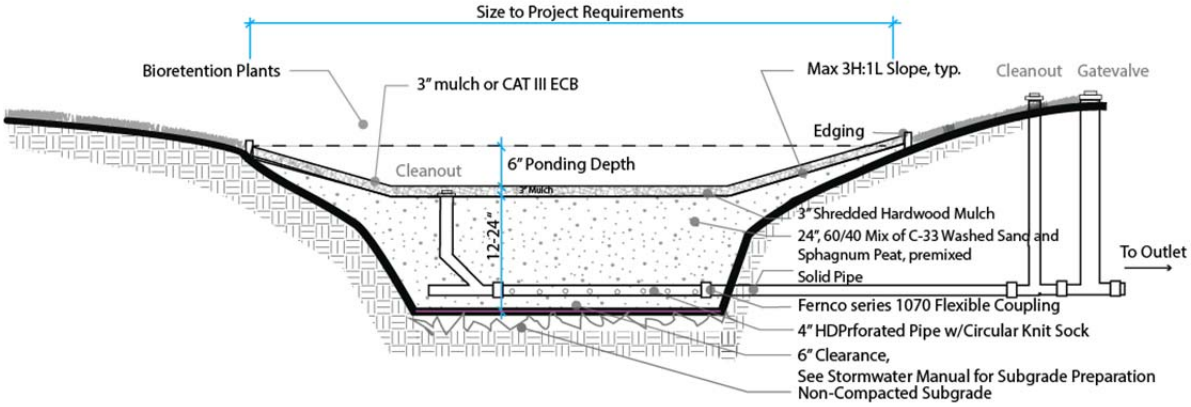
Typical Biofiltration, BioInfiltration, and Ponded Swale Design

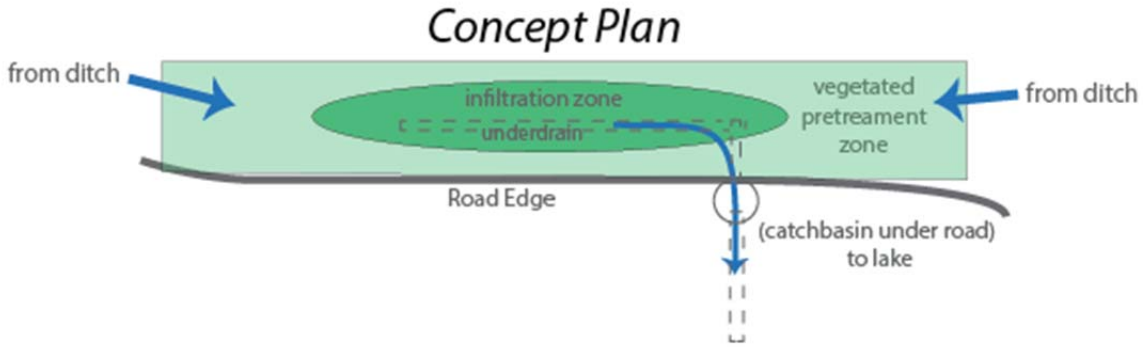
Biofiltration and BioInfiltration

Biofiltration is bioretention basin that requires an underdrain. This is usually required when soils do not infiltrate fast enough or when there is a need for a liner beneath the cell. Cleanouts and gatevalves will typically accompany the draintile assembly. All basins of either type in the analysis do not have pretreatment devices to limit gross solid accumulation and rely on additional tall vegetation upstream to capture sediment prior to entering the basin.

BioFiltration Basin

With Underdrain and Gatevalve Assembly



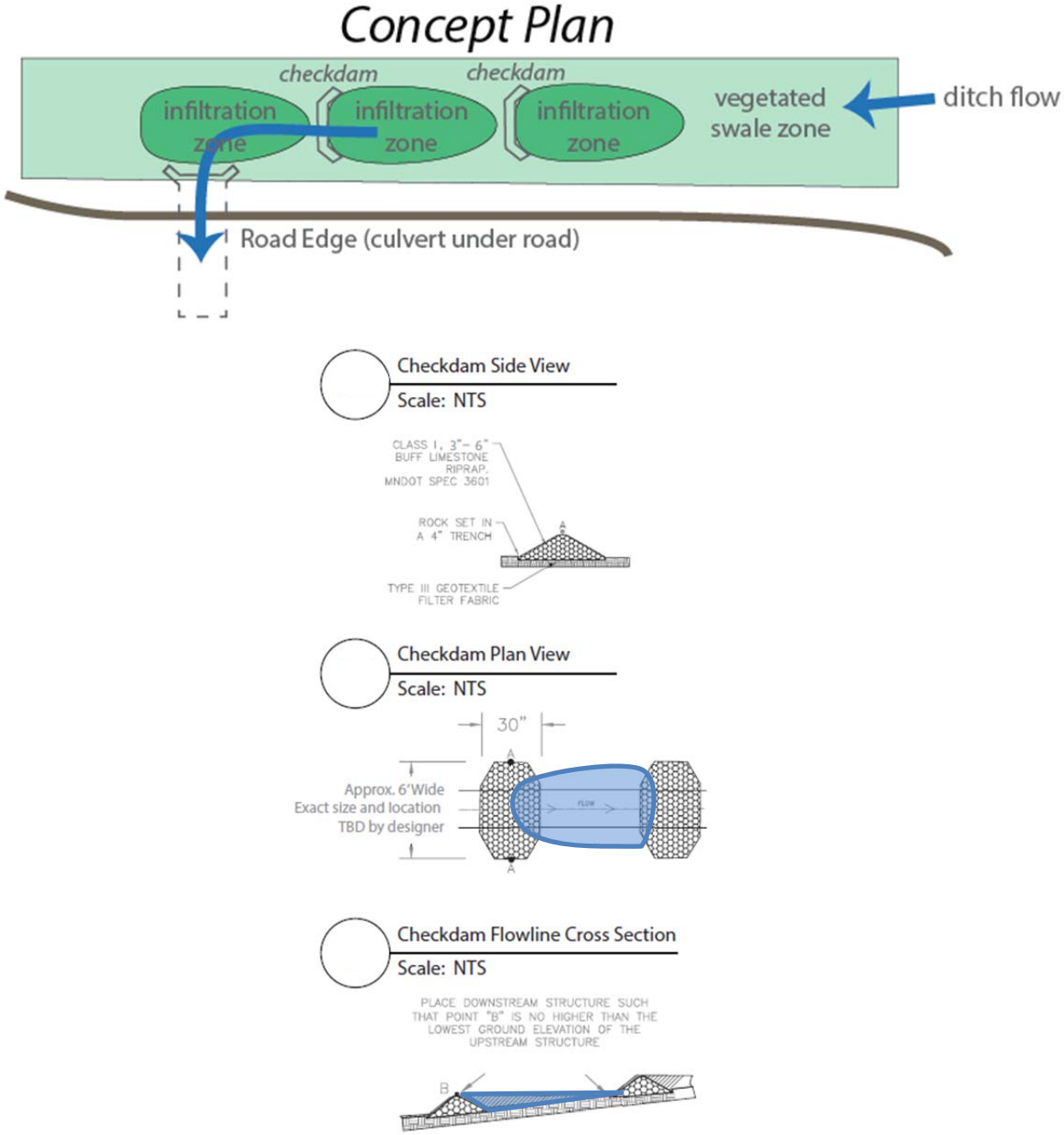


Methods *(specific to this report only)*

Typical Biofiltration, BioInfiltration, and Ponded Swale Design

Ponded Swales

Ponded swales are essentially a flow-through (or in-line) BioInfiltration basin. Some sort of detention device will be installed at the downstream end of the swale to promote ponding at a specified depth (riprap check dam or earthen berm). The ponding area created allows for increased treatment of TP and TSS, and is a form of volume control as well. All swales were modelled with 3-6" of ponding and soils infiltrate at 0.2 in/hr (minimum).



Methods *(specific to this report only)*

Iron Enhanced Sand Filter (IESF)

Iron Enhanced Sand Filter Pond Bench Retrofit

Iron enhanced sand filters help to remove dissolved phosphorus that typical bioinfiltration practices cannot. Efficiencies in removal for IESF range from 30% to 90% reduction in dissolved phosphorus. The study chose a 65% removal rate of dissolved phosphorus to account for inefficiencies in removal rates as the practice ages. Below is a typical section for an IESF pond bench retrofit. There will likely be a deviation from this design to fit site specific constraints of the IESF proposed in this report.

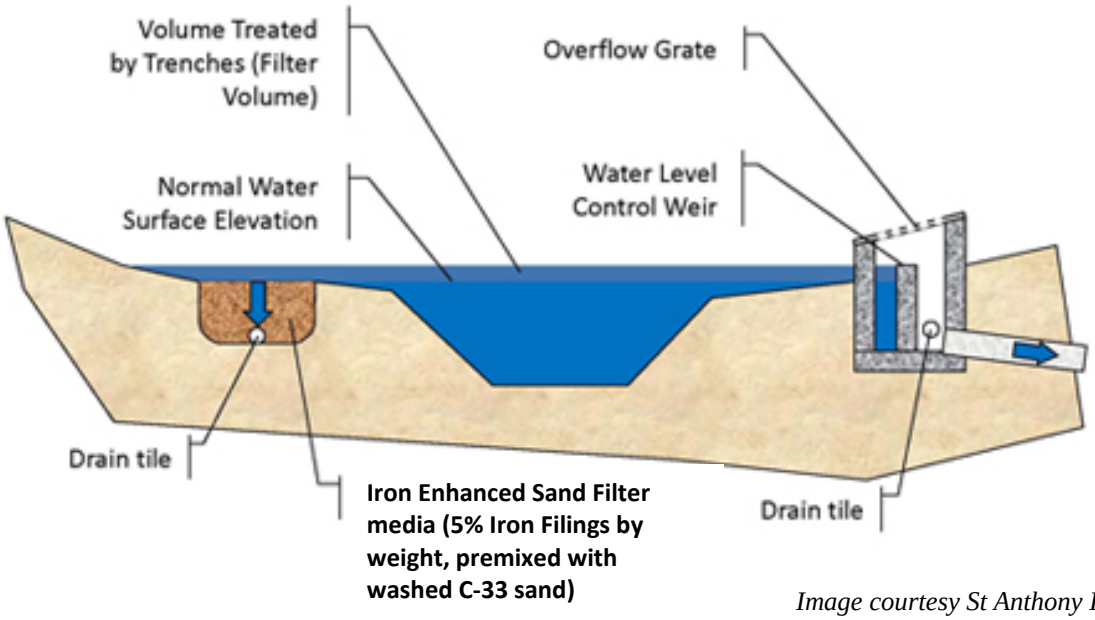


Image courtesy St Anthony Falls Laboratory, MN (2009)

Catchment Profiles and BMP Rankings

Catchment FL01-N2



Existing Catchment Summary	
Acres	18.73
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	15.87
TP (lb/yr)	15.18
TSS (lb/yr)	7,680

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	17.6	2.4	14%	**15.2**
	TSS (lb/yr)	8,822	1,142.0	13%	**7,680**
	Volume (acre-feet/yr)	16.4	0.6	3%	**15.9**
	Number of BMP's				
	BMP Size/Description				
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

Catchment FL01-N2 is comprised of primarily medium density, single-family residential land use type as well as a few acres of multi-family residential and commercial land uses. This catchment is directly connected to Lake 1 of Forest Lake via multiple stormsewer system inlets and direct runoff.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets and parking lots occur approximately twice annually. There is also a "Dead End Street" infiltration basin that exists at the end of 2nd Ave SW. Both practices were factored into the existing loads.

FL01-N2: RETROFIT RECOMMENDATIONS

RANK 1/64 - **Increased Street Sweeping:** Increase Street Sweeping from 2x/year to 4x/year. This includes sweeping the private (but easily accessible) parking areas that are adjacent to the main roads.

RANK 51/62 - **Typical Shoreline Restorations:** Up to 15 properties with 15' shoreline buffers.

RANK 52/62 - **Priority Shoreline 135:** Disconnect Buried Downspouts from Shore and install buffer



Cost/Benefit Analysis		RETROFIT OPTIONS *Catchment FL01-N2*							
		Priority Shoreline 135		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.12	1%	1.0	7%	1.5	10%	2.6	17%
	TSS (lb/yr)	74	1%	522.5	7%	600.0	8%	1197	16%
	Volume (acre-feet/yr)	0.1	1%	0.0	0%	1.3	8%	1.4	9%
	Number of BMP's	1		1		15		17	
	BMP Size/Description	1,000	sf	1.224	curb miles	15,000	sf	All Practices	
	BMP Type	Priority Lakeshore restoration		Street Sweeping		Lakeshore Restoration		Sweeping and Shores	
Cost	Materials/Labor/Design	$7,050.00		$419.30		$77,160.00		$84,629.30	
	Promotion & Admin Costs	$325		$50		$4,875		$5,250	
	Probable Project Cost	$7,375		$469		$82,035		$89,879	
	Annual O&M	$450		$0		$6,750		$7,200	
	10-yr Cost/lb-TP/yr	$10,064		$46		$9,969		$6,693	
	10-yr Cost/2,000lb-TSS/yr	$32,095		$180		$49,845		$27,373	

FL01-N2: Increased Street Sweeping

Rank 1/64

Drainage Area – 1.224 curb miles (0.94 curb miles plus 30,000sf of parking lots)
Location – All major roads and parking lots in the catchment
Property Ownership – Mostly Public, some Private Lots
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the sweepings are equally spread throughout the season between the first Spring sweeping and the final Fall sweeping. A large amount of sediment can be captured if the parking lots that are adjacent to Lake St S and 1st St SE are included in the street sweeping (factored into the modelling).



Cost/Removal Analysis		*Project ID* Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.0	7%
	TSS (lb/yr)	522.5	7%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	1.224	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$419.30	
	Promotion & Admin Costs	$50	
	Probable Project Cost	$469	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$46	
	10-yr Cost/2,000lb-TSS/yr	$180	

FL01-N2: Typical Shoreline Restorations

Rank 51/64

Drainage Area –0.5 acres average.
Location – any 15 Participating Shorelines within FL01-N2 (in addition to Priority Shorelines)
Property Ownership – Private

Description – About 60% of the FL01-N2 catchment drainage area is from the rear yard (lake facing) area of each lakefront residence. At least 50% of these lakefront residences backyards and shorelines are composed primarily of turfgrass flowing to sandy beaches while the other 50% consists of turfgrass flowing to riprap. Shoreline conditions devoid of native plant vegetation allow for stormwater runoff, fertilizer, pesticides, and herbicides to enter the lake without any treatment. Moreover, shoreline erosion occurs much more readily along shorelines without native plant vegetation. The proposed stormwater BMP for these areas is an enhanced shoreline buffer that can pond up to 1" of water to more effectively filter stormwater and associated pollutants prior to entering the lake as well as providing structural stability to the shoreline.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 15 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

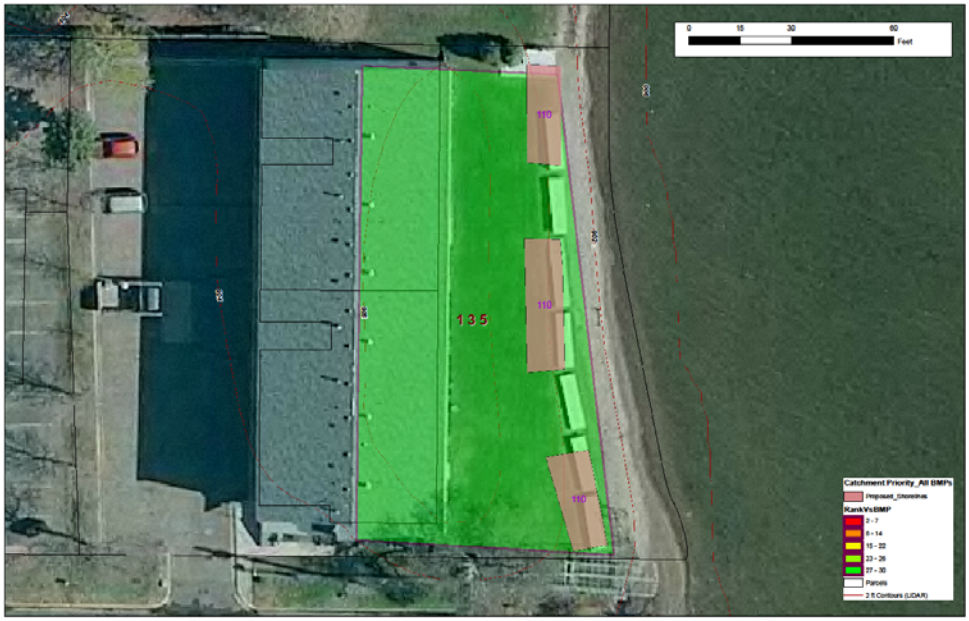
Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.5	10%
	TSS (lb/yr)	600.0	8%
	Volume (acre-feet/yr)	1.3	8%
	Number of BMP's	15	
	BMP Size/Description	15,000	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$77,160.00	
	Promotion & Admin Costs	$4,875	
	Probable Project Cost	$82,035	
	Annual O&M	$6,750	
	10-yr Cost/lb-TP/yr	$9,969	
	10-yr Cost/2,000lb-TSS/yr	$49,845	

FL01-N2: Priority Shoreline 135

Rank 52/64

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **52/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **29/30**

Drainage Area – 0.214 acres
Location – 2nd Ave SW at the lake
Property Ownership – Private
Description – The BMP for this high density residential location includes disconnecting the buried downspout pipes that are directly outletting into the lake and letting them flow over land into a series of buffer plantings that are 15' wide. This project has a small load reduction but is a great educational opportunity for lakeside runoff management.



	Cost/Removal Analysis	Project ID: Priority Shoreline 135	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.12	1%
	TSS (lb/yr)	74	1%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	1	
	BMP Size/Description	1,000	sf
	BMP Type	Priority Lakeshore restoration	
Cost	Materials/Labor/Design	$7,050.00	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$7,375	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$10,064	
	10-yr Cost/2,000lb-TSS/yr	$32,095	

Catchment FL01-N3



Existing Catchment Summary	
Acres	14.28
Dominant Land Cover	DOWNTOWN
Volume (acre-feet/yr)	15.55
TP (lb/yr)	11.55
TSS (lb/yr)	6,760

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	13.2	1.6	12%	**11.6**
	TSS (lb/yr)	7,741	981.0	13%	**6,760**
	Volume (acre-feet/yr)	15.8	0.3	2%	**15.5**
	Number of BMP's				
	BMP Size/Description				
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

Catchment FL01-N3 is comprised mostly of Commercial land uses and a highly impervious character. This catchment is directly connected to lake 1 (west) of Forest lake via direct runoff and pipe conveyance. There were no existing BMPs discovered. Therefore, most runoff flows untreated to the lake.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets and parking lots occur approximately twice annually. WinSLAMM street sweeping inputs factored street sweeping taking place outside of the winter season (11/04 – 03/13) once in the Spring and once in the Fall using a vacuum-assisted sweeper.

RETROFIT RECOMMENDATIONS

RANK 6/64 - **Increased Street Sweeping:** Increase Street Sweeping from 2x/year to 4x/year. This includes sweeping the private (but easily accessible) parking areas that are adjacent to the main roads.

UNRANKED - **Runoff Diversion:** Not explored in this report is the option to redirect some runoff from Hwy 61 and the parking lots to existing stormwater facilities west down Broadway Ave, or nearby along Centennial Drive where space theoretically exists to install a new sub-regional stormwater BMP.



		Existing Conditions	Project ID: Increased Street Sweeping to 4x per year		Project ID: Total Reductions (all implemented)	
			New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)		0.8	7%	0.8	7%
	TSS (lb/yr)		490.5	7%	490.5	7%
	Volume (acre-feet/yr)		0.0	0%	0.0	0%
	Number of BMP's		1		1	
	BMP Size/Description		1.052	curb miles	All Practices	
	BMP Type		Street Sweeping		Sweeping	
Cost	Materials/Labor/Design		$389.89		$389.89	
	Promotion & Admin Costs		$400		$400	
	Probable Project Cost		$790		$790	
	Annual O&M		$0		$0	
	10-yr Cost/lb-TP/yr		$98		$98	
	10-yr Cost/2,000lb-TSS/yr		$322		$322	

FL01-N3: Increased Street Sweeping

Rank 6/64

Drainage Area – 1.052 curb miles (0.112 curb miles plus 100,000sf of parking lots)
Location – All major roads and parking lots in the catchment
Property Ownership – Some Public, many Private Lots
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the sweepings are equally spread throughout the season between the first Spring sweeping and the final Fall sweeping. A large amount of sediment can be captured if the parking lots between the park and Hwy 61 are included in the street sweeping (factored into the modelling).



Cost/Benefit Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.8	7%
	TSS (lb/yr)	490.5	7%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	1.052	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$389.89	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$790	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$98	
	10-yr Cost/2,000lb-TSS/yr	$322	

Catchment FL01-N5



Existing Catchment Summary	
Acres	36.66
Dominant Land Cover	MDRNA
Parcels	
Volume (acre-feet/yr)	17.18
TP (lb/yr)	22.64
TSS (lb/yr)	8,768

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	27.7	5.0	18%	**22.6**
	TSS (lb/yr)	10,387	1,619.5	16%	**8,768**
	Volume (acre-feet/yr)	18.6	1.4	8%	**17.2**
	Number of BMP's	5			
	BMP Type	Street Sweep 2x annually, 2 Dead End Streets Basins, 1 Curb Cut Filtration Basin, 1 Shoreline			

CATCHMENT DESCRIPTION

FL01-N5 is mostly comprised of medium density, single-family residential clustered on 50' wide lots (making impervious concentrations higher than an average lake lot). There are not many roads that drain into the lake from this catchment. As of the report's creation, the existing practice at the green star (near Mattson Funeral Home and Hwy 61) was suspected to be disconnected from the watershed entirely and drains to the west but it was undetermined. The results have factored in these the load reduction of the existing practice only. There is a lot of shoreline ice heave on mostly flat lots, both limiting existing runoff but adding to soil losses on the shore.

EXISTING STORMWATER TREATMENT

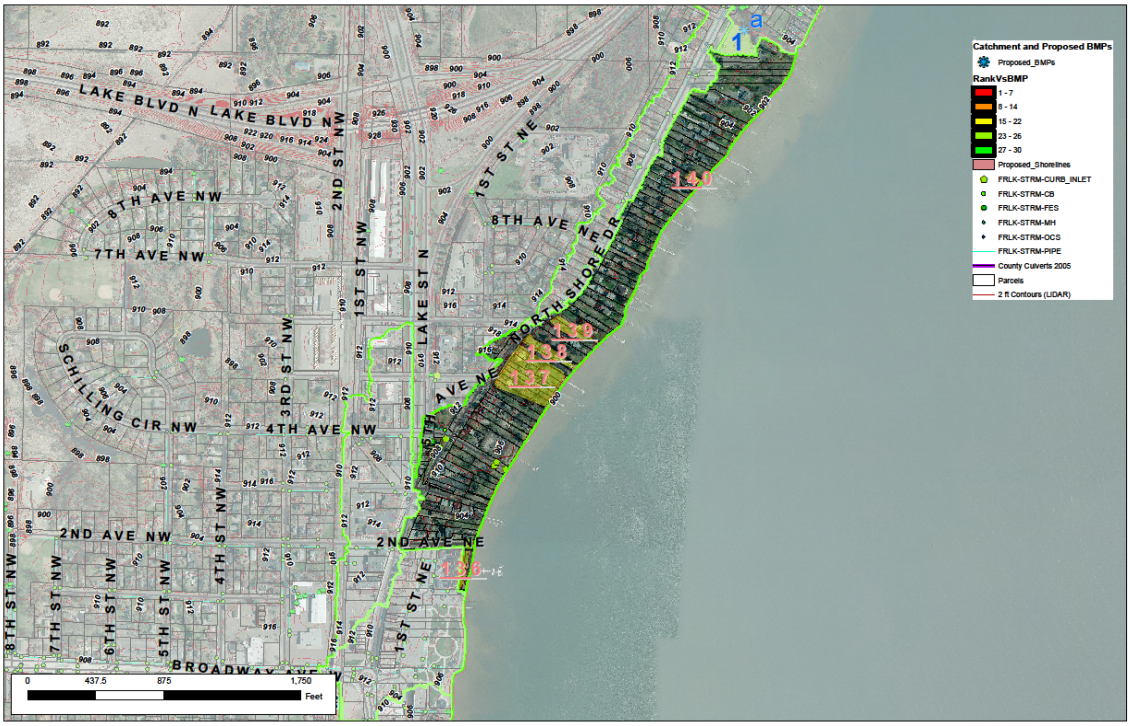
Street sweeping of city streets and parking lots occur approximately twice annually. There are two "Dead End Street" infiltration basins that exist at the end of NE 2nd Ave and NE 4th Ave. There is a filtration basin behind the Mattson Funeral Home and there is a shoreline buffer at a residence east of 6th Ave and North Shore Trail intersection. All practices were factored into the existing loads.

RETROFIT RECOMMENDATIONS

RANK 2/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year. This includes sweeping the private (but easily accessible) parking areas that are adjacent to the main roads.

RANK 35/64 - Priority Shoreline 136 to 140: 10 properties with observed heave and erosion are fair enhanced shoreline restoration candidates.

RANK 55/64 - Typical Shoreline Restorations: Up to 15 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N5*							
		Priority Shoreline 136-140		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.15	9%	1.6	7%	1.4	6%	5.1	22%
	TSS (lb/yr)	2,735	31%	599.5	7%	540.0	6%	3875	44%
	Volume (acre-feet/yr)	1.1	6%	0.0	0%	1.3	8%	2.4	14%
	Number of BMP's	10		1		15		26	
	BMP Size/Description	8,500 sf		1.180 curb miles		15,000 sf		All Practices	
	BMP Type	Priority Lakeshore restoration		Street Sweeping		Lakeshore Restoration		Sweeping and Shores	
Cost	Materials/Labor/Design	$58,350.00		$411.78		$77,160.00		$135,921.78	
	Promotion & Admin Costs	$3,250		$400		$4,875		$8,525	
	Probable Project Cost	**$61,600**		**$812**		**$82,035**		$144,447	
	Annual O&M	$3,825		$0		$6,750		$10,575	
	10-yr Cost/lb-TP/yr	**$4,655**		**$52**		**$11,077**		$5,261	
	10-yr Cost/2,000lb-TSS/yr	**$7,302**		**$271**		**$55,383**		$20,985	

FL01-N5: Increased Street Sweeping

Rank 2/64

Drainage Area – 1.18 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the sweepings are equally spread throughout the season between the first Spring sweeping and the final Fall sweeping.



Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.6	7%
	TSS (lb/yr)	599.5	7%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	1.180	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$411.78	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$812	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$52	
	10-yr Cost/2,000lb-TSS/yr	$271	

FL01-N5 – Priority Shorelines 136, 137, 138, 139, 140

Rank 35/64

Drainage Area – 4.743 acres (0.473 acre average per property)
Location – 9 private residences and 1 high density residential (*see maps*)
Property Ownership – Private
Description – **136**: High Density Residential with sandy beach front. This site has installed riprap 'bars' across the shoreline to prevent erosion of the beach from their downspouts (it is assumed). With a more robust shoreline buffer that is strategically placed they may be able to eliminate the riprap and provide a more beneficial buffer that will help keep the shoreline intact. There is also a large eroded area on the south of the lot that is contributing greatly to this TP/TSS load reduction.
137, 138, 139, 140: These are all densely arranged, narrow shore lots with signs of erosion. See proceeding profiles for individual shorelines.

Cost/Removal Analysis		Project ID: Priority Shoreline 136-140	
		New trtmt	Net %
Treatment	TP (lb/yr)	2.15	9%
	TSS (lb/yr)	2,735	31%
	Volume (acre-feet/yr)	1.1	6%
	Number of BMP's	10	
	BMP Size/Description	8,500	sf
	BMP Type	Priority Lakeshore restoration	
Cost	Materials/Labor/Design	$58,350.00	
	Promotion & Admin Costs	$3,250	
	Probable Project Cost	**$61,600**	
	Annual O&M	$3,825	
	10-yr Cost/lb-TP/yr	**$4,655**	
	10-yr Cost/2,000lb-TSS/yr	**$7,302**	

PRIORITY CATCHMENT 136 to 140 - SUMMARY

			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
136	1	0.483	9579	52	0.13	600	0.300	9579	652	0.43
137	6	2.745	25018	237	0.57	860	0.430	25018	1097	1.00
138	1	0.68	5294	64	0.15	100	0.050	5294	164	0.20
139	1	0.655	3598	23	0.07	100	0.050	3598	123	0.12
140	1	0.18	2364	19	0.06	680	0.340	2364	699	0.40
	TOTAL	4.743					TOTAL	45853	2735	2.145

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Methods section for explanation of full methodology.***

FL01-N5 – MAP of Priority Shoreline Catchment 136

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **35/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **18/30**

Notes: High Density Residential with sandy beach front. This site has installed riprap 'bars' across the shoreline to prevent erosion of the beach from their downspouts (it is assumed). With a more robust shoreline buffer that is strategically placed they may be able to eliminate the riprap and provide a more beneficial buffer that will help keep the shoreline intact. There is also a large eroded area on the south of the lot that is contributing greatly to this TP/TSS load reduction.



PRIORITY CATCHMENT 136 to 140 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
136	1	0.483	9579	52	0.13	600	0.300	9579	652	0.43
137	6	2.745	25018	237	0.57	860	0.430	25018	1097	1.00
138	1	0.68	5294	64	0.15	100	0.050	5294	164	0.20
139	1	0.655	3598	23	0.07	100	0.050	3598	123	0.12
140	1	0.18	2364	19	0.06	680	0.340	2364	699	0.40
	TOTAL	4.743					TOTAL	45853	2735	2.145

FL01-N5 – MAP of Priority Shoreline Catchment 137, 138

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **35/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **18/30**

Notes: Densely arranged, narrow 50' wide lots with signs of erosion and some ice heave. Shore Segments 114, 115, and 116 exhibit the greatest losses of 12" lateral recession and 9" vertical loss over an assumed 10 year period. Shore Segment 119 shows minor losses of 6" lateral recession and 6" vertical loss over an assumed 10 year period.



PRIORITY CATCHMENT 136 to 140 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
136	1	0.483	9579	52	0.13	600	0.300	9579	652	0.43
137	6	2.745	25018	237	0.57	860	0.430	25018	1097	1.00
138	1	0.68	5294	64	0.15	100	0.050	5294	164	0.20
139	1	0.655	3598	23	0.07	100	0.050	3598	123	0.12
140	1	0.18	2364	19	0.06	680	0.340	2364	699	0.40
	TOTAL	4.743					TOTAL	45853	2735	2.145

FL01-N5 – MAP of Priority Shoreline Catchment 139

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **35/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **18/30**

Notes: Densely arranged, narrow 50' wide lots with signs of erosion and some ice heave. Shore Segment 120 is more of a swale draining to the bare shore. Modelling included 1" of ponding behind a shallow berm and a native shoreline at the outlet.



PRIORITY CATCHMENT 136 to 140 - SUMMARY

			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
136	1	0.483	9579	52	0.13	600	0.300	9579	652	0.43
137	6	2.745	25018	237	0.57	860	0.430	25018	1097	1.00
138	1	0.68	5294	64	0.15	100	0.050	5294	164	0.20
139	1	0.655	3598	23	0.07	100	0.050	3598	123	0.12
140	1	0.18	2364	19	0.06	680	0.340	2364	699	0.40
	TOTAL	4.743					TOTAL	45853	2735	2.145

FL01-N5 – MAP of Priority Shoreline Catchment 140

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **35/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **18/30**

Notes: Densely arranged, narrow 50' wide lots with signs of erosion and some ice heave. Shore Segment 121 has exposed geotextile fabric in large swaths along a 3' high embankment of riprap that is showing some signs of localized failure. Shore Segment 121 exhibits losses of 12" lateral recession and 2" vertical loss on average over an assumed 10 year period. Duration of losses is likely shorter than 10 years but cannot be determined without consultation with landowner.



PRIORITY CATCHMENT 136 to 140 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
136	1	0.483	9579	52	0.13	600	0.300	9579	652	0.43
137	6	2.745	25018	237	0.57	860	0.430	25018	1097	1.00
138	1	0.68	5294	64	0.15	100	0.050	5294	164	0.20
139	1	0.655	3598	23	0.07	100	0.050	3598	123	0.12
140	1	0.18	2364	19	0.06	680	0.340	2364	699	0.40
	TOTAL	4.743					TOTAL	45853	2735	2.145

FL01-N5 – Typical Shoreline Restorations

Rank 55/64

Drainage Area – 7.11 acres (0.473 acre average per property)
Location – any 15 Participating Shorelines within FL01-N5 (in addition to Priority Shorelines)
Property Ownership – Private
Description – About 90% of the FL01-N5 catchment drainage area is direct discharge from the entirety of each lakefront property. Some minor heave causes pooling and allows for some runoff control on select properties. The general shoreline character of this catchment is 40% turf mown to edges, 40% turf to riprap, 10% turf to sandy beach, and 10% mix of weedy vegetation cover or gardened shoreline. Shoreline conditions devoid of native plant vegetation allow for stormwater runoff, fertilizer, pesticides, and herbicides to enter the lake without any treatment. Moreover, shoreline erosion occurs much more readily along shorelines without native plant vegetation.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 15 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.4	6%
	TSS (lb/yr)	540.0	6%
	Volume (acre-feet/yr)	1.3	8%
	Number of BMP's	15	
	BMP Size/Description	15,000	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$77,160.00	
	Promotion & Admin Costs	$4,875	
	Probable Project Cost	$82,035	
	Annual O&M	$6,750	
	10-yr Cost/lb-TP/yr	$11,077	
	10-yr Cost/2,000lb-TSS/yr	$55,383	

Catchment FL01-N7



Existing Catchment Summary	
Acres	15.22
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	5.86
TP (lb/yr)	9.76
TSS (lb/yr)	3,685

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	13.1	3.3	25%	9.8
	TSS (lb/yr)	4,711	1,026.0	22%	3,685
	Volume (acre-feet/yr)	7.1	1.3	18%	5.9
	BMP Type	Street Sweep 2x annually, 2 Dead End Streets Basins, 5 Shoreline			

CATCHMENT DESCRIPTION

FL01-N7 is mostly comprised of medium density, single-family residential clustered on 50' wide lots in the south and up to 100' wide lots in the north (lots with less % impervious). There are not many roads that drain into the lake from this catchment except for on the south half. The northern runoff contributions are from large suburban style backyards that are connected directly to the lake. There is some shoreline ice heave and erosion on a couple isolated shorelines, both limiting existing runoff but adding to soil losses.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets and parking lots occur approximately twice annually. There are two "Dead End Street" infiltration basins that exist at the end of 236th St and 237th St. There is a mown swale that drains an area at 236th and North Shore Trail, and there are 5 shoreline buffers (cost share projects) at 5 residences at the Red Star locations on the map. All practices were factored into the existing loads.

RETROFIT RECOMMENDATIONS

RANK 4/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 20/64 - BMP 2b Vegetated Swale: Vegetate currently mown swale

RANK 41/64 - Priority Shoreline 100 and 141: 3 properties with observed heave and erosion are good enhanced shoreline restoration candidates.

RANK 44/64 - BMP 1a Parking Lot Retrofit: Filtration basin in parking lot of North Shore Apts

RANK 57/64 - Typical Shoreline Restorations: Up to 15 non-priority shorelines with 15' wide enhanced shoreline buffers.



RETROFIT OPTIONS												
Catchment FL01-N7												
Cost/Removal Analysis		BMP 1a - Parking Lot Retrofit		BMP 2b - Vegetated Swale		Priority Shoreline 100 & 141		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.44	5%	0.14	1%	0.87	9%	0.7	7%	1.4	14%	2.7	27%
	TSS (lb/yr)	53	1%	53	1%	1,243	34%	306.5	8%	540.0	15%	1836	50%
	Volume (acre-feet/yr)	0.8	13%	0.0	1%	0.3	6%	0.0	0%	1.3	22%	2.4	41%
	Number of BMP's	1		1		3		1		15		26	
	BMP Size/Description	600	sf	1,320	sf	3,833	sf	0.490	curb miles	15,000	sf	All Practices	
	BMP Type	Highly Complex BioFiltration		Unmown Swale Minimal Veg		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioFiltration, and Shores	
Cost	Materials/Labor/Design	$22,181.22		$1,489.80		$26,427.72		$293.79		$77,160.00		$127,552.53	
	Promotion & Admin Costs	$325		$130		$975		$400		$4,875		$6,705	
	Probable Project Cost	**$22,506**		**$1,620**		**$27,403**		**$694**		**$82,035**		$134,258	
	Annual O&M	$450		$132		$1,725		$0		$6,750		$9,057	
	10-yr Cost/lb-TP/yr	**$6,082**		**$2,085**		**$5,138**		**$96**		**$11,077**		$4,896	
	10-yr Cost/2,000lb-TSS/yr	**$101,910**		**$11,094**		**$7,184**		**$453**		**$55,383**		$35,205	

FL01-N7: Increased Street Sweeping

Rank 4/64

Drainage Area – 0.49 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the sweepings are equally spread throughout the season between the first Spring sweeping and the final Fall sweeping.



Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.7	7%
	TSS (lb/yr)	306.5	8%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.490	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$293.79	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$694	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$96	
	10-yr Cost/2,000lb-TSS/yr	$453	

FL01-N7: BMP 2b Vegetated Swale

Rank 20/62

Drainage Area – 0.873 acres
Location – Intersection of North Shore Trail and 236th St Ct N
Property Ownership – Public (City of Forest Lake)
Description – Currently a 12" pipe drains the catchment through a mown swale that is approx. 110' long and directly outlets to Forest Lake above the Forest Lake outlet dam (Sunrise River). With minimal plantings of native plugs, some erosion control blanket, and twice yearly maintenance a very inexpensive retrofit can be achieved. This practice would be even less expensive (increasing its #20 rank) if the area were just left unmown and periodically checked for noxious weeds. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 2b - Vegetated Swale	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.14	1%
	TSS (lb/yr)	53	1%
	Volume (acre-feet/yr)	0.0	1%
	Number of BMP's	1	
	BMP Size/Description	1,320	sf
	BMP Type	Unmown Swale Minimal Veg	
Cost	Materials/Labor/Design	$1,489.80	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$1,620	
	Annual O&M	$132	
	10-yr Cost/lb-TP/yr	$2,085	
	10-yr Cost/2,000lb-TSS/yr	$11,094	

FL01-N7 – Priority Shoreline Catchments 100 and 141

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **41/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **23/30**



Drainage Area – 1.136 acres
Location – 3 private residences
Property Ownership – Private
Description – Densely arranged, narrow 50'-75' wide lots with signs of erosion and some ice heave. Both 100 and 141 have visual signs of erosion losses across entire width of property and would make a great candidate for enhanced shoreline restoration.

Cost/Removal Analysis		*Project ID*	
		Priority Shoreline 100 & 141	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.87	9%
	TSS (lb/yr)	1,243	34%
	Volume (acre-feet/yr)	0.3	6%
	Number of BMP's	3	
	BMP Size/Description	3,833	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$26,427.72	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$27,403	
	Annual O&M	$1,725	
	10-yr Cost/lb-TP/yr	$5,138	
	10-yr Cost/2,000lb-TSS/yr	$7,184	

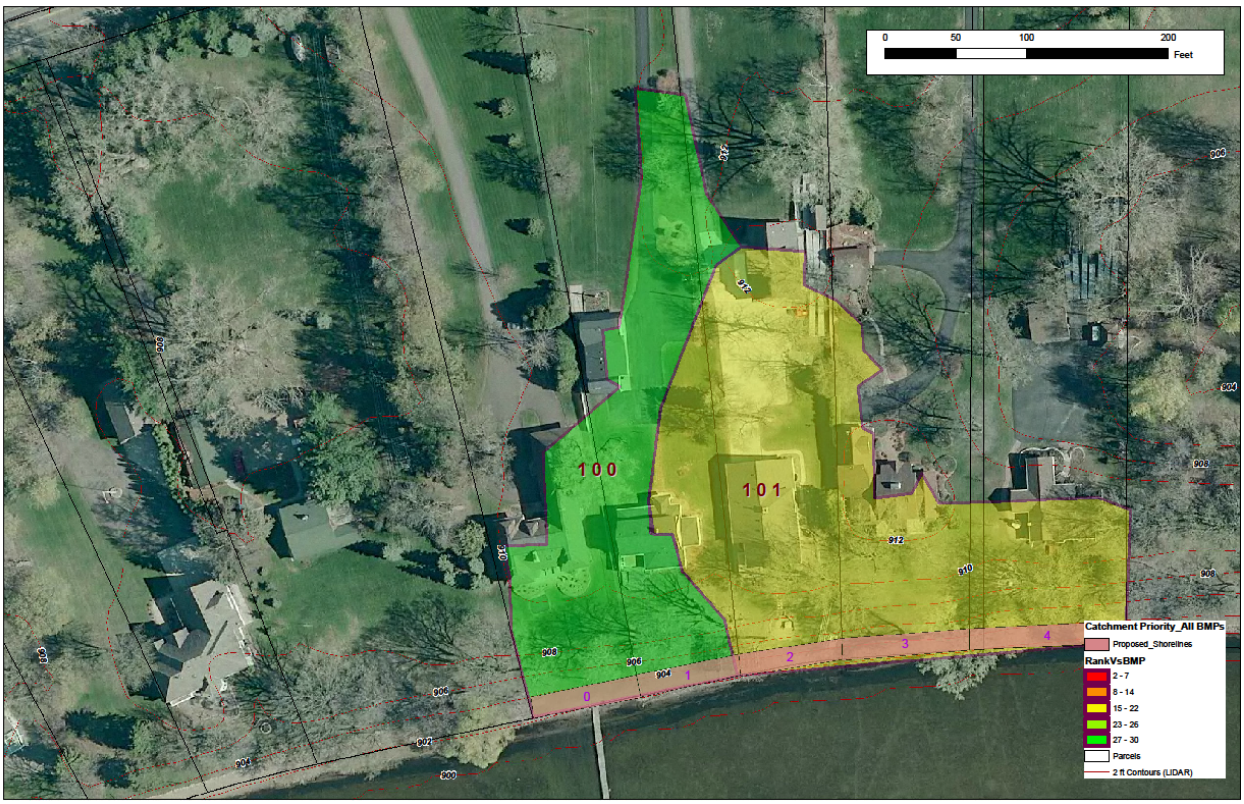
PRIORITY SHORELINE CATCHMENT 100 AND 141										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
100	2	0.772	8033	84	0.20	360	0.180	8033	444	0.38
141	1	0.364	6494	39	0.11	760	0.380	6494	799	0.49
	TOTAL	1.136					TOTAL	14527	1243	0.87

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N7 – MAP of Priority Shoreline Catchment 100

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **41/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **23/30**

Notes: Densely arranged, narrow 50' wide lots with signs of erosion and some ice heave. Both Shore Segments 0 and 1 of Priority Shoreline Catchment 100 are showing some signs of bank failure. Shore Segment 100 exhibits losses of 6" lateral recession and 6" vertical loss on average. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 7yrs).



PRIORITY SHORELINE CATCHMENT 100 AND 141										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
100	2	0.772	8033	84	0.20	360	0.180	8033	444	0.38
141	1	0.364	6494	39	0.11	760	0.380	6494	799	0.49
	TOTAL	1.136					TOTAL	14527	1243	0.87

FL01-N7 – MAP of Priority Shoreline Catchment 141

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **41/64***

BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **23/30**

**If ranked independently of Priority Shoreline 100; it would cost approximately $2,500/LbTP over 10 years and would have roughly a #5/30 BMP Only Ranking (or #20/64 overall).*

Notes: This lot is 50% impervious and 100' wide shore with signs of major ice heave and erosion, including large swaths of erosion control blanket or geotextile exposed in patches of failing riprap. Shore Segment 122 exhibits losses of 6" lateral recession and 18" vertical loss on average. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 5yrs).



PRIORITY SHORELINE CATCHMENT 100 AND 141										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
100	2	0.772	8033	84	0.20	360	0.180	8033	444	0.38
141	1	0.364	6494	39	0.11	760	0.380	6494	799	0.49
	TOTAL	1.136					TOTAL	14527	1243	0.87

FL01-N7: BMP 1a Parking Lot Retrofit

Rank 44/64

Drainage Area – 0.835 acres (90% Impervious)
Location – Intersection of North Shore Trail and Sunrise River/Forest Lake Dam @ North Shore Apts.
Property Ownership – Private
Description – Create a shallow filtration basin with an underdrain and lined bottom. Sod will be the plant media in the swale zones since these areas are the primary snow storage zone for the parking lot and will need to withstand harsh conditions and also be easily maintainable and replaceable over the life of the project. Basin will be 600 sf, will have 6" of ponding, and 1' of replacement soils (70/30 sand /compost) and will be planted with natives. A level spreader or multiple pretreatment inlets will have to be installed to intercept gross solids. An overflow of limestone steppers is also included in the concept. Other ideas beyond this concept could include an expanded footprint (removing parking stalls), alternative snow storage scenarios, or different vegetation for the basin (sod). The cost of $22,506 could be substantially lower if alternatives to using a 12" deep channel drain as pretreatment are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for cost estimate***



Cost/Removal Analysis		Project ID	
		BMP 1a - Parking Lot Retrofit	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.44	5%
	TSS (lb/yr)	53	1%
	Volume (acre-feet/yr)	0.8	13%
	Number of BMP's	1	
	BMP Size/Description	600	sf
	BMP Type	Highly Complex BioFiltration	
Cost	Materials/Labor/Design	$22,181.22	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$22,506	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$6,082	
	10-yr Cost/2,000lb-TSS/yr	$101,910	

FL01-N7 – Typical Shoreline Restorations

Rank 57/64

Drainage Area – 6.0 acres (0.40 acre average per property)
Location – any 15 Participating Shorelines within FL01-N7 (in addition to Priority Shorelines)
Property Ownership – Private
Description – Even though ranked low, Typical Shoreline properties in this catchment that were not identified as Priority are still fairly good candidates for outreach and/or buffers. Minor to major ice heave is found frequently. About 70% of the FL01-N7 catchment drainage area is direct discharge from the entirety of each lakefront property. Heaving causes pooling and allows for some runoff control on select properties. The general shoreline character of this catchment is 20% turf mown to edges, 60% turf to riprap, 10% turf to sandy beach, and 10% mix of weedy vegetation cover or gardened shoreline. Shoreline conditions devoid of native plant vegetation allow for stormwater runoff, fertilizer, pesticides, and herbicides to enter the lake without any treatment. Moreover, shoreline erosion and impacts from ice heave are much more noticeable along shorelines without native plant vegetation or low gradient riprap. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 15 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.4	14%
	TSS (lb/yr)	540.0	15%
	Volume (acre-feet/yr)	1.3	22%
	Number of BMP's	15	
	BMP Size/Description	15,000	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$77,160.00	
	Promotion & Admin Costs	$4,875	
	Probable Project Cost	$82,035	
	Annual O&M	$6,750	
	10-yr Cost/lb-TP/yr	$11,077	
	10-yr Cost/2,000lb-TSS/yr	$55,383	

Catchment FL01-N10



Existing Catchment Summary	
Acres	6.76
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	1.73
TP (lb/yr)	3.93
TSS (lb/yr)	1,140

EXISTING CONDITIONS					
Existing Conditions		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	4.0	0.0	1%	**3.9**
	TSS (lb/yr)	1,151	11.0	1%	**1,140**
	Volume (acre-feet/yr)	1.7	0.0	1%	**1.7**
	BMP Type	No Existing Practices, No Roads to Sweep			

CATCHMENT DESCRIPTION

FL01-N10 is mostly comprised of medium density, single-family residential clustered on 75-125' wide lots. There are no roads that drain into the lake from this catchment and all runoff is generated from the lakeside portions of each parcel. The runoff contributions are from large suburban style backyards that are connected directly to the lake. There is some minor shoreline ice heave and erosion on a couple isolated shorelines, both limiting existing runoff but adding to soil losses. Only one yard is exhibiting major shoreline losses that need immediate attention. There is also a property that appears to be a good example of a non-traditional buffer planting (a 'gardened' shoreline that intercepts runoff, maintains shore stability, and increases pollinator benefits without the 'wild' native appearance).

EXISTING STORMWATER TREATMENT

There is no existing treatment of stormwater runoff in this catchment.

RETROFIT RECOMMENDATIONS

RANK 34/64 - Priority Shoreline 101: 3 properties (parcel 4 is most serious) with observed heave and erosion. All 3 are good enhanced shoreline restoration candidates.

RANK 55/64 - Typical Shoreline Restorations: Up to 3 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N10*					
		Priority Shoreline 101		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.12	29%	0.4	11%	1.5	39%
	TSS (lb/yr)	1,543	135%	162.0	14%	1705	150%
	Volume (acre-feet/yr)	0.4	24%	0.2	14%	0.7	38%
	Number of BMP's	3		3		6	
	BMP Size/Description	4,138	sf	4,500	sf	All Practices	
	BMP Type	Priority Lakeshore Restoration		Lakeshore Restoration		Shorelines	
Cost	Materials/Labor/Design	$28,513.92		$23,295.00		$51,808.92	
	Promotion & Admin Costs	$975		$975		$1,950	
	Probable Project Cost	$29,489		$24,270		$53,759	
	Annual O&M	$1,862		$2,025		$3,887	
	10-yr Cost/lb-TP/yr	$4,296		$10,600		$7,448	
	10-yr Cost/2,000lb-TSS/yr	$6,236		$54,963		$30,599	

FL01-N10 – Priority Shoreline Catchment 101

Rank 34/64

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **34/64***
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **17/30**

Drainage Area – 1.297 acres
Location – 3 private residences on north shore of Lake 1
Property Ownership – Private

**If Shore Segment 4 were ranked independently of Shore Segments 2 and 3; it would cost approximately $1,800/LbTP over 10 years and would have roughly a #3/30 BMP Only Ranking (or #19/64 overall).*

Notes: This catchment is 50-60% impervious with 75-110' wide shores, all showing signs of ice heave and erosion, most notably Shore Segment 4. Shore Segments 2 and 3 exhibit losses of 6" lateral recession and 6" vertical loss on average. Shore Segment 4 exhibits losses of 18" lateral recession and 18" vertical loss on average. Losses on Shore Segment 4 likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N10 Priority Shoreline 101	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.12	29%
	TSS (lb/yr)	1,543	135%
	Volume (acre-feet/yr)	0.4	24%
	Number of BMP's	3	
	BMP Size/Description	4,138	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$28,513.92	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$29,489	
	Annual O&M	$1,862	
	10-yr Cost/lb-TP/yr	$4,296	
	10-yr Cost/2,000lb-TSS/yr	$6,236	

PRIORITY SHORELINE CATCHMENT 100 AND 141										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
101	3	1.297	18278	163	0.43	1380	0.690	18278	1543	1.12
	TOTAL	1.297					TOTAL	14527	1243	0.87

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Methods section for explanation of full methodology.***

FL01-N10 – Typical Shoreline Restorations

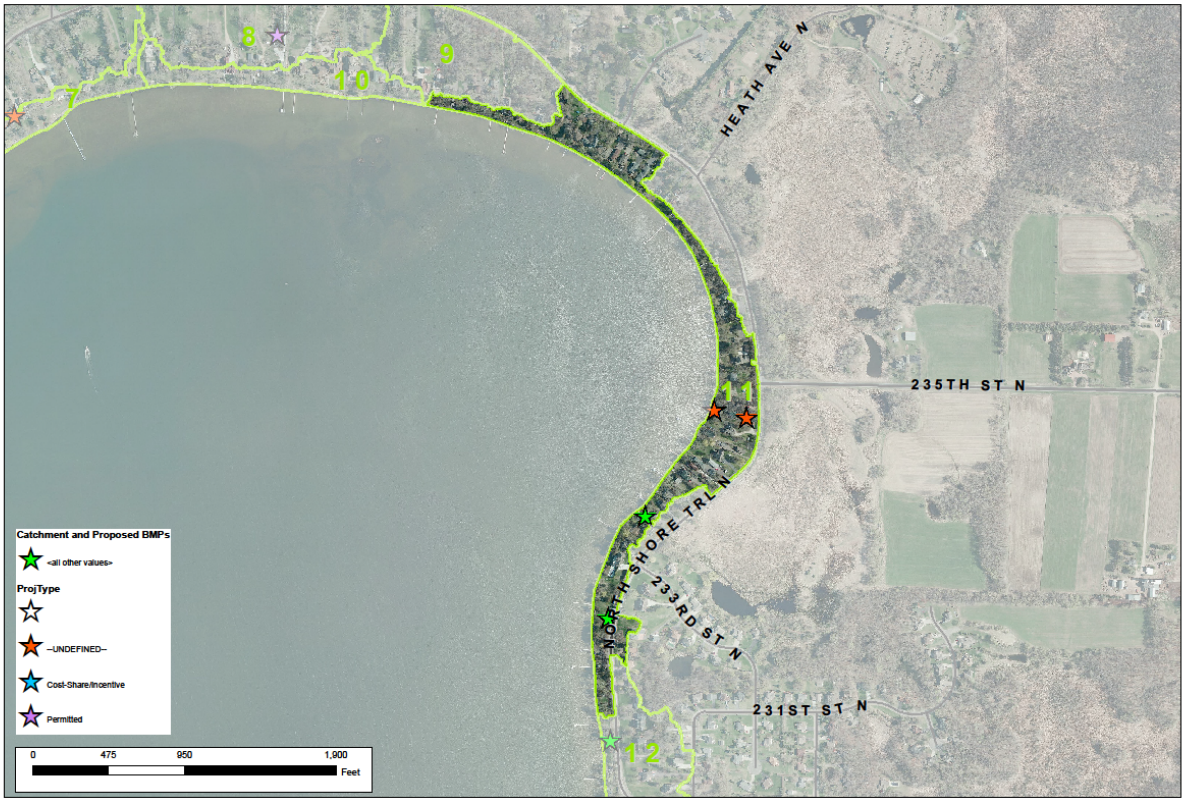
Rank 55/64

Drainage Area – 1.29 acres (0.43 acre average per property)
Location – any 3 Participating Shorelines within FL01-N10 (in addition to Priority Shorelines)
Property Ownership – Private
Description – Even though ranked low, Typical Shoreline properties in this catchment that were not identified as Priority are still fairly good candidates for outreach and/or buffers. Minor to major ice heave is found frequently. 100% of the FL01-N7 catchment drainage area is direct discharge from the entirety of each lakefront property. Heaving causes pooling and allows for some runoff control on select properties. The general shoreline character of this catchment is 20% turf mown to edges, 50% turf to riprap, 15% turf to sandy beach, and 15% mix of weedy vegetation cover or gardened shoreline. Shoreline conditions devoid of native plant vegetation allow for stormwater runoff, fertilizer, pesticides, and herbicides to enter the lake without any treatment. Moreover, shoreline erosion and impacts from ice heave are much more noticeable along shorelines without native plant vegetation or low gradient riprap. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 3 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		RETROFIT OPTIONS	
		Catchment FL01-N10	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.4	11%
	TSS (lb/yr)	162.0	14%
	Volume (acre-feet/yr)	0.2	14%
	Number of BMP's	3	
	BMP Size/Description	4,500	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$23,295.00	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$24,270	
	Annual O&M	$2,025	
	10-yr Cost/lb-TP/yr	$10,600	
	10-yr Cost/2,000lb-TSS/yr	$54,963	

Catchment FL01-N11



Existing Catchment Summary	
Acres	21.99
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	8.22
TP (lb/yr)	14.55
TSS (lb/yr)	4,675

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	15.9	1.3	8%	**14.6**
	TSS (lb/yr)	5,188	513.0	10%	**4,675**
	Volume (acre-feet/yr)	8.5	0.3	3%	**8.2**
	BMP Type	Street Sweep 2x annually, 1 Raingarden, 1 Shoreline			

CATCHMENT DESCRIPTION

FL01-N11 is a mixture of lot types, widths, and character. There are a couple segments of road that drain through residential lots and to the lake. Most other runoff is generated from the lakeside portions of each parcel. The north half is dominated by tightly packed 50' wide lots that all appear to be in a greater state of degradation than the rest of the lots observed in this SWA (most consisting of bare sand or inconsistent riprap). The south half is a mix of shoreline-only access lots and 50-75' wide widths.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. 1 raingarden and 1 shoreline buffer exist that were previous cost-share projects.

RETROFIT RECOMMENDATIONS

RANK 11/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 19/64 - Priority Shoreline 102 to 105: 15 properties with observed heave and erosion are great enhanced shoreline restoration candidates. Narrow lots and heavy use make this a prime restoration opportunity.

RANK 39/64 - BMP 3c BioInfiltration Mod. Complex: Install infiltration basin adjacent to catchbasin that drains roadway and discharges under road to lake.

RANK 64/64 - Typical Shoreline Restorations: Up to 10 non-priority shorelines with 15' wide enhanced shoreline buffers. Small drainage areas in south rank this practice last, but north has good opportunities.



Cost/Removal Analysis		Retrofit Options — Catchment FL01-N11									
		BMP 3c - BioInfiltration Mod Complex		Priority Shoreline 102,103,104,105		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.36	3%	8.69	60%	0.5	4%	0.8	5%	10.4	71%
	TSS (lb/yr)	152	3%	15,449	330%	216.5	5%	320.0	7%	16138	345%
	Volume (acre-feet/yr)	0.2	2%	1.0	12%	0.0	0%	1.0	13%	2.2	26%
	Number of BMP's	1		15		1		10		27	
	BMP Size/Description	500	sf	13,416	sf	0.530	curb miles	33,540	sf	All Practices	
	BMP Type	Moderately Complex BioInfiltration		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$14,175.00		$91,975.44		$300.63		$172,270.20		$278,721.27	
	Promotion & Admin Costs	$130		$4,875		$400		$3,250		$8,655	
	Probable Project Cost	**$14,305**		**$96,850**		**$701**		**$175,520**		$287,376	
	Annual O&M	$375		$6,037		$0		$15,093		$21,505	
	10-yr Cost/lb-TP/yr	**$4,951**		**$1,810**		**$135**		**$40,806**		$11,925	
	10-yr Cost/2,000lb-TSS/yr	**$23,757**		**$2,035**		**$647**		**$204,031**		$57,618	

FL01-N11: Increased Street Sweeping

Rank 11/64

Drainage Area – 0.53 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the sweepings are equally spread throughout the season between the first Spring sweeping and the final Fall sweeping.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N11* Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.5	4%
	TSS (lb/yr)	216.5	5%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.530	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$300.63	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$701	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$135	
	10-yr Cost/2,000lb-TSS/yr	$647	

FL01-N11 – Priority Shoreline Catchments 102 to 105

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **19/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **2/30**



Drainage Area – 3.949 acres
Location – 15 private residences
Property Ownership – Private
Description – Densely arranged, narrow 50'-75' wide lots with signs of erosion and some ice heave. This stretch of parcels all show signs of heavy shoreline use, and many erosion issues appear to be a combination of a lack of vegetative buffers and intense dock/foot traffic. All Shore Segments in Priority Shoreline Catchment 103 and Shore Segment 19 (Priority Shoreline Catchment 105) are the most severely eroded and in need of immediate restoration. All other parcels identified as a Priority have visual signs of minor to moderate erosion losses across entire width of each property and would all make a great candidate for enhanced shoreline restoration.

Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N11* Priority Shoreline 102,103,104,105	
		New trtmt	Net %
Treatment	TP (lb/yr)	8.69	60%
	TSS (lb/yr)	15,449	330%
	Volume (acre-feet/yr)	1.0	12%
	Number of BMP's	15	
	BMP Size/Description	13,416	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$91,975.44	
	Promotion & Admin Costs	$4,875	
	Probable Project Cost	$96,850	
	Annual O&M	$6,037	
	10-yr Cost/lb-TP/yr	$1,810	
	10-yr Cost/2,000lb-TSS/yr	$2,035	

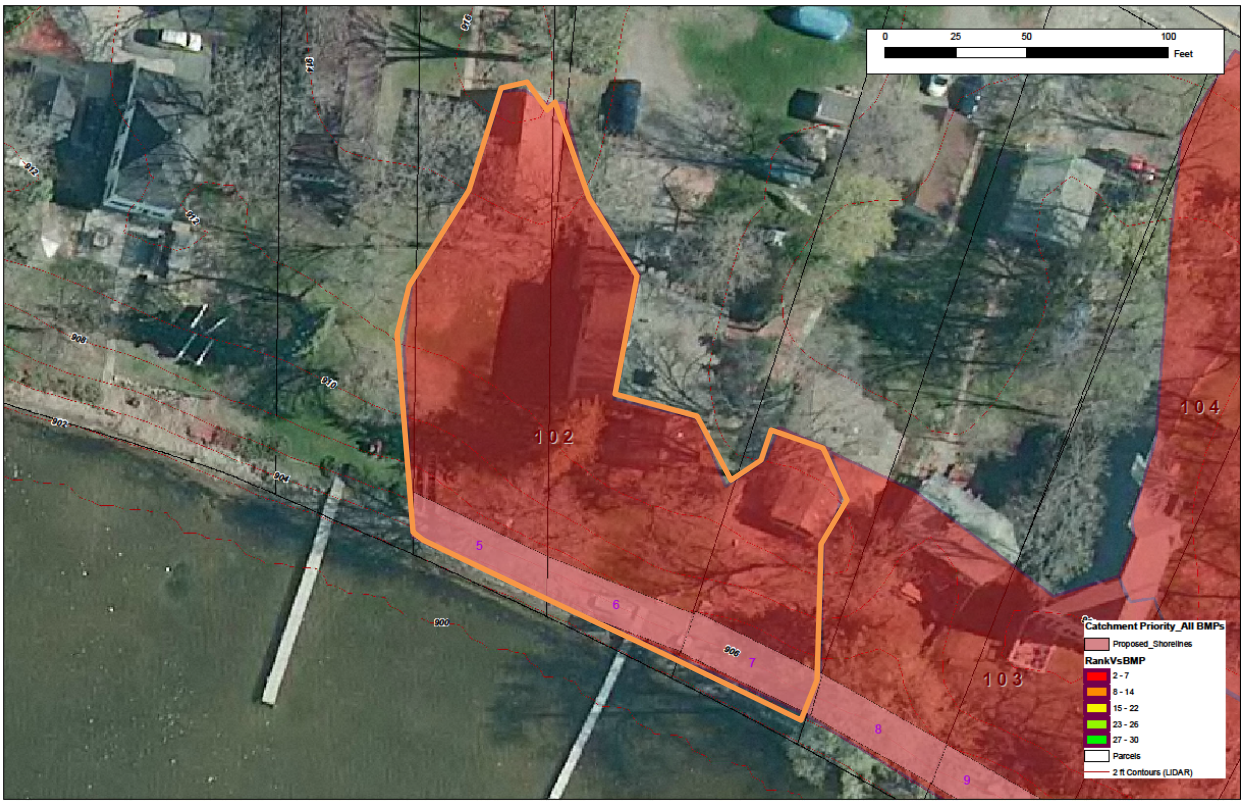
PRIORITY CATCHMENT 102 to 105 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
102	3	0.393	7003	46	0.14	1260	0.630	7003	1306	0.77
103	5	0.565	8753	64	0.21	9520	4.760	8753	9584	4.97
104	3	2.467	19658	261	0.61	1800	0.900	19658	2061	1.51
105	4	0.524	6174	58	0.22	2440	1.220	6174	2498	1.44
	TOTAL	3.949					TOTAL	41588	15449	8.686

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N11 – MAP of Priority Shoreline Catchment 102

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **19/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **2/30**

Notes: Densely arranged, narrow 50' wide lots with signs of erosion and some ice heave. All Shore Segments 5,6 and 7 are showing some signs of bank failure. Shore Segment 102 exhibits average losses of 12" lateral recession and 12" vertical loss. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



PRIORITY CATCHMENT 102 to 105 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
102	3	0.393	7003	46	0.14	1260	0.630	7003	1306	0.77
103	5	0.565	8753	64	0.21	9520	4.760	8753	9584	4.97
104	3	2.467	19658	261	0.61	1800	0.900	19658	2061	1.51
105	4	0.524	6174	58	0.22	2440	1.220	6174	2498	1.44
	TOTAL	3.949					TOTAL	41588	15449	8.686

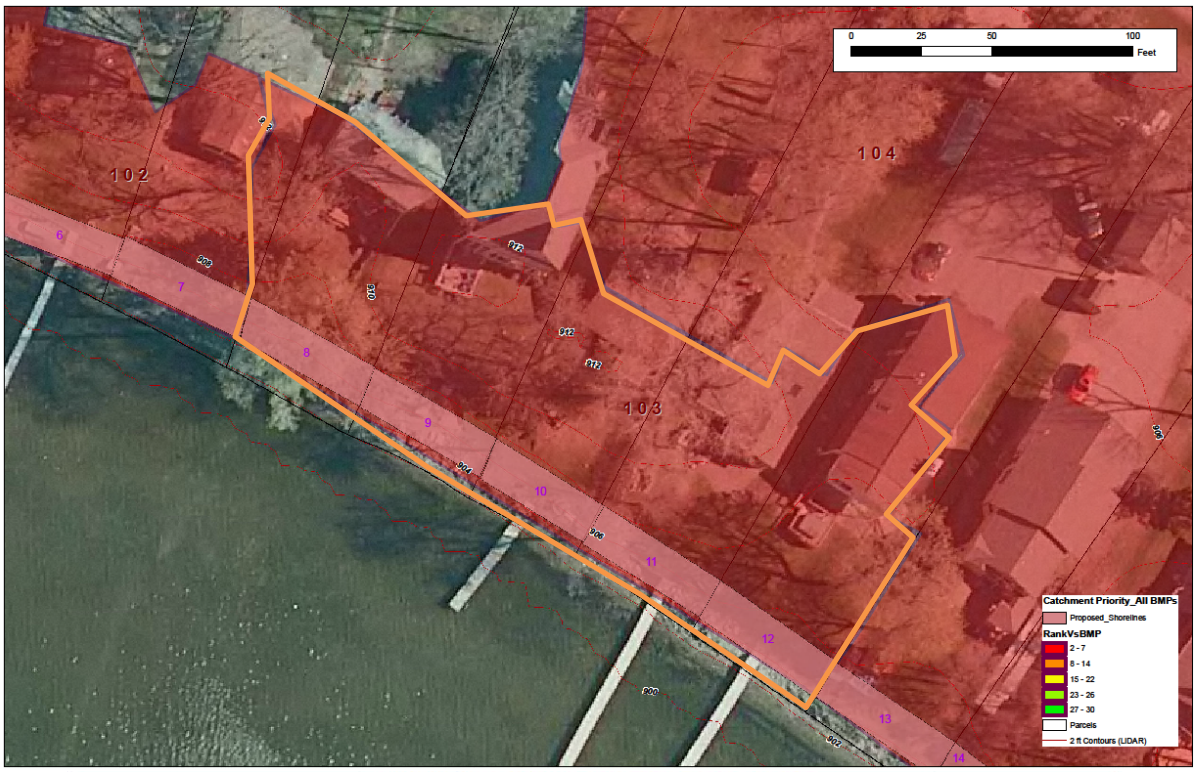
FL01-N11 – MAP of Priority Shoreline Catchment 103

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **19/64***

BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **2/30**

**If Priority Shoreline Catchment 103 were ranked independently of Priority Shoreline Catchments102, 104 and 105; it would cost approximately $1,000/LbTP over 10 years and would have a #1/30 BMP Only Ranking (or #17/64 overall).*

Notes: Densely arranged, narrow 50' wide lots with signs of severe erosion and some ice heave. All 5 Shore Segments (8-12) are likely the most degraded stretch in the northern SWA area. Priority Shoreline Catchment 103 exhibits average losses of 24" lateral recession and 24" vertical loss. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).

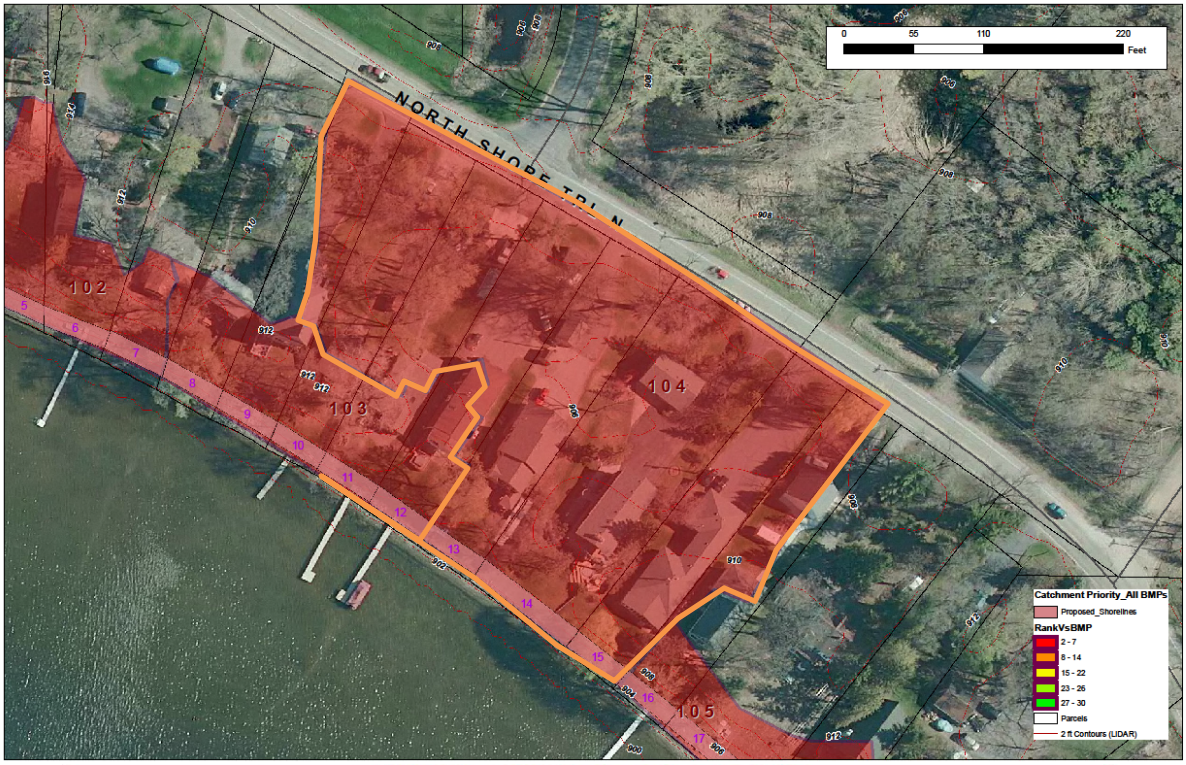


PRIORITY CATCHMENT 102 to 105 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
102	3	0.393	7003	46	0.14	1260	0.630	7003	1306	0.77
103	5	0.565	8753	64	0.21	9520	4.760	8753	9584	4.97
104	3	2.467	19658	261	0.61	1800	0.900	19658	2061	1.51
105	4	0.524	6174	58	0.22	2440	1.220	6174	2498	1.44
	TOTAL	3.949					TOTAL	41588	15449	8.686

FL01-N11 – MAP of Priority Shoreline Catchment 104

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **19/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **2/30**

Notes: Densely arranged, narrow 50-75' wide lots with signs of erosion and some ice heave. All Shore Segments in Priority Shoreline Catchment 104 are showing some signs of bank erosion. This Catchment exhibits average losses of 12" lateral recession and 12" vertical loss. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs). ***This Catchment 104 would rank higher if it were ranked independently of the rest of the Priority Shorelines in FL01-N11.***



PRIORITY CATCHMENT 102 to 105 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
102	3	0.393	7003	46	0.14	1260	0.630	7003	1306	0.77
103	5	0.565	8753	64	0.21	9520	4.760	8753	9584	4.97
104	3	2.467	19658	261	0.61	1800	0.900	19658	2061	1.51
105	4	0.524	6174	58	0.22	2440	1.220	6174	2498	1.44
	TOTAL	3.949					TOTAL	41588	15449	8.686

FL01-N11 – MAP of Priority Shoreline Catchment 105

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **19/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **2/30**

Notes: Densely arranged, 65-100' wide lots with signs of erosion and some ice heave. All Shore Segments of Priority Shoreline Catchment 100 are showing some signs of bank failure. Shore Segment 16 and 17 exhibit losses of 6" lateral recession and 6" vertical loss. Shore Segment 18 shows losses of 12" lateral recession and 12" vertical loss. Shore Segment 19 shows the heaviest losses of 24" lateral recession and 24" vertical loss. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs). ***Shore Segment 19 should be one of the highest priority individual shorelines in the study area.***



PRIORITY CATCHMENT 102 to 105 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
102	3	0.393	7003	46	0.14	1260	0.630	7003	1306	0.77
103	5	0.565	8753	64	0.21	9520	4.760	8753	9584	4.97
104	3	2.467	19658	261	0.61	1800	0.900	19658	2061	1.51
105	4	0.524	6174	58	0.22	2440	1.220	6174	2498	1.44
	TOTAL	3.949					TOTAL	41588	15449	8.686

FL01-N11: BMP 3c BioInfiltration Basin

Rank 39/64

Drainage Area – 0.879 acres (50% Impervious)
Location – South of Intersection of North Shore Trail and 233rd St N
Property Ownership – Private/Public, in Right of Way
Description – This catchment has a new house built in the northernmost lot in the catchment that was not accounted for in the analysis, thus increasing the potential runoff and capture opportunities. Catchment may actually be larger now. Create a shallow BioInfiltration basin adjacent to the existing catchbasin on the shoulder of North Shore Trail. Basin ponding area will be 500 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand /compost). A 200sf planted zone on the outsides of the basin area will act as a pretreatment device to extend life of the practice. The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $14,305 could be substantially lower if alternatives planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N11* BMP 3c - BioInfiltration Mod Complex	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.36	3%
	TSS (lb/yr)	152	3%
	Volume (acre-feet/yr)	0.2	2%
	Number of BMP's	1	
	BMP Size/Description	500	sf
	BMP Type	Moderately Complex BioInfiltration	
Cost	Materials/Labor/Design	$14,175.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$14,305	
	Annual O&M	$375	
	10-yr Cost/lb-TP/yr	$4,951	
	10-yr Cost/2,000lb-TSS/yr	$23,757	

FL01-N11 – Typical Shoreline Restorations

Rank 64/64

Drainage Area – 4.0 acres (0.40 acre average per property)
Location – any 10 Participating Shorelines within FL01-N11 (in addition to Priority Shorelines)
Property Ownership – Private
Description – Even though ranked low, Typical Shoreline properties in this catchment that were not identified as Priority are still fairly good candidates for outreach and/or buffers, especially on the northern half of the catchment. Minor to major ice heave is found frequently and eroding sandy beaches are common. About 70% of the FL01-N11 catchment drainage area is direct discharge from the entirety of each lakefront property. Heaving causes pooling and allows for some runoff control on select properties. The general shoreline character of this catchment is 20% turf mown to edges, 30% turf to riprap, 30% turf to sandy beach, and 20% mix of weedy vegetation cover or gardened shoreline. Shoreline conditions devoid of native plant vegetation allow for stormwater runoff, fertilizer, pesticides, and herbicides to enter the lake without any treatment. Moreover, shoreline erosion and impacts from ice heave are much more noticeable along shorelines without native plant vegetation or low gradient riprap. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 10 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N11* Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.8	5%
	TSS (lb/yr)	320.0	7%
	Volume (acre-feet/yr)	1.0	13%
	Number of BMP's	10	
	BMP Size/Description	33,540	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$172,270.20	
	Promotion & Admin Costs	$3,250	
	Probable Project Cost	$175,520	
	Annual O&M	$15,093	
	10-yr Cost/lb-TP/yr	$40,806	
	10-yr Cost/2,000lb-TSS/yr	$204,031	

Catchment FL01-N12



Existing Catchment Summary	
Acres	10.82
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	5.34
TP (lb/yr)	8.39
TSS (lb/yr)	3,001

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	9.6	1.2	12%	8.4
	TSS (lb/yr)	3,512	511.0	15%	3,001
	Volume (acre-feet/yr)	5.4	0.1	1%	5.3
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

FL01-N12 is a small catchment with North Shore Trail bisecting most of the lots, separating houses from direct shore access. As a result, all road runoff is redirected under the road from east to west, and outlets to the shoreline in multiple pipes. There is a fragment pipe at the east end of the catchment and it cannot be determined whether the pipe is still active (draining the wetland overflows just east of Hayward) or if it has been bypassed after an Iron Enhanced Sand Filter had been installed on the SW Corner of NST and Hayward Ave.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. It appears one non-documented practice may exist at the northernmost pipe outfall under the road. At the outfall is a patch of riprap an a long native planting for the runoff to flow through. This could be a good enhancement opportunity for BMP 4d (see 4d discussion page).

RETROFIT RECOMMENDATIONS

RANK 10/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 24/64 - BMP 6g, 7f, 8e Retention Swales and BioInfiltration Basin: Treatment train of vegetated swales with 3" ponding and a 500sf basin at pipe crossing before drainage crosses road to lake.

RANK 27/64 - BMP 4d BioInfiltration Basin: Infiltration Basin near existing catchbasin treating road runoff prior to discharging via pipe to lake. Basin area 800sf with 3" ponding.

RANK 36/64 - Priority Shoreline Catchment 106: 3 properties for enhanced shoreline buffers

RANK 61/64 - Typical Shoreline Restorations: Up to 2 non-priority shorelines with 15' wide enhanced shoreline buffers.



RETROFIT OPTIONS												
Catchment FL01-N12												
Cost/Removal Analysis		BMP 4d-BioInfiltration Simple		BMP 6g,7f,8e - Retention Swales and BioInfiltration Mod Complex		Priority Shoreline 106		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
				New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.45	38%	1.14	14%	0.97	12%	0.6	7%	0.2	2%	3.3	40%
	TSS (lb/yr)	182.0	36%	455.0	15%	1,535	51%	255.5	9%	64.0	2%	2492	83%
	Volume (acre-feet/yr)	0.3	6%	0.6	11%	0.1	2%	0.0	0%	0.1	1%	1.1	21%
	Number of BMP's	1		3		3		1		2		10	
	BMP Size/Description	800	sf	1,500	sf	3,877	sf	0.480	curb miles	2,584	sf	All Practices	
	BMP Type	Simple BioInfiltration		Simple BioInfiltration		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$8,649.20		$20,021.68		$26,728.68		$292.08		$13,465.92		$60,508.36	
	Promotion & Admin Costs	$400		$1,000		$975		$400		$650		$3,025	
	Probable Project Cost	**$9,049**		**$21,022**		**$27,704**		**$692**		**$14,116**		$63,533	
	Annual O&M	$600		$1,125		$1,745		$0		$1,163		$4,032	
	10-yr Cost/lb-TP/yr	**$3,322**		**$2,831**		**$4,674**		**$116**		**$16,090**		$5,928	
	10-yr Cost/2,000lb-TSS/yr	**$16,538**		**$14,185**		**$5,883**		**$542**		**$80,450**		$25,265	

FL01-N12: Increased Street Sweeping

Rank 10/64

Drainage Area – 0.48 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.

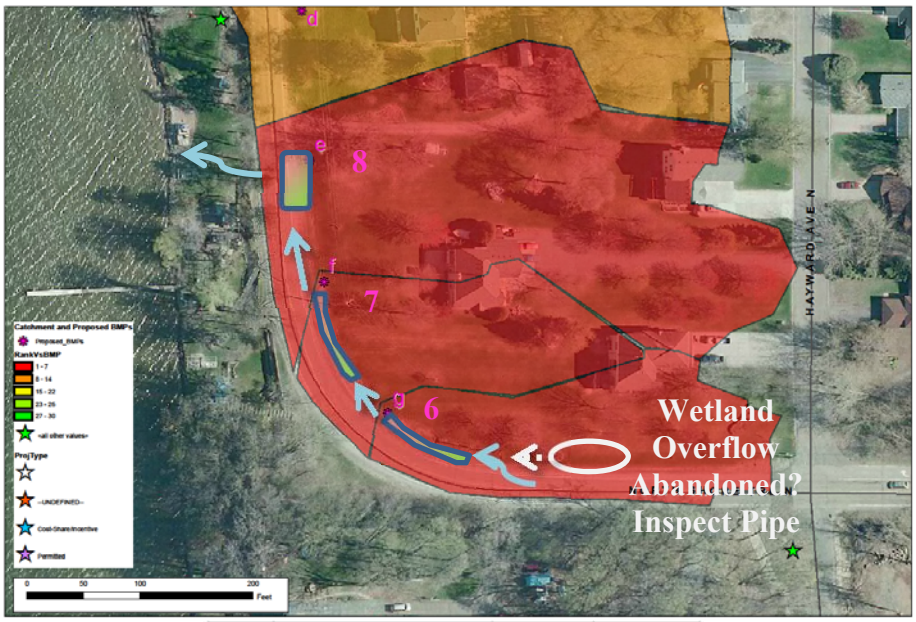


Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.6	7%
	TSS (lb/yr)	255.5	9%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.480	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$292.08	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$692	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$116	
	10-yr Cost/2,000lb-TSS/yr	$542	

FL01-N12: BMP 6g, 7f, 8e Swales and BioInfiltration

Rank 24/64

Drainage Area – 3.319 acres (25% Impervious)
Location – West of Intersection of North Shore Trail and Hayward Ave N
Property Ownership – Private/Public, in Right of Way
Description – Convert two existing mown turf ditches to Vegetated Swales (max area 500sf each). Swale bottoms will be excavated 3" below inverts of existing culvert pipes that connect under pedestrian/mower access ramps on each lot. Create a shallow BioInfiltration Basin adjacent to the existing catchbasin at end of swale run. Basin ponding area will be 500 sf, will have 6" of ponding, and 1' of replacement soils (70/30 sand /compost). Presence of swales will act as pretreatment for basin. The overflow will be the invert elevation of the existing pipe under the road. *Verify actual catchment area by inspecting whether ditch pipe is still an active overflow for a wetland area upstream. Currently this area is not being considered as part of the catchment area.* Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin, or just stop mowing the ditches. There is also the potential to amend the existing swale below the outfall of 8e to increase treatment. The cost of $21,022 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***

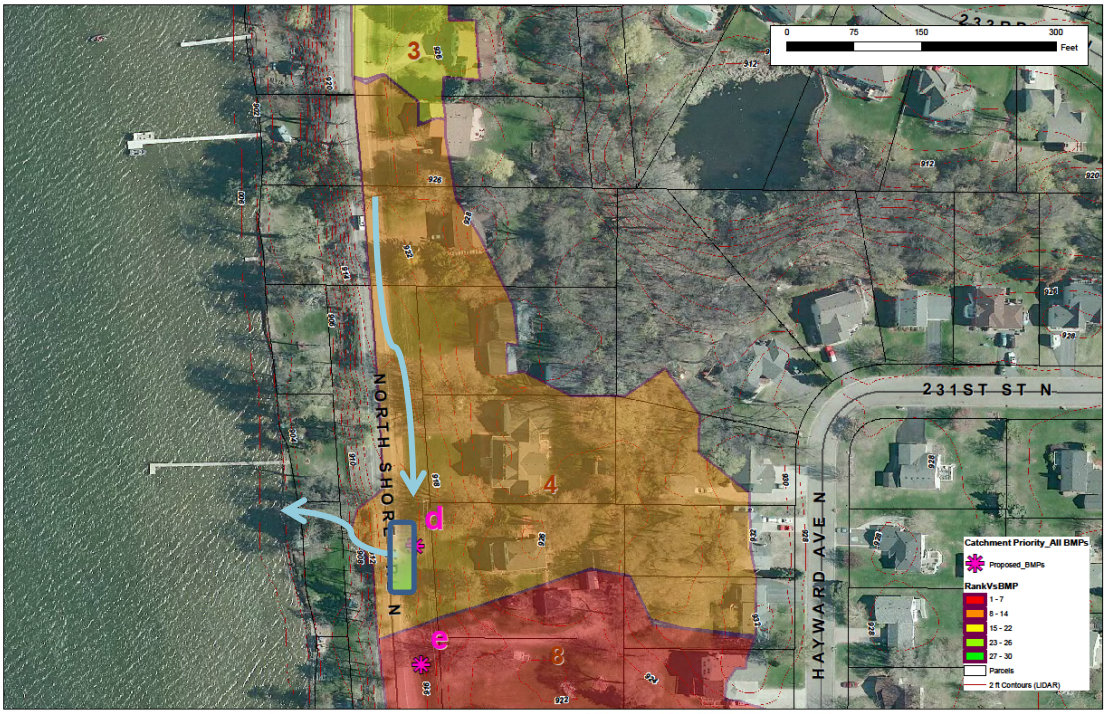


Cost/Removal Analysis		Project ID: BMP 6g,7f,8e - Retention Swales and BioInfiltration Mod	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.14	14%
	TSS (lb/yr)	455.0	15%
	Volume (acre-feet/yr)	0.6	11%
	Number of BMP's	3	
	BMP Size/Description	1,500	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$20,021.68	
	Promotion & Admin Costs	$1,000	
	Probable Project Cost	**$21,022**	
	Annual O&M	$1,125	
	10-yr Cost/lb-TP/yr	**$2,831**	
	10-yr Cost/2,000lb-TSS/yr	**$14,185**	

FL01-N12: BMP 4d BioInfiltration Basin

Rank 27/64

Drainage Area – 3.198 acres (25% Impervious)
Location – West of Intersection of North Shore Trail and Hayward Ave N
Property Ownership – Private/Public, in Right of Way
Description – Create a shallow BioInfiltration Basin adjacent to the existing catchbasin on the shoulder of North Shore Trail. Basin ponding area will be 800 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand /compost). Up to 300sf planted zone on the outsides of the basin area will act as a pretreatment device to extend life of the practice. The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $9,049 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 4d- BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.45	38%
	TSS (lb/yr)	182.0	36%
	Volume (acre-feet/yr)	0.3	6%
	Number of BMP's	1	
	BMP Size/Description	800	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$8,649.20	
	Promotion & Admin Costs	$400	
	Probable Project Cost	**$9,049**	
	Annual O&M	$600	
	10-yr Cost/lb-TP/yr	**$3,322**	
	10-yr Cost/2,000lb-TSS/yr	**$16,538**	

FL01-N12 – Priority Shoreline Catchments 106

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **36/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **19/30**



Drainage Area – 0.606 acres
Location – 3 private residences
Property Ownership – Private
Description – These three parcels are all located on steep slopes and show an abrupt shoreline dropoff into the water. Erosion decreases in severity of vertical loss from north to south. Shore Segment 22 exhibits 36" of vertical loss and 12" of lateral recession and accounts for half of the sediment load in this Priority Shoreline Catchment. Shore Segment 22 should be an immediate target for restoration. Shore Segment 22 exhibits 24" of vertical loss and 12" of lateral recession. Shore Segment 20 exhibits 18" of vertical loss and 6" of lateral recession. All are candidates for both an enhanced shoreline buffer but also stabilization techniques should be incorporated. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



Cost/Removal Analysis		Project ID: Priority Shoreline 106	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.97	12%
	TSS (lb/yr)	1,535	51%
	Volume (acre-feet/yr)	0.1	2%
	Number of BMP's	3	
	BMP Size/Description	3,877	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$26,728.68	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$27,704	
	Annual O&M	$1,745	
	10-yr Cost/lb-TP/yr	$4,674	
	10-yr Cost/2,000lb-TSS/yr	$5,883	

PRIORITY SHORELINE CATCHMENT 106										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
106	3	0.606	8033	84	0.20	360	0.180	8033	444	0.38
	TOTAL	0.606					TOTAL	8033	444	0.382

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N12 – Typical Shoreline Restorations

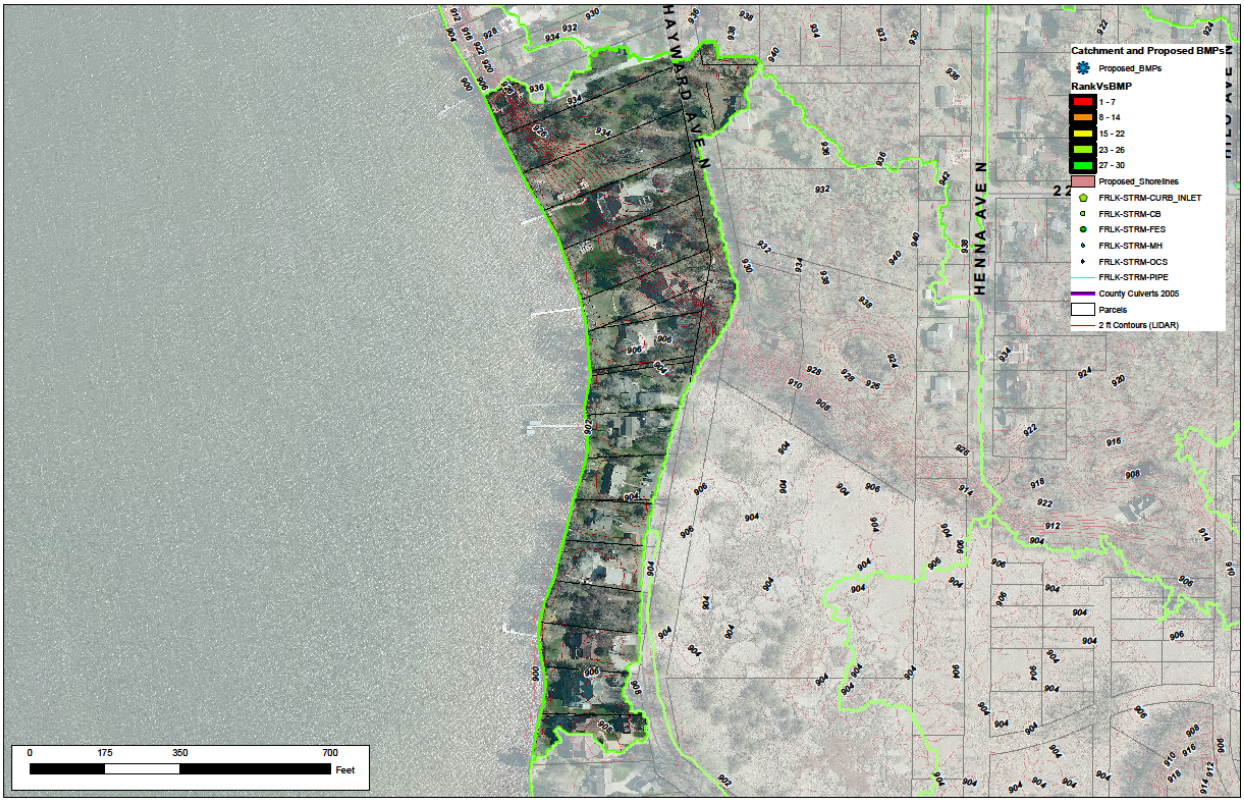
Rank 61/64

Drainage Area – 0.80 acres (0.40 acre average per property)
Location – any 2 Participating Shorelines within FL01-N12 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 70% of the FL01-N11 catchment drainage area is direct discharge from the entirety of each lakefront property. Minor to moderate heaving causes pooling and allows for some runoff control on the northern properties. The general shoreline character of this catchment is 20% turf mown to edges, 40% turf or woods to riprap, 40% mix of weedy vegetation cover from steep slopes (mostly in the south half). Steep slopes on the south half contribute excessive bank losses. Northern parcels have good opportunities for enhanced buffers. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 2 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.2	2%
	TSS (lb/yr)	64.0	2%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	2	
	BMP Size/Description	2,584	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$13,465.92	
	Promotion & Admin Costs	$650	
	Probable Project Cost	**$14,116**	
	Annual O&M	$1,163	
	10-yr Cost/lb-TP/yr	**$16,090**	
	10-yr Cost/2,000lb-TSS/yr	**$80,450**	

Catchment FL01-N13



Existing Catchment Summary	
Acres	11.12
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	5.47
TP (lb/yr)	8.51
TSS (lb/yr)	3,068

	Existing Conditions	EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	9.7	1.2	12%	8.5
	TSS (lb/yr)	3,589	521.0	15%	3,068
	Volume (acre-feet/yr)	5.5	0.1	1%	5.5
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

FL01-N13 is a small catchment that sits between Hayward Ave N and the lake shore. There is a section of Hayward that drains through the lots to the lake. The northern lots are large homes and very steep slopes. Many northern parcels have large embankments of stone wall in excess of 20' high (in 3-5' tall terraces). The south 10 lots are more shallow sloped and only show signs of minor degradation or ice heaving on the shorelines.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There are no other known BMPs in the catchment although there is a new home being built on the 3rd north lot and may be installing a large BMP for permit requirements (unverified as of report completion).

RETROFIT RECOMMENDATIONS

RANK 8/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.
RANK 59/64 - Typical Shoreline Restorations: Up to 5 non-priority shorelines with 15' wide enhanced shoreline buffers.

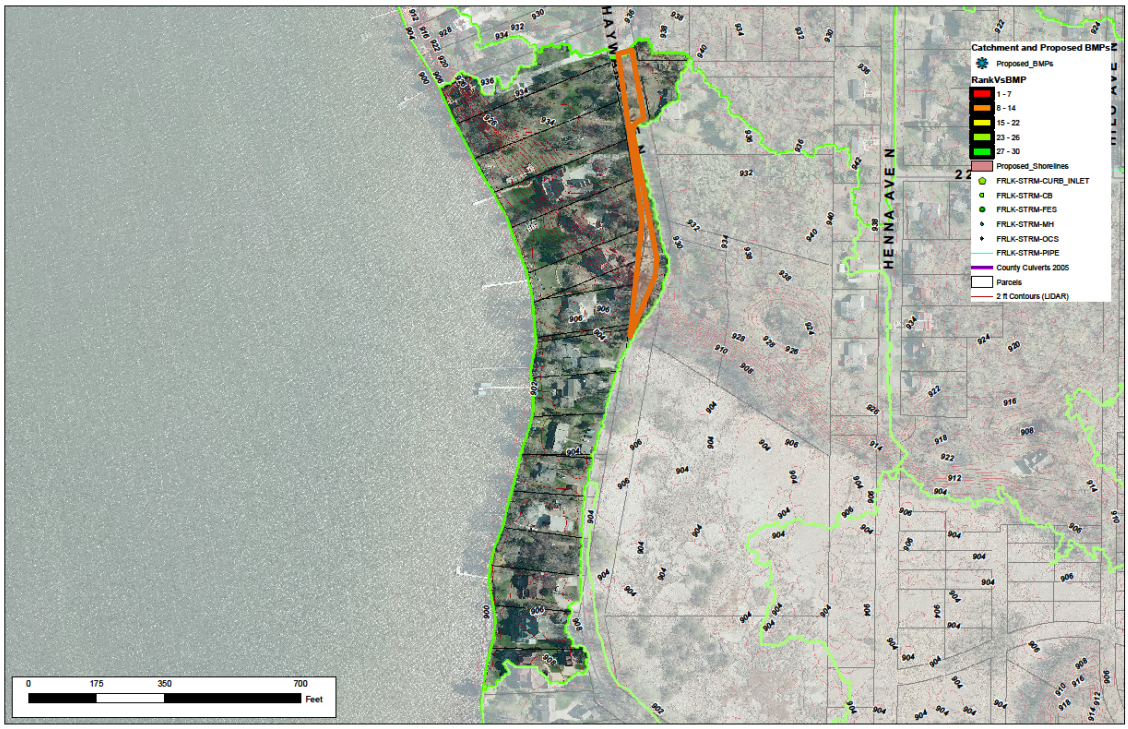


Cost/Removal Analysis		RETROFIT OPTIONS – Catchment FL01-N13					
		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.6	7%	0.6	7%	1.2	14%
	TSS (lb/yr)	260.5	8%	220.0	7%	481	16%
	Volume (acre-feet/yr)	0.0	0%	0.3	6%	0.3	6%
	Number of BMP's	1		5		6	
	BMP Size/Description	0.210	curb miles	7,500	sf	All Practices	
	BMP Type	Street Sweeping		Lakeshore Restoration		Sweeping and Shorelines	
Cost	Materials/Labor/Design	$245.91		$38,685.00		$38,930.91	
	Promotion & Admin Costs	$400		$1,625		$2,025	
	Probable Project Cost	$646		$40,310		$40,956	
	Annual O&M	$0		$3,375		$3,375	
	10-yr Cost/lb-TP/yr	$106		$12,343		$6,225	
	10-yr Cost/2,000lb-TSS/yr	$496		$67,327		$33,912	

FL01-N13: Increased Street Sweeping

Rank #8/64

Drainage Area – 0.21 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.



Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.6	7%
	TSS (lb/yr)	260.5	8%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.210	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$245.91	
	Promotion & Admin Costs	$400	
	Probable Project Cost	**$646**	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	**$106**	
	10-yr Cost/2,000lb-TSS/yr	**$496**	

FL01-N13 – Typical Shoreline Restorations

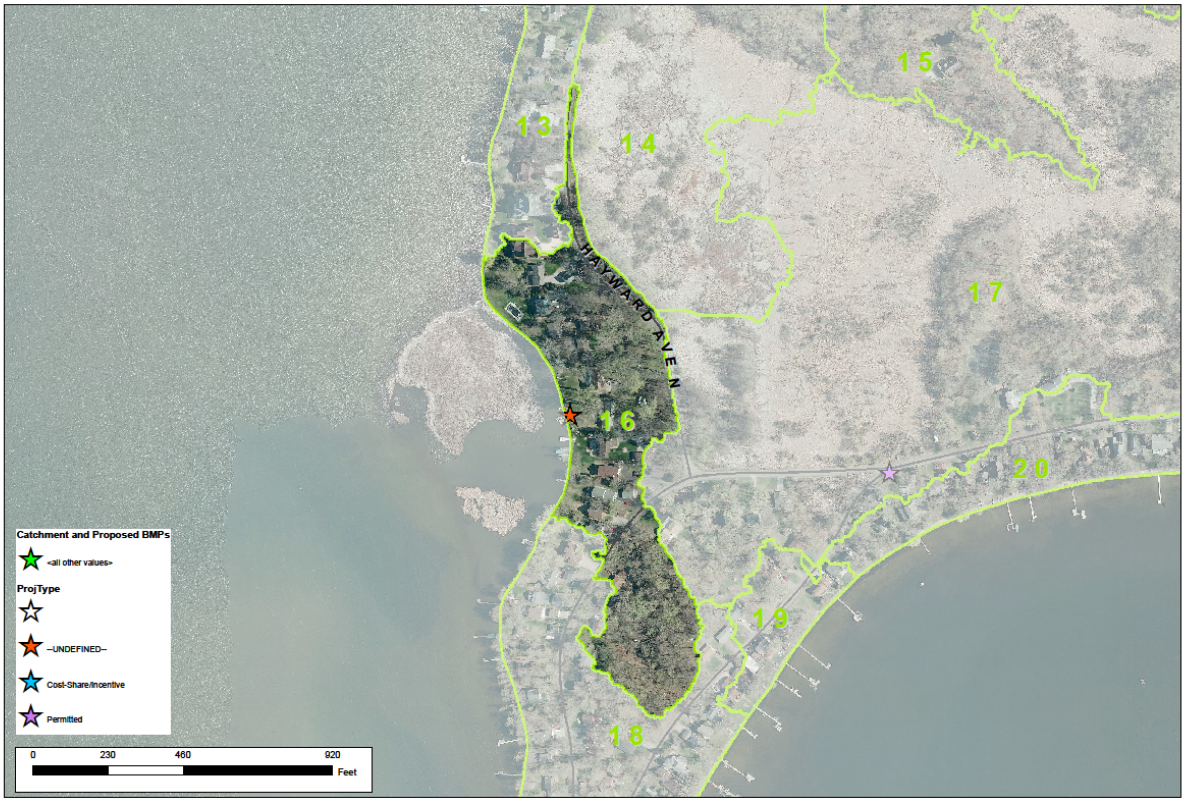
Rank 59/64

Drainage Area – 2.0 acres (0.40 acre average per property)
Location – any 5 Participating Shorelines within FL01-N13 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 70% of the FL01-N13 catchment drainage area is direct discharge from the entirety of each lakefront property. Minor to moderate heaving causes pooling and allows for some runoff control on the northern properties. The general shoreline character of this catchment is 20% turf mown to edges, 40% turf or woods to riprap, 40% mix of weedy vegetation cover from steep slopes (mostly in the south half). Steep slopes on the south half contribute excessive bank losses. Northern parcels have good opportunities for enhanced buffers. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 2 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.2	2%
	TSS (lb/yr)	64.0	2%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	2	
	BMP Size/Description	2,584	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$13,465.92	
	Promotion & Admin Costs	$650	
	Probable Project Cost	**$14,116**	
	Annual O&M	$1,163	
	10-yr Cost/lb-TP/yr	**$16,090**	
	10-yr Cost/2,000lb-TSS/yr	**$80,450**	

Catchment FL01-N16



Existing Catchment Summary	
Acres	10.63
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	4.81
TP (lb/yr)	5.70
TSS (lb/yr)	2,471

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	7.9	2.2	28%	**5.7**
	TSS (lb/yr)	2,915	444.3	15%	**2,471**
	Volume (acre-feet/yr)	5.0	0.2	4%	**4.8**
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

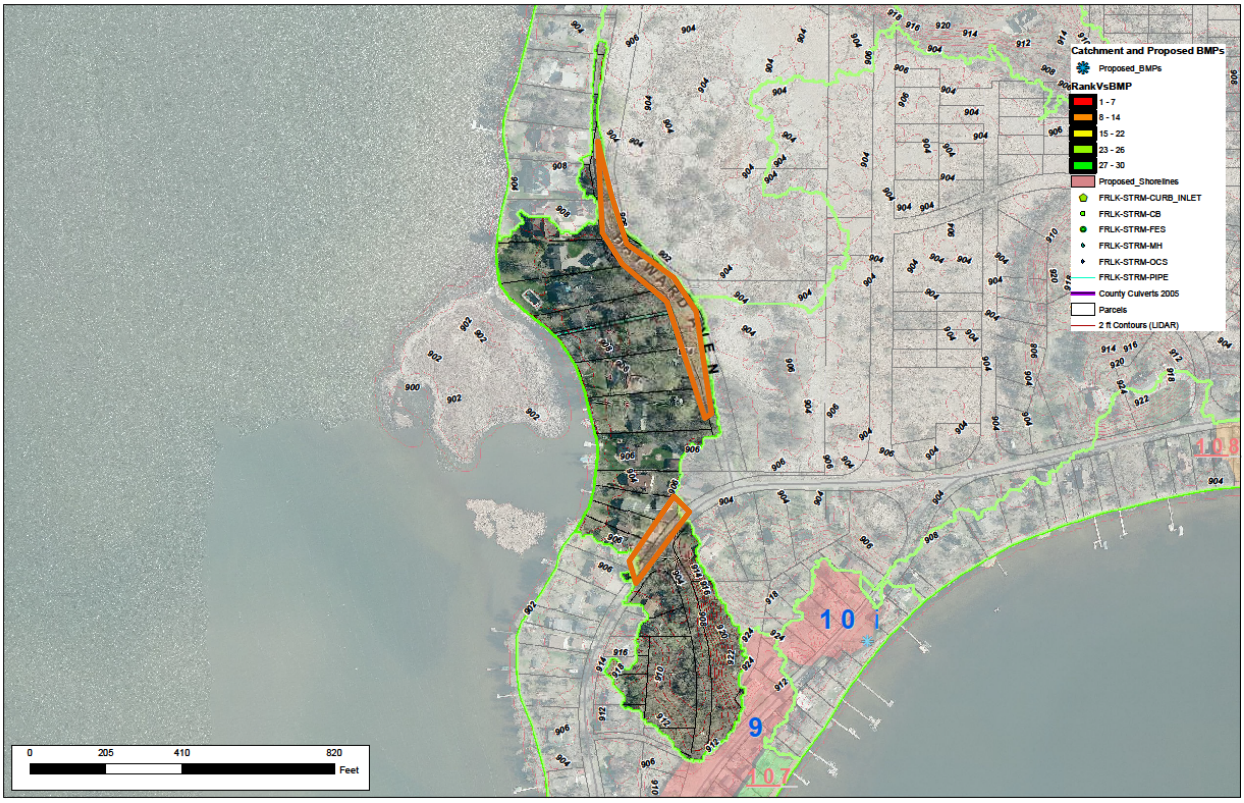
FL01-N16 is a small catchment that sits between Hayward Ave N and the lake shore. There is a section of Hayward that drains through the lots to the lake. The southern half is partially landlocked, wet woods. The northern half consists of lots 60-90' in width; where shorelines appear to be protected by a mass of aquatic vegetation.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There is a cost-share shoreline restoration that accounts for a larger than average TP load reduction.

RETROFIT RECOMMENDATIONS

RANK 14/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.
RANK 60/64 - Typical Shoreline Restorations: Up to 4 non-priority shorelines with 15' wide enhanced shoreline buffers.

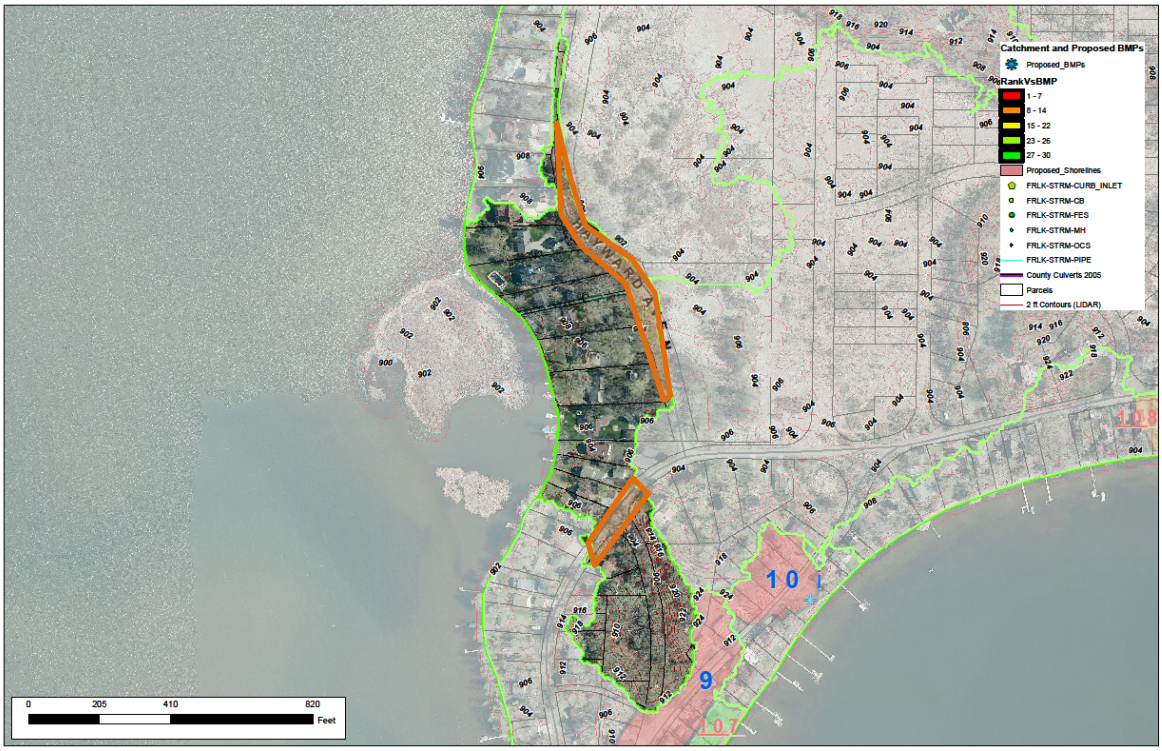


Cost/Removal Analysis		RETROFIT OPTIONS – Catchment FL01-N16					
		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.4	8%	0.5	8%	0.9	16%
	TSS (lb/yr)	190.5	8%	160.0	6%	351	14%
	Volume (acre-feet/yr)	0.0	0%	0.3	6%	0.3	6%
	Number of BMP's	1		4		1	
	BMP Size/Description	0.383	curb miles	6,000	sf	All Practices	
	BMP Type	Street Sweeping		Lakeshore Restoration		Sweeping	
Cost	Materials/Labor/Design	$275.49		$30,990.00		$31,265.49	
	Promotion & Admin Costs	$400		$1,300		$1,700	
	Probable Project Cost	$675		$32,290		$32,965	
	Annual O&M	$0		$2,700		$2,700	
	10-yr Cost/lb-TP/yr	$152		$12,352		$6,252	
	10-yr Cost/2,000lb-TSS/yr	$709		$74,113		$37,411	

FL01-N16: Increased Street Sweeping

Rank 14/64

Drainage Area – 0.383 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.



Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.4	8%
	TSS (lb/yr)	190.5	8%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.383	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$275.49	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$675	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$152	
	10-yr Cost/2,000lb-TSS/yr	$709	

FL01-N16 – Typical Shoreline Restorations

Rank 60/64

Drainage Area – 2.0 acres (0.50 acre average per property)
Location – any 4 Participating Shorelines within FL01-N16 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 60% of the FL01-N16 catchment drainage area is direct discharge from the entirety of each lakefront property. The general shoreline character of this catchment is 40% turf mown to edges, 40% turf or woods to riprap, 20% mix of weedy or native vegetation. This area is rather protected from heave and wave action as a result of the large mass of aquatic vegetation in front of the lots and exhibits a stable condition. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 4 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.5	8%
	TSS (lb/yr)	160.0	6%
	Volume (acre-feet/yr)	0.3	6%
	Number of BMP's	4	
	BMP Size/Description	6,000	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$30,990.00	
	Promotion & Admin Costs	$1,300	
	Probable Project Cost	**$32,290**	
	Annual O&M	$2,700	
	10-yr Cost/lb-TP/yr	**$12,352**	
	10-yr Cost/2,000lb-TSS/yr	**$74,113**	

Catchment FL01-N18



Existing Catchment Summary	
Acres	11.92
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	5.76
TP (lb/yr)	8.98
TSS (lb/yr)	3,222

	Existing Conditions	EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	10.2	1.2	12%	9.0
	TSS (lb/yr)	3,757	535.0	14%	3,222
	Volume (acre-feet/yr)	5.8	0.1	1%	5.8
	BMP Type	No Existing Practices, Street Sweep 2x annually			

CATCHMENT DESCRIPTION

FL01-N18 is a medium sized catchment situated on the peninsula that divides lake 1 and lake 2. North Shore Circle bisects the catchment and the entire eastern half drains to a shallow mowed depression that drains to the lake via a 4" buried pipe. The western half of the catchment drains through the yards to the shore with small pockets of landlocked wet woods in the north-center of the catchment. Shore frontages are larger throughout this stretch and homes are very close to the shore, leaving not much room for wide shoreline buffer opportunties.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There were no other existing BMPs found within the catchment.

RETROFIT RECOMMENDATIONS

RANK 9/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 21/64 - BMP 9h BioInfiltration Basin: Turning a mown depression into an Infiltration Basin near an existing 4" drainpipe treating runoff prior to discharging to lake. Basin area 750sf with 3" ponding.

RANK 48/64 - Priority Shoreline 107: 10 contiguous properties with high ice heave with opportunity for 15' wide enhanced shoreline buffers and stabilization.

RANK 63/64 - Typical Shoreline Restorations: Up to 5 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS – Catchment FL01-N18									
		BMP 9h - BioInfiltration Simple		Priority Shoreline 107		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.42	5%	1.51	17%	0.6	7%	0.4	4%	2.9	32%
	TSS (lb/yr)	185	6%	1,832	57%	267.5	8%	115.0	4%	2400	74%
	Volume (acre-feet/yr)	0.3	5%	0.6	10%	0.0	0%	0.3	5%	1.2	20%
	Number of BMP's	1		10		1		5		17	
	BMP Size/Description	750	sf	11,805	sf	0.590	curb miles	5,900	sf	All Practices	
	BMP Type	Simple BioInfiltration		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$4,242.00		$80,956.20		$310.89		$30,477.00		$115,986.09	
	Promotion & Admin Costs	$325		$3,250		$400		$1,625		$5,600	
	Probable Project Cost	$4,567		$84,206		$711		$32,102		$121,586	
	Annual O&M	$563		$5,312		$0		$2,655		$8,530	
	10-yr Cost/lb-TP/yr	$2,409		$9,077		$114		$16,758		$7,089	
	10-yr Cost/2,000lb-TSS/yr	$11,018		$14,992		$532		$102,003		$32,136	

FL01-N18: Increased Street Sweeping

Rank 9/64

Drainage Area – 0.59 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.

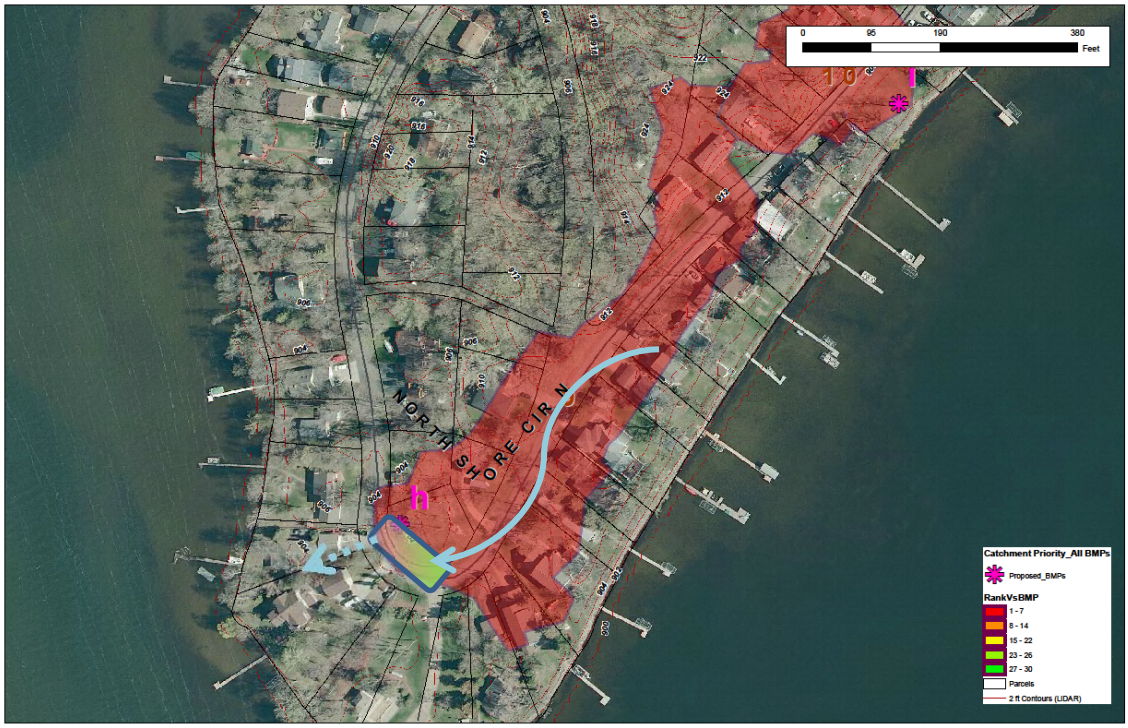


Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N18* Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.6	7%
	TSS (lb/yr)	267.5	8%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.590	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$310.89	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$711	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$114	
	10-yr Cost/2,000lb-TSS/yr	$532	

FL01-N18: BMP 9h BioInfiltration Basin

Rank 21/64

Drainage Area – 3.042 acres (33% Impervious)
Location – Tip of Road Loop on North Shore Circle
Property Ownership – Private/Public, partially in Right of Way
Description – Create a shallow BioInfiltration Basin adjacent to the existing 4" drain pipe on the north side of North Shore Circle. Basin ponding area will be 750 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost). The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $4,567 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N18* BMP 9h - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.42	5%
	TSS (lb/yr)	185	6%
	Volume (acre-feet/yr)	0.3	5%
	Number of BMP's	1	
	BMP Size/Description	750	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$4,242.00	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$4,567	
	Annual O&M	$563	
	10-yr Cost/lb-TP/yr	$2,409	
	10-yr Cost/2,000lb-TSS/yr	$11,018	

FL01-N18 – Priority Shoreline Catchments 107

Rank 48/64

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **48/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **28/30**

Drainage Area – 1.589 acres
Location – 10 private residences
Property Ownership – Private
Description – These ten parcels are all located on the east side of the peninsula and all show signs of high ice heave which have been partially stabilized with large quantities of riprap and stone. All homes are very close to the shore and there are not many great opportunities for large shoreline projects. All shorelines were given a loose estimate of 6" of vertical loss and 6" of lateral recession since it was hard to discern what was heave and what was erosion. Losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N18 Priority Shoreline 107	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.51	17%
	TSS (lb/yr)	1,832	57%
	Volume (acre-feet/yr)	0.6	10%
	Number of BMP's	10	
	BMP Size/Description	11,805	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$80,956.20	
	Promotion & Admin Costs	$3,250	
	Probable Project Cost	$84,206	
	Annual O&M	$5,312	
	10-yr Cost/lb-TP/yr	$9,077	
	10-yr Cost/2,000lb-TSS/yr	$14,992	

PRIORITY CATCHMENT 107 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
107	10	1.589	25122	232	0.71	1600	0.800	25122	1832	1.51
	TOTAL	1.589					TOTAL	25122	1832	1.51

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N18 – Typical Shoreline Restorations

Rank 64/64

Drainage Area – 1.75 acres (0.35 acre average per property)
Location – any 5 Participating Shorelines within FL01-N18 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 50% of the FL01-N18 catchment drainage area is direct discharge from the entirety of each lakefront property. Minor to major heaving causes pooling but also allows for some runoff control on these properties. The general shoreline character of this catchment is 20% turf mown to edges, 70% turf to riprap, and 10% mix of weedy or native vegetation. Western parcels have better opportunities and more space for enhanced buffers but the eastern half may be more in need of ice heave interventions or consultations. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 5 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N18* Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.4	4%
	TSS (lb/yr)	115.0	4%
	Volume (acre-feet/yr)	0.3	5%
	Number of BMP's	5	
	BMP Size/Description	5,900	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$30,477.00	
	Promotion & Admin Costs	$1,625	
	Probable Project Cost	$32,102	
	Annual O&M	$2,655	
	10-yr Cost/lb-TP/yr	$16,758	
	10-yr Cost/2,000lb-TSS/yr	$102,003	

Catchment FL01-N19



Existing Catchment Summary	
Acres	2.27
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	1.05
TP (lb/yr)	1.71
TSS (lb/yr)	596

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	2.0	0.2	12%	1.7
	TSS (lb/yr)	698	102.0	15%	596
	Volume (acre-feet/yr)	1.1	0.0	2%	1.0
	BMP Type	No Existing Practices, Street Sweep 2x annually			

CATCHMENT DESCRIPTION

FL01-N19 is a small catchment situated on North Shore Circle on Lake 2. It is primarily ¼ acre to ½ acre residential lots. About 50% of this catchment drains into North Shore Circle Park and overflows into the lake via an unofficial (and eroded) canoe access point. The other half drains over land through each yard and into the lake. Most lots have riprap on the shore and exhibit minor heave and minimal erosion.

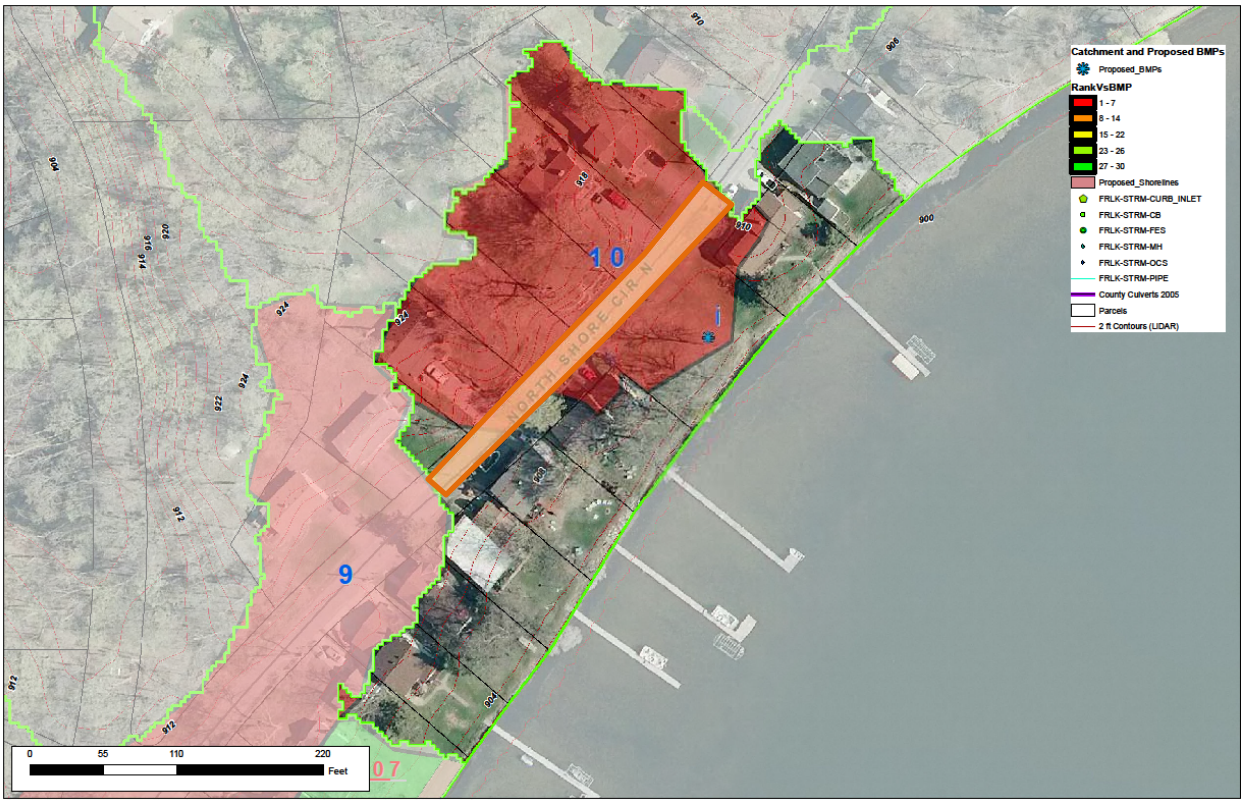
EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There were no other existing BMPs found within the catchment.

RETROFIT RECOMMENDATIONS

RANK 17/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 22/64 - BMP 10i BioInfiltration Basin: Regrade west side of park into an Infiltration Basin that will be covered with turf so that it can still be used as a park except in rain events. Basin area is 1600sf with 3" ponding and 12" replacement soils.

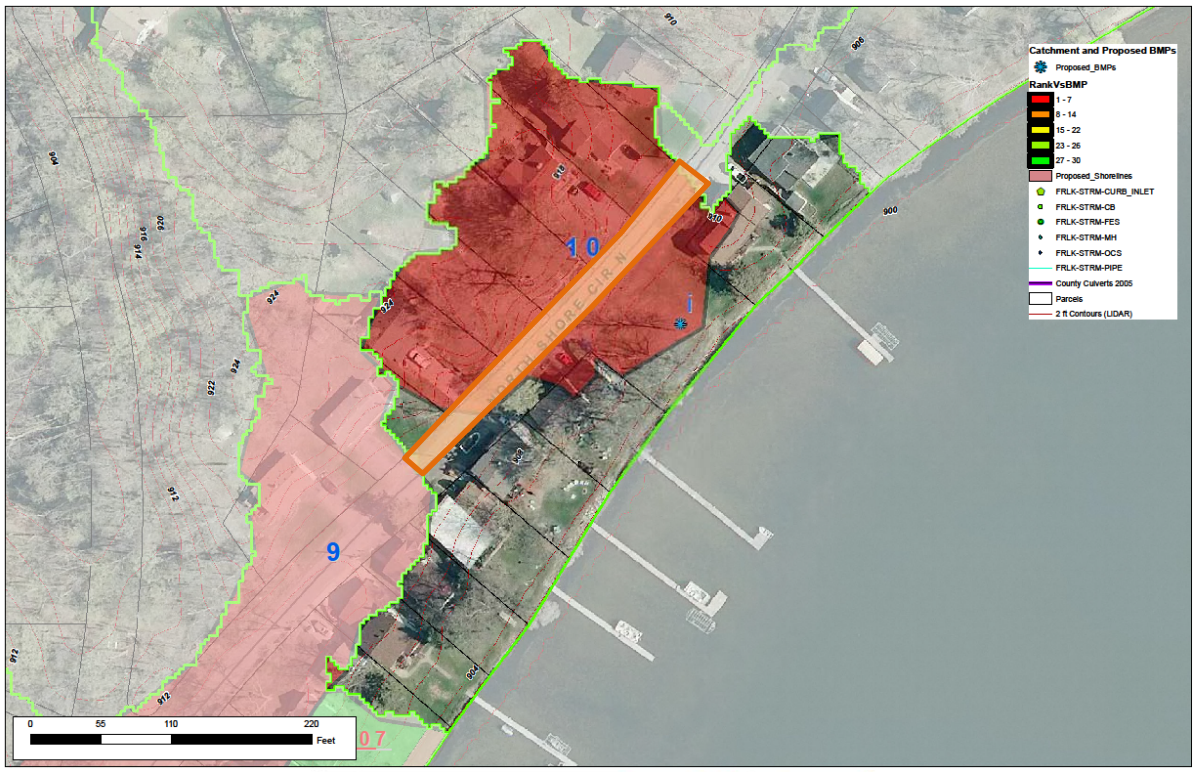


	Cost/Removal Analysis	RETROFIT OPTIONS					
		Catchment FL01- N19					
		BMP 10i - BioInfiltration Mod Complex		Increased Street Sweeping to 4x per year		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.69	41%	0.1	7%	0.8	48%
	TSS (lb/yr)	279	47%	51.0	9%	330	55%
	Volume (acre-feet/yr)	0.5	44%	0.0	0%	0.5	44%
	Number of BMP's	1		1		2	
	BMP Size/Description	1,600	sf	0.088	curb miles	All Practices	
	BMP Type	Moderately Complex BioInfiltration		Street Sweeping		Sweeping	
Cost	Materials/Labor/Design	$14,701.30		$225.05		$14,926.35	
	Promotion & Admin Costs	$325		$400		$725	
	Probable Project Cost	$15,026		$625		$15,651	
	Annual O&M	$200		$0		$200	
	10-yr Cost/lb-TP/yr	$2,451		$517		$1,484	
	10-yr Cost/2,000lb-TSS/yr	$12,205		$2,451		$7,328	

FL01-N19: Increased Street Sweeping

Rank 17/64

Drainage Area – 0.088 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.

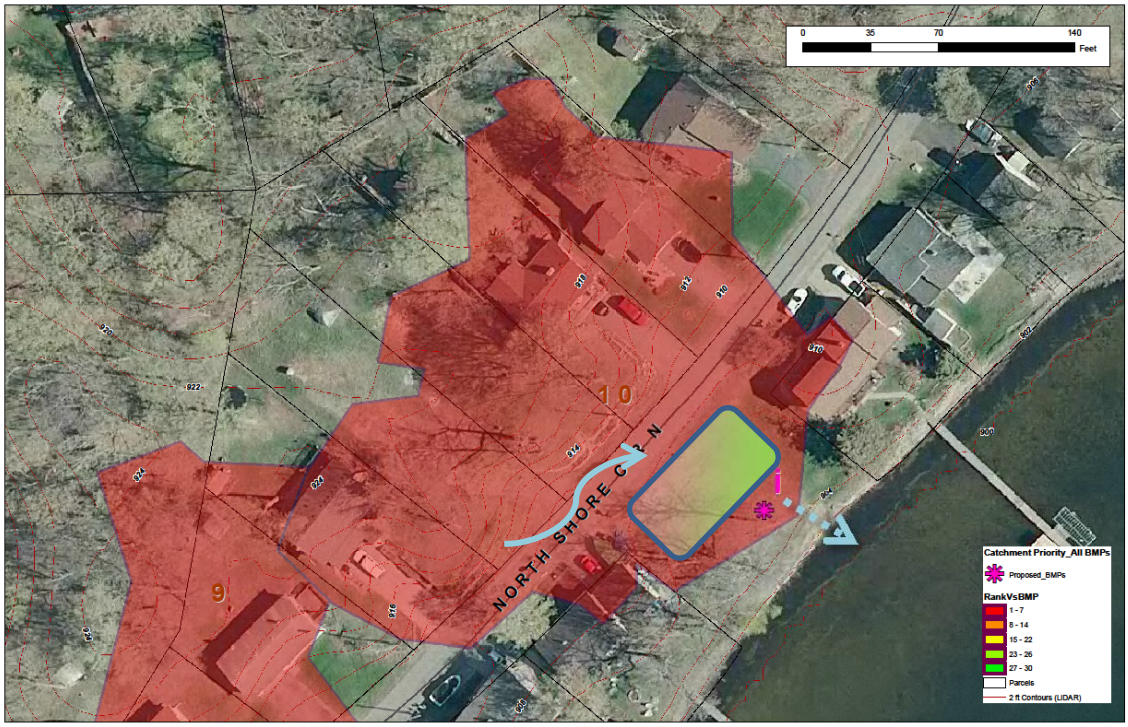


Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.1	7%
	TSS (lb/yr)	51.0	9%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.088	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$225.05	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$625	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$517	
	10-yr Cost/2,000lb-TSS/yr	$2,451	

FL01-N19: BMP 10i BioInfiltration Basin

Rank 22/64

Drainage Area – 1.16 acres (33% Impervious)
Location – North Shore Circle Park
Property Ownership –Public (City of Forest Lake)
Description – Create a shallow BioInfiltration Basin on the west side of North Shore Circle Park. Basin ponding area will be 1600 sf, will have 3" of ponding and 1' of replacement soils (70/30 sand/compost) and will be vegetated with regular sod. Sod cover is to be used so that park can remain usable in between rain events. The overflow will be a shallow berm that then will flow towards the restored 'unofficial' canoe access point. The basin will be underdrained, and depending on lake elevation relative to the bottom of the treatment cell, underdrain will either be a 4" typical underdrain system or just a narrow vein of buried pea rock (dry well) that weeps to the shore. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $15,206 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 10i - BioInfiltration Mod Complex	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.69	41%
	TSS (lb/yr)	279	47%
	Volume (acre-feet/yr)	0.5	44%
	Number of BMP's	1	
	BMP Size/Description	1,600 sf	
	BMP Type	Moderately Complex BioInfiltration	
Cost	Materials/Labor/Design	$14,701.30	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$15,026	
	Annual O&M	$200	
	10-yr Cost/lb-TP/yr	$2,451	
	10-yr Cost/2,000lb-TSS/yr	$12,205	

Catchment FL01-N20



Existing Catchment Summary	
Acres	6.40
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	3.11
TP (lb/yr)	4.92
TSS (lb/yr)	1,767

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	5.7	0.8	14%	**4.9**
	TSS (lb/yr)	2,096	329.0	16%	**1,767**
	Volume (acre-feet/yr)	3.2	0.1	4%	**3.1**
	BMP Type	Street Sweep 2x annually, 1 Raingarden			

CATCHMENT DESCRIPTION

FL01-N20 is a medium sized catchment at the intersection of North Shore Trail and North Shore Circle. There is a shallow pocket of ponding in the northeast corner of the catchment that takes a larger rain event in order to overflow to the shoreline, but otherwise all else is direct drainage to the lake. Shore frontages on the west are relatively stable with minor heaving. Shore frontages on the east have large areas of bare soil and would benefit from shoreline interventions. Priority Shoreline Catchment 109 was not originally part of this catchment, but upon further inspection it will be included with FL01-N20 since it has been found to drain directly to the lake. All data presented reflects this change except the drawn Catchment Boundary.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There were no other existing BMPs found within the catchment.

RETROFIT RECOMMENDATIONS

RANK 16/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 25/64 - Priority Shoreline 108 and 109: 7 properties with minor to moderate erosion with opportunity for 15' wide enhanced shoreline buffers and stabilization. See notes in profile for 109.

RANK 49/64 - Typical Shoreline Restorations: Up to 3 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N20*							
		Priority Shoreline 108, 109		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	2.49	51%	0.3	7%	0.5	10%	3.3	68%
	TSS (lb/yr)	2,588	146%	150	8%	156.0	9%	2894	164%
	Volume (acre-feet/yr)	0.9	28%	0.0	0%	0.2	7%	1.1	35%
	Number of BMP's	7		1		3		11	
	BMP Size/Description	6,578	sf	0.272	curb miles	4,500	sf	All Practices	
	BMP Type	Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Shorelines	
Cost	Materials/Labor/Design	$45,203.52		$256.51		$23,295.00		$68,755.03	
	Promotion & Admin Costs	$2,275		$400		$975		$3,650	
	Probable Project Cost	**$47,479**		**$657**		**$24,270**		$72,405	
	Annual O&M	$2,960		$0		$2,025		$4,985	
	10-yr Cost/lb-TP/yr	**$3,094**		**$188**		**$9,275**		$4,186	
	10-yr Cost/2,000lb-TSS/yr	**$5,957**		**$878**		**$57,077**		$21,304	

FL01-N20: Increased Street Sweeping

Rank 16/64

Drainage Area – 0.272 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning



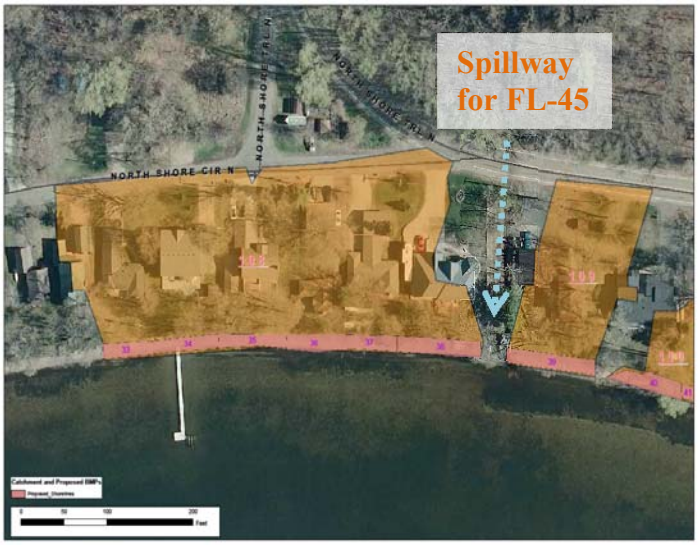
Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.3	7%
	TSS (lb/yr)	150	8%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.272	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$256.51	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$657	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$188	
	10-yr Cost/2,000lb-TSS/yr	$878	

FL01-N20 – Priority Shoreline Catchments 108 and 109

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **25/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **8/30**

Rank 25/64

Drainage Area – 2.397 acres
Location – 7 private residences
Property Ownership – Private
Description – These seven parcels are all located adjacent to the intersection of North Shore Trail and North Shore Circle. All homes are fairly close to the shore and most exhibit light to moderate soil losses as a result of heave and shoreline practices. All Shore Segments (except within PSC 109) were given a loose estimate of 6" of vertical loss and 6" of lateral recession. Losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



Cost/Removal Analysis		Project ID: Priority Shoreline 108, 109	
		New trtmt	Net %
Treatment	TP (lb/yr)	2.49	51%
	TSS (lb/yr)	2,588	146%
	Volume (acre-feet/yr)	0.9	28%
	Number of BMP's	7	
	BMP Size/Description	6,578	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$45,203.52	
	Promotion & Admin Costs	$2,275	
	Probable Project Cost	$47,479	
	Annual O&M	$2,960	
	10-yr Cost/lb-TP/yr	$3,094	
	10-yr Cost/2,000lb-TSS/yr	$5,957	

PRIORITY CATCHMENT 108 and 109 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
108	6	1.917	31288	407	0.98	820	0.410	31288	1227	1.39
109	1	0.48	6374	221	0.53	1140	0.570	6374	1361	1.10
	TOTAL	2.397					TOTAL	37662	2588	2.491

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N20 – MAP Priority Shoreline Catchment 108

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **25/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **8/30**

Rank 25/64

Drainage Area – 1.917 acres
Location – 6 private residences
Property Ownership – Private
Description – These six parcels are all located adjacent to the intersection of North Shore Trail and North Shore Circle. All homes are fairly close to the shore and most exhibit light to moderate soil losses (with minimal heaving), mostly as a result of shoreline management practices and wave action. All shorelines were given a loose estimate of 6" of vertical loss and 6" of lateral recession. Losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



PRIORITY CATCHMENT 108 and 109 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
108	6	1.917	31288	407	0.98	820	0.410	31288	1227	1.39
109	1	0.48	6374	221	0.53	1140	0.570	6374	1361	1.10
	TOTAL	2.397					TOTAL	37662	2588	2.491

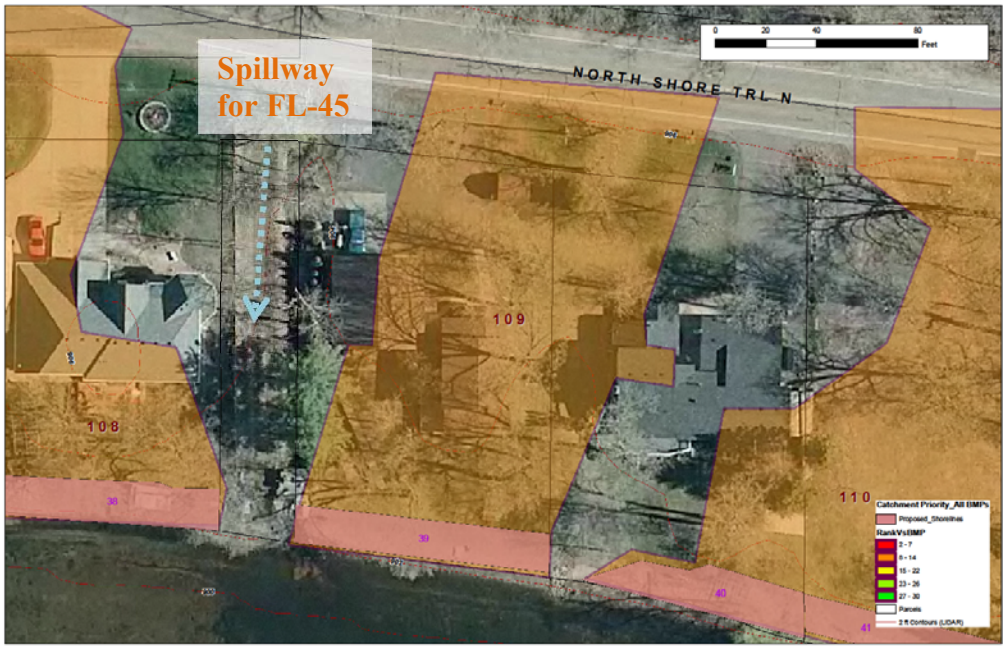
******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N20 – MAP of Priority Shoreline Catchment 109

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **25/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **8/30**

Rank 25/64

Drainage Area – 0.48 acres
Location – 1 private residence
Property Ownership – Private
Description – This parcel is located adjacent to the intersection of North Shore Trail and North Shore Circle. This parcel was originally not in the analysis and was included as the report was being written since it does indeed drain to the lake proper and not to FL-45 as originally delineated. All associated areas and loads are included with Catchment FL01-N20. This shoreline was estimated at 24" of vertical loss and 12" of lateral recession. Losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs). This parcel is a high ranking candidate if ranked separate from the rest of Priority Shoreline Catchment 108. Additional treatment opportunities could be explored (outside of this analysis) along the spillway from FL-45.



PRIORITY CATCHMENT 108 and 109 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
108	6	1.917	31288	407	0.98	820	0.410	31288	1227	1.39
109	1	0.48	6374	221	0.53	1140	0.570	6374	1361	1.10
	TOTAL	2.397					TOTAL	37662	2588	2.491

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N20 – Typical Shoreline Restorations

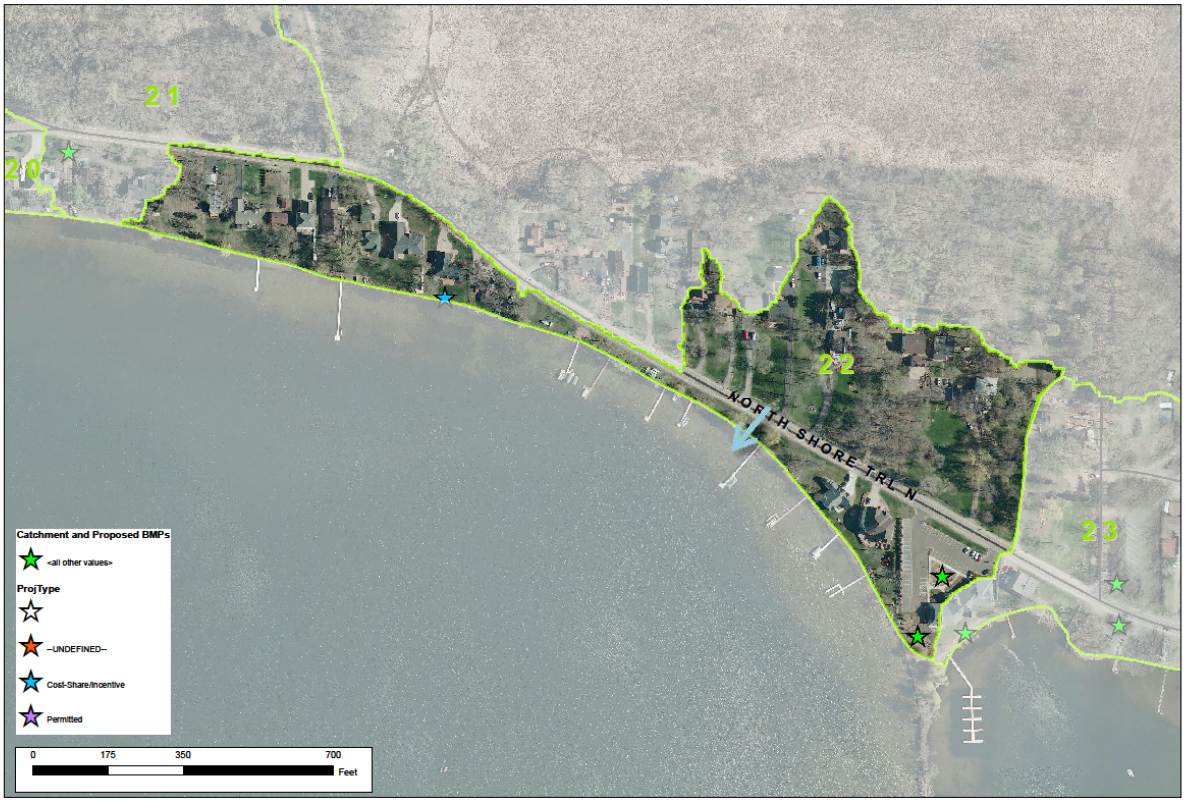
Rank 64/64

Drainage Area – 1.05 acres (0.35 acre average per property)
Location – any 3 Participating Shorelines within FL01-N20 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 35% of the FL01-N20 catchment drainage area is already designated as Priority Shoreline Restoration. Eastern parcels have better opportunities and more space for enhanced buffers and the western half is mostly lawn edges of shoreline but relatively stable. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 3 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.5	10%
	TSS (lb/yr)	156.0	9%
	Volume (acre-feet/yr)	0.2	7%
	Number of BMP's	3	
	BMP Size/Description	4,500	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$23,295.00	
	Promotion & Admin Costs	$975	
	Probable Project Cost	**$24,270**	
	Annual O&M	$2,025	
	10-yr Cost/lb-TP/yr	**$9,275**	
	10-yr Cost/2,000lb-TSS/yr	**$57,077**	

Catchment FL01-N22



Existing Catchment Summary	
Acres	15.06
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	6.75
TP (lb/yr)	9.76
TSS (lb/yr)	3,631

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	12.2	2.4	20%	9.8
	TSS (lb/yr)	4,823	1,192.0	25%	3,631
	Volume (acre-feet/yr)	7.8	1.0	13%	6.7
	BMP Type	Street Sweep 2x annually, 1 shoreline, Acqua BMPs (shore, pervious lot, 2x raingarden)			

CATCHMENT DESCRIPTION

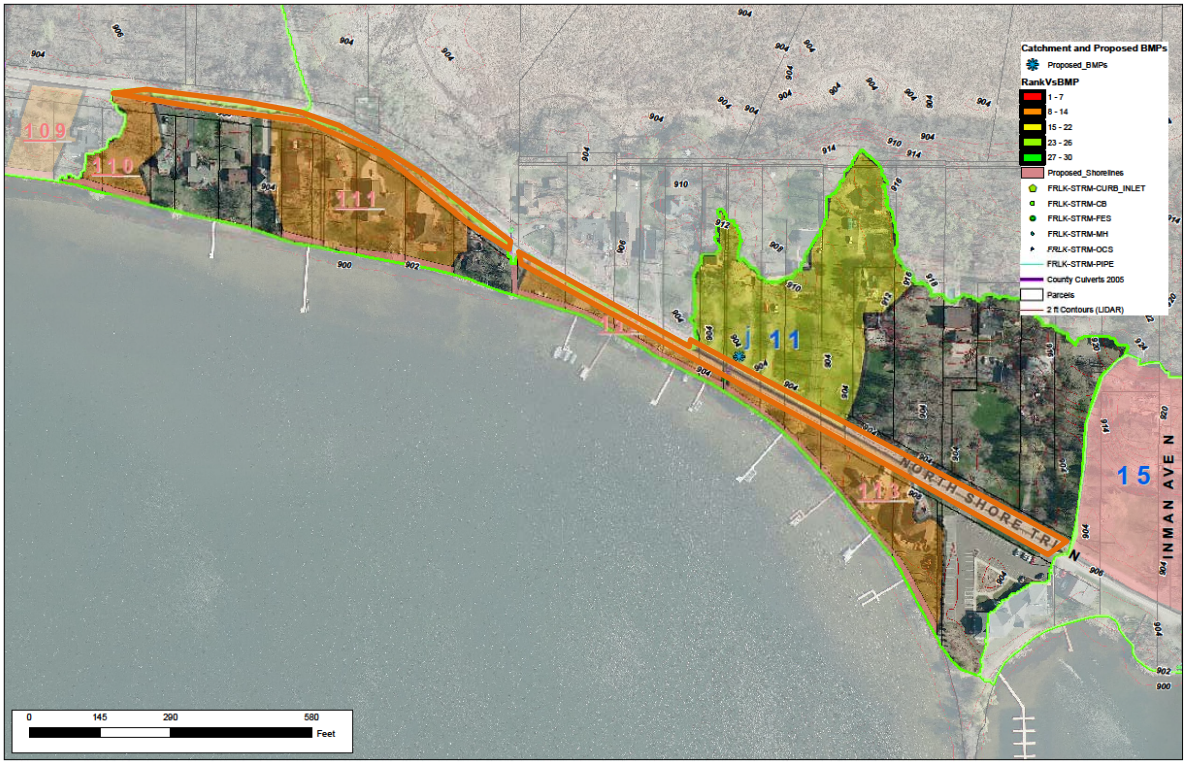
FL01-N22 is a larger catchment with North Shore Trail bisecting over half of the lots, separating houses from direct shore access. As a result, all road runoff in the east is redirected under the road from north to south, and outlets to the shoreline in a 12" pipe. The western portion of the catchment is direct drainage, with North Shore Trail flowing through each yard before it reaches the shore. A lot of ponding occurs in several discreet depressions on the north half of North Shore Trail, right near the road. These were factored into the WinSLAMM modelling for existing conditions as well as for BMP retrofit implementation.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. Acqua Restaurant has several BMPs that were installed as a permit requirement in 2006/2007. No permitting records were found relating to their sizing requirements, but each BMP was modelled in WinSLAMM according to the designs. There is also a cost-share shoreline installed on the western portion of the catchment.

RETROFIT RECOMMENDATIONS

RANK 5/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.
RANK 28/64 - BMP 11j BioInfiltration Basin: Infiltration Basin near existing 12" pipe draining to lake. Second upstream basin also proposed. Basins each 600sf with 3" ponding, amending existing depressions near road.
RANK 37/64 - Priority Shoreline Catchment 110, 111, 112, 113: 18 properties for enhanced shoreline buffers
RANK 45/64 - Typical Shoreline Restorations: Up to 2 non-priority shorelines with 15' wide enhanced shoreline buffers.

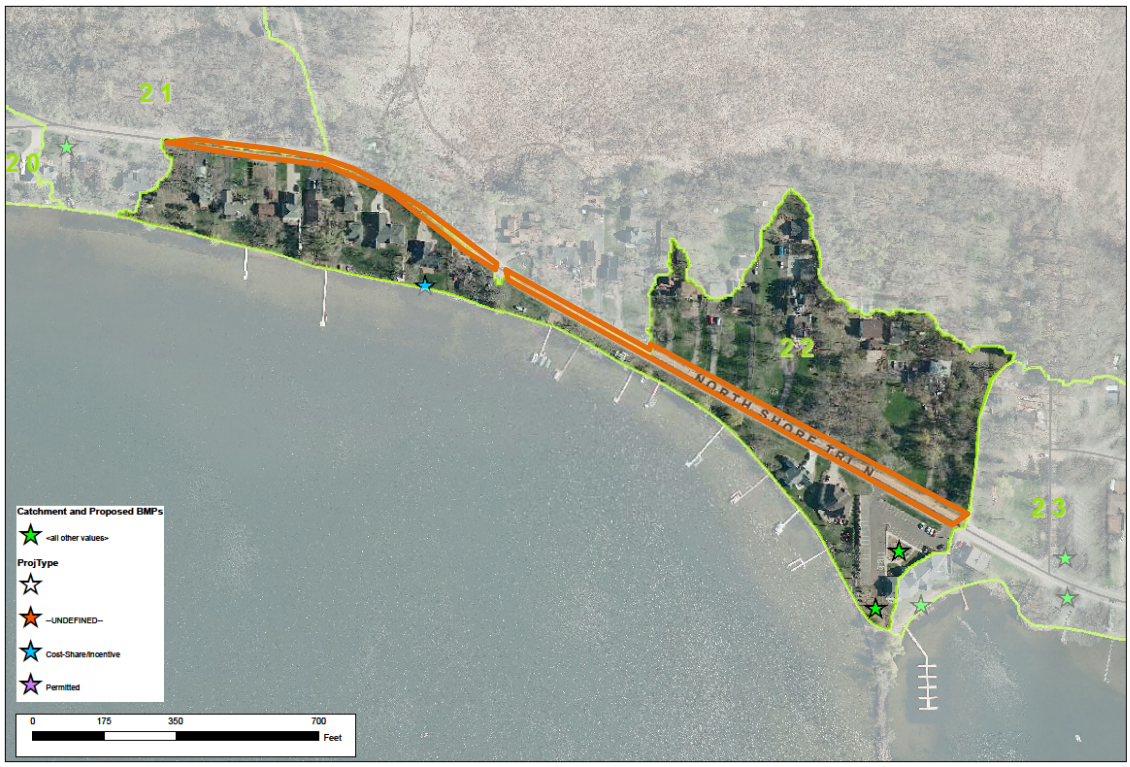


Cost/Removal Analysis		RETROFIT OPTIONS – Catchment FL01-N22									
		BMP 11j - BioInfiltration Mod Complex		Priority Shoreline 110, 111, 112, 113		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.66	7%	8.21	84%	0.8	8%	0.4	4%	10.0	103%
	TSS (lb/yr)	247	7%	10,892	300%	337.0	9%	156.0	4%	11632	320%
	Volume (acre-feet/yr)	0.4	6%	1.6	24%	0.0	0%	0.2	3%	2.2	33%
	Number of BMP's	2		18		1		2		23	
	BMP Size/Description	1,800	sf	23,610	sf	0.788	curb miles	2,360	sf	All Practices	
	BMP Type	Moderately Complex BioInfiltration		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$17,712.96		$161,699.12		$344.75		$12,316.80		$192,073.62	
	Promotion & Admin Costs	$400		$5,850		$400		$650		$7,300	
	Probable Project Cost	$18,113		$167,549		$745		$12,967		$199,374	
	Annual O&M	$1,350		$10,624		$0		$1,062		$13,036	
	10-yr Cost/lb-TP/yr	$4,790		$3,334		$97		$6,207		$3,607	
	10-yr Cost/2,000lb-TSS/yr	$25,598		$5,027		$442		$30,239		$15,327	

FL01-N22: Increased Street Sweeping

Rank 5/64

Drainage Area – 0.788 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N22* Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.8	8%
	TSS (lb/yr)	337.0	9%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.788	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$344.75	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$745	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$97	
	10-yr Cost/2,000lb-TSS/yr	$442	

FL01-N22: BMP 11j BioInfiltration Basins

Rank 28/64

Drainage Area – 2.977 acres (25% Impervious)
Location – North side North Shore Trail, west of Acqua Restaurant
Property Ownership – Private/Public, in Right of Way
Description – Convert two existing mown turf depressions to Vegetated BioInfiltration Basins. Depression bottoms will be excavated 3" below inverts of existing culvert pipes that connect under driveways and roads on each lot. Basin ponding area will be 600 sf, will have 3" of ponding, and amended with 70/30 sand /compost mix. The overflow to then lake will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept include an expanded footprint, different vegetation for the basin, or stop mowing the ditches. The cost of $18,113 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



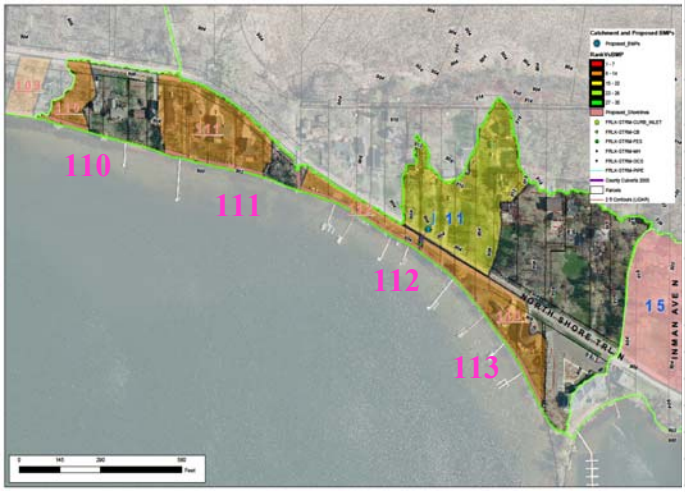
Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N22 BMP 11j - BioInfiltration Mod Complex	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.66	7%
	TSS (lb/yr)	247	7%
	Volume (acre-feet/yr)	0.4	6%
	Number of BMP's	2	
	BMP Size/Description	1,800	sf
	BMP Type	Moderately Complex BioInfiltration	
Cost	Materials/Labor/Design	$17,712.96	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$18,113	
	Annual O&M	$1,350	
	10-yr Cost/lb-TP/yr	$4,790	
	10-yr Cost/2,000lb-TSS/yr	$25,598	

FL01-N22 – Priority Shoreline Catchments 110 to 113

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **37/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **11/30**

Rank 37/64

Drainage Area – 4.502 acres
Location – 18 private residences
Property Ownership – Private
Description – These 18 parcels are all located on shallow slopes on residential lots. Erosion is mixed in severity across the catchment. PSC 110 and PSC 113 are the most heavily degraded shorelines and if they were ranked independently of the other shores in the catchment they would rank much higher priority. All parcels are candidates for both an enhanced shoreline buffer as well as improved stabilization techniques. Losses likely occurred over a shorter duration than the typical assumption of 10 years on some properties, but actual duration of losses cannot be determined without consultation with landowner (see individual PSC profiles for modelling assumptions).



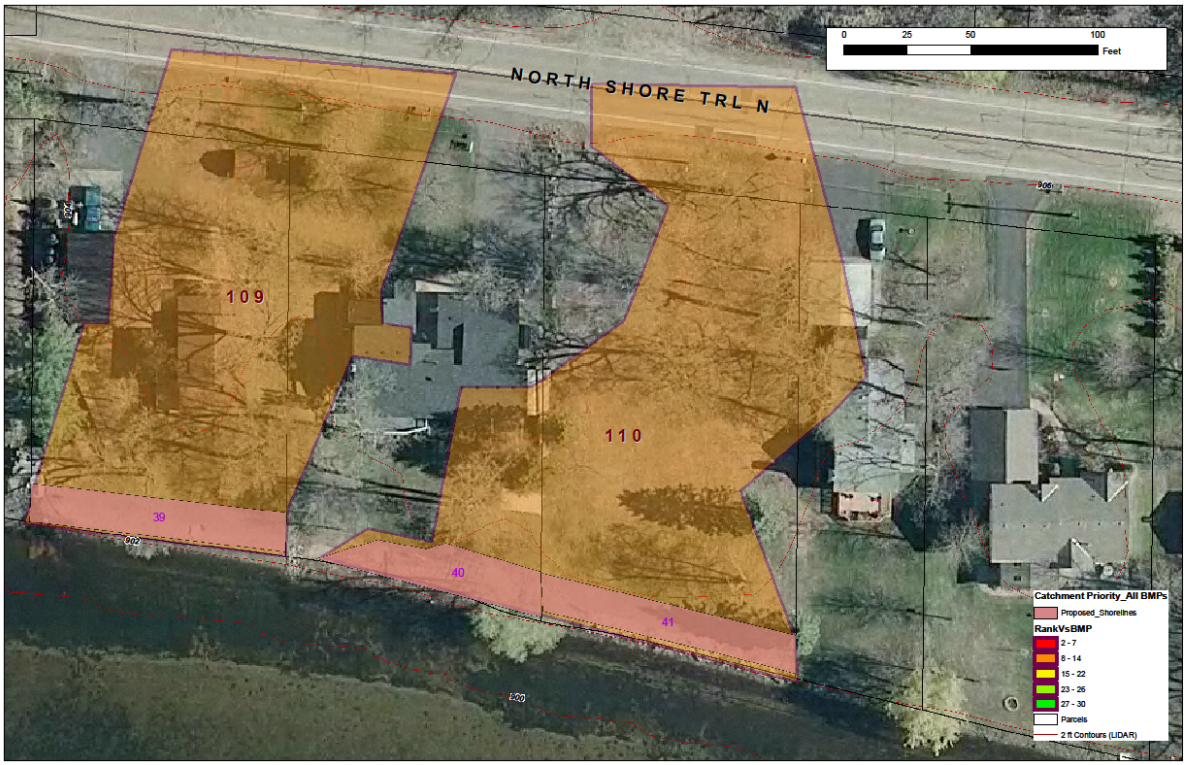
Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N22 Priority Shoreline 110, 111, 112, 113 New trtmt	Net %
Treatment	TP (lb/yr)	8.21	84%
	TSS (lb/yr)	10,892	300%
	Volume (acre-feet/yr)	1.6	24%
	Number of BMP's	18	
	BMP Size/Description	23,610	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$161,699.12	
	Promotion & Admin Costs	$5,850	
	Probable Project Cost	$167,549	
	Annual O&M	$10,624	
	10-yr Cost/lb-TP/yr	$3,334	
	10-yr Cost/2,000lb-TSS/yr	$5,027	

PRIORITY CATCHMENT 110 to 113 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
110	2	0.544	6396	281	0.71	2560	1.280	6396	2841	1.99
111	4	2.031	27139	360	0.88	960	0.480	27139	1320	1.36
112	6	0.576	12174	313	0.76	2340	1.170	12174	2653	1.93
113	6	1.351	25975	458	1.13	3620	1.810	25975	4078	2.94
	TOTAL	4.502					TOTAL	71684	10892	8.21

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N22 – MAP Priority Shoreline Catchment 110

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **37/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **11/30**
Drainage Area – 0.544 acres
Location – 2 private residences
Property Ownership – Private
Description – These two parcels showed 24" of vertical loss and 12" of lateral recession and if they were ranked independently of the other shores in the catchment they would rank as a much higher priority. Unclear as to whether ice heave is causing the soil loss as ice heave does not look extreme on adjacent properties and the losses appear in large localized pockets. Losses appear to have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 7yrs).



PRIORITY CATCHMENT 110 to 113 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
110	2	0.544	6396	281	0.71	2560	1.280	6396	2841	1.99
111	4	2.031	27139	360	0.88	960	0.480	27139	1320	1.36
112	6	0.576	12174	313	0.76	2340	1.170	12174	2653	1.93
113	6	1.351	25975	458	1.13	3620	1.810	25975	4078	2.94
	TOTAL	4.502					TOTAL	71684	10892	8.21

****NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N22 – MAP Priority Shoreline Catchment 111

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **37/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **11/30**
Drainage Area – 2.031 acres
Location – 4 private residences
Property Ownership – Private
Description – These four parcels showed a range of 6-12" of vertical loss and 6-12" of lateral recession. Unclear as to whether ice heave is causing the soil loss as ice heave does not look extreme on adjacent properties. Losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



PRIORITY CATCHMENT 110 to 113 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
110	2	0.544	6396	281	0.71	2560	1.280	6396	2841	1.99
111	4	2.031	27139	360	0.88	960	0.480	27139	1320	1.36
112	6	0.576	12174	313	0.76	2340	1.170	12174	2653	1.93
113	6	1.351	25975	458	1.13	3620	1.810	25975	4078	2.94
	TOTAL	4.502					TOTAL	71684	10892	8.21

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N22 – MAP Priority Shoreline Catchment 112

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **37/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **11/30**
Drainage Area – 0.576 acres
Location – 4 private residences
Property Ownership – Private
Description – These six parcels are purely for shoreline access and have no homes on them and show signs of heavy use for pedestrian and boat access. Ice heave has left some depressions for pooling behind the ice ridges. All parcels showed a range of 6-12" of vertical loss and 6-12" of lateral recession. Losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



PRIORITY CATCHMENT 110 to 113 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
110	2	0.544	6396	281	0.71	2560	1.280	6396	2841	1.99
111	4	2.031	27139	360	0.88	960	0.480	27139	1320	1.36
112	6	0.576	12174	313	0.76	2340	1.170	12174	2653	1.93
113	6	1.351	25975	458	1.13	3620	1.810	25975	4078	2.94
	TOTAL	4.502					TOTAL	71684	10892	8.21

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N20 – MAP Priority Shoreline Catchment 113

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **25/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **8/30**
Drainage Area – 1.351 acres
Location – 6 private residences
Property Ownership – Private
Description – These six parcels are all located west of Acqua Restaurant. Two homes are located here and are fairly close to the shore. The home parcels exhibit moderate soil losses in localized areas, mostly as a result of shoreline management practices and recreation use. All shorelines were given an average of 12" of vertical loss and 12" of lateral recession and the losses were heavier near parcels 56, 57, and 58. Losses appear to have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 7yrs on parcel 57).



PRIORITY CATCHMENT 110 to 113 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
110	2	0.544	6396	281	0.71	2560	1.280	6396	2841	1.99
111	4	2.031	27139	360	0.88	960	0.480	27139	1320	1.36
112	6	0.576	12174	313	0.76	2340	1.170	12174	2653	1.93
113	6	1.351	25975	458	1.13	3620	1.810	25975	4078	2.94
	TOTAL	4.502					TOTAL	71684	10892	8.21

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N22 – Typical Shoreline Restorations

Rank 45/64

Drainage Area – 0.80 acres (0.40 acre average per property)
Location – any 2 Participating Shorelines within FL01-N22 (in addition to Priority Shorelines)
Property Ownership – Private
Description –Most of the FL01-N22 catchment drainage area has been identified as a Priority Shoreline Catchment. The few remaining properties that have not been identified also exhibit some minor erosion, but more intermittently across portions of the shorelines (as opposed to entire parcel widths). All remaining parcels have good opportunities for enhanced buffers and have a larger buffer size to drainage area ratio; making a buffer installation more effective as treating a larger portion of the contributing drainage area. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 2 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		RETROFIT OPTIONS	
		Catchment FL01-N22	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.4	4%
	TSS (lb/yr)	156.0	4%
	Volume (acre-feet/yr)	0.2	3%
	Number of BMP's	2	
	BMP Size/Description	2,360	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$12,316.80	
	Promotion & Admin Costs	$650	
	Probable Project Cost	**$12,967**	
	Annual O&M	$1,062	
	10-yr Cost/lb-TP/yr	**$6,207**	
	10-yr Cost/2,000lb-TSS/yr	**$30,239**	

Catchment FL01-N23



Existing Catchment Summary	
Acres	8.95
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	2.88
TP (lb/yr)	4.96
TSS (lb/yr)	1,595

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	7.2	2.2	31%	**5.0**
	TSS (lb/yr)	2,865	1,270.0	44%	**1,595**
	Volume (acre-feet/yr)	4.1	1.3	30%	**2.9**
	BMP Type	3 infiltration basins, 1 in-line infiltration swale, 1 shoreline			

CATCHMENT DESCRIPTION

FL01-N23 is a medium sized catchment with North Shore Trail bisecting the southern lots, separating medium density residential homes from direct shore access. As a result, all road runoff is redirected under the road from north to south, and outlets to the shoreline in a single 12" pipe. Inman Ave N and 224th St N are both gravel roads.

EXISTING STORMWATER TREATMENT

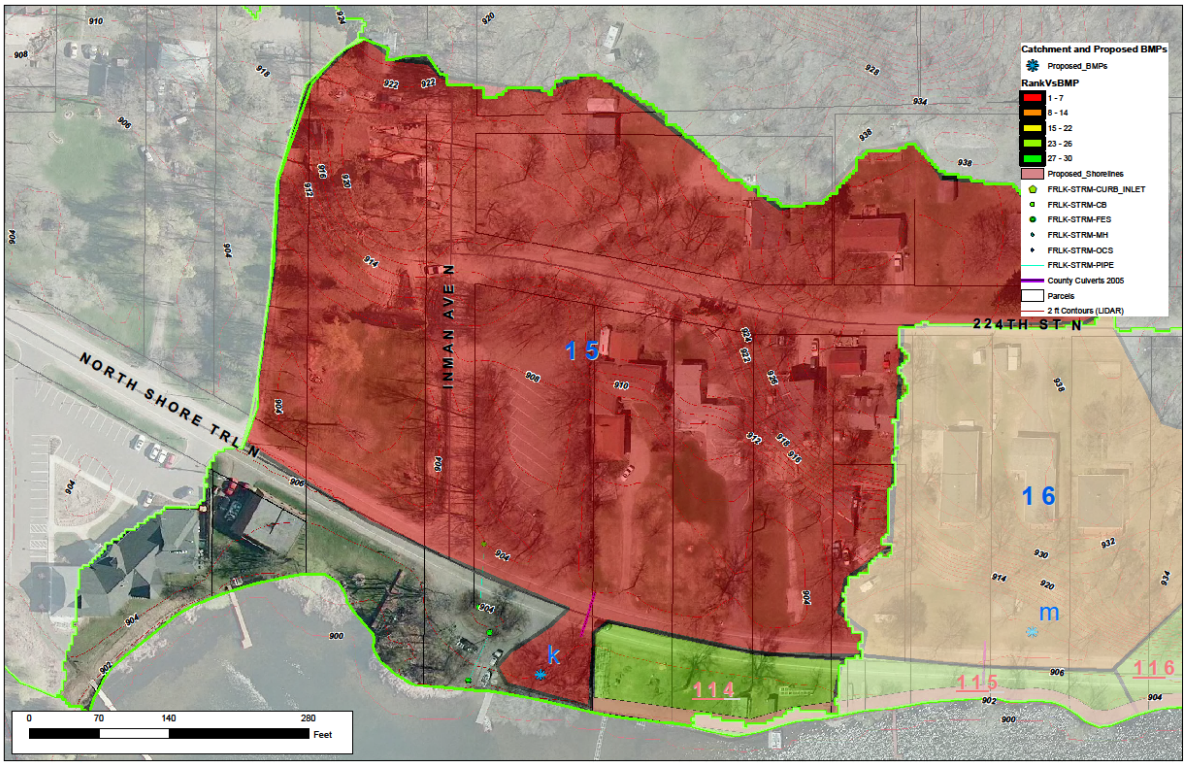
Street sweeping of city streets occurs approximately twice annually. Much of the northern and western portion of the catchment flows through a series of infiltration basins and an infiltration swale at the DNR Public Water Access parking lot (pre-treating the gravel roads). The DNR PWA launch has an infiltration basin but does not receive much water. The Acqua Restaurant shoreline has also been maintained as a native buffer at least 15' wide.

RETROFIT RECOMMENDATIONS

RANK 15/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 18/64 - BMP 15k BioInfiltration Basin: Retrofit lawn depression to facilitate 3" ponding and a 450sf basin at pipe crossing before drainage crosses road to lake.

RANK 47/64 - Priority Shoreline Catchment 106: 3 properties for enhanced shoreline buffers



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N23*							
		BMP 15k - BioInfiltration Simple		Priority Shoreline 114		Increased Street Sweeping to 4x per year		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.7	14%	0.62	12%	0.4	8%	1.7	35%
	TSS (lb/yr)	102.0	6%	376	24%	143.6	9%	621.6	39%
	Volume (acre-feet/yr)	0.2	7%	0.2	6%	0.0	0%	0.4	13%
	Number of BMP's	1		3		1		5	
	BMP Size/Description	420	sf	3,659	sf	0.250	curb miles	All Practices	
	BMP Type	Simple BioInfiltration		Priority Lakeshore Restoration		Street Sweeping		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$6,328.00		$25,237.56		$252.75		$31,818.31	
	Promotion & Admin Costs	$400		$975		$400		$1,775	
	Probable Project Cost	**$6,728**		**$26,213**		**$653**		$33,593	
	Annual O&M	$315		$1,647		$0		$1,962	
	10-yr Cost/lb-TP/yr	**$1,399**		**$6,884**		**$164**		$2,816	
	10-yr Cost/2,000lb-TSS/yr	**$19,369**		**$22,701**		**$909**		$14,326	

FL01-N23: Increased Street Sweeping

Rank 15/64

Drainage Area – 0.25 curb miles
Location – North Shore Trail Only (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.

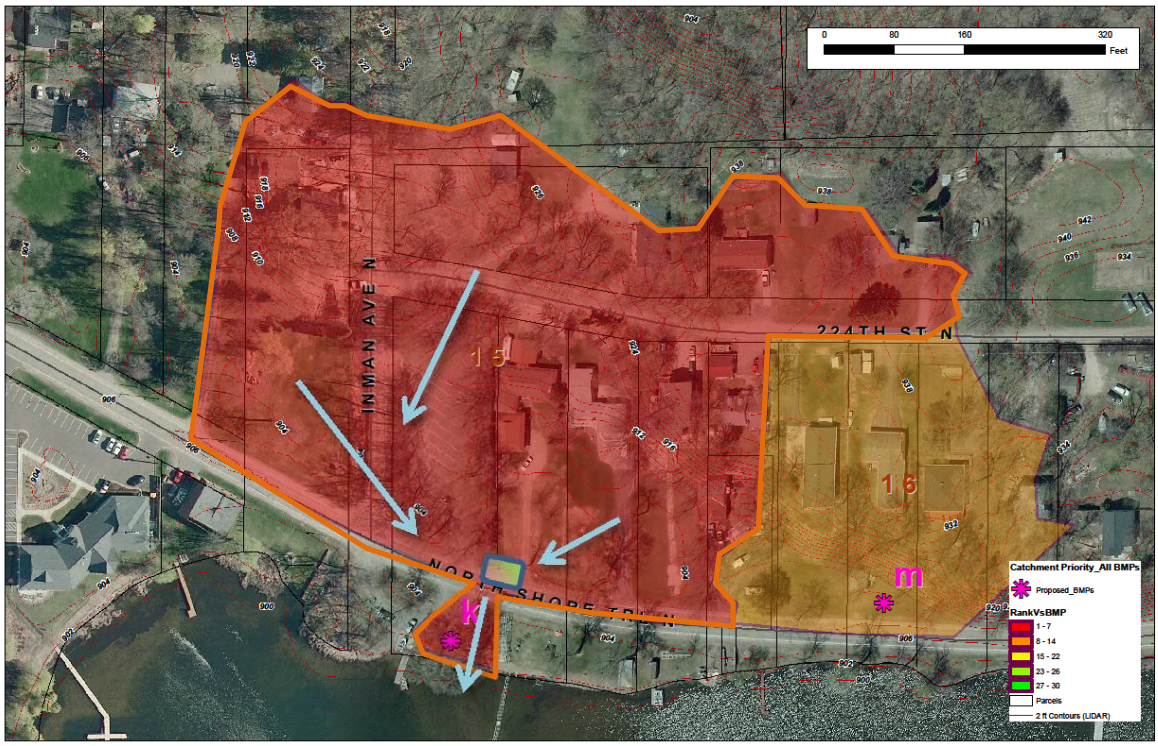


Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.4	8%
	TSS (lb/yr)	143.6	9%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.250	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$252.75	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$653	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$164	
	10-yr Cost/2,000lb-TSS/yr	$909	

FL01-N23: BMP 15k BioInfiltration Basin

Rank 18/64

Drainage Area – 7.611 acres (30% Impervious)
Location – East of Intersection of North Shore Trail and Inman Ave N
Property Ownership – Private/Public, in Right of Way
Description – Convert existing mown turf depression to Vegetated BioInfiltration Basin adjacent to the existing 12" pipe at end of swale run. Basin ponding area will be 500 sf, will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. Presence of existing swales will act as pretreatment for basin. The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin, or just stop mowing the depression. The cost of $6,728 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



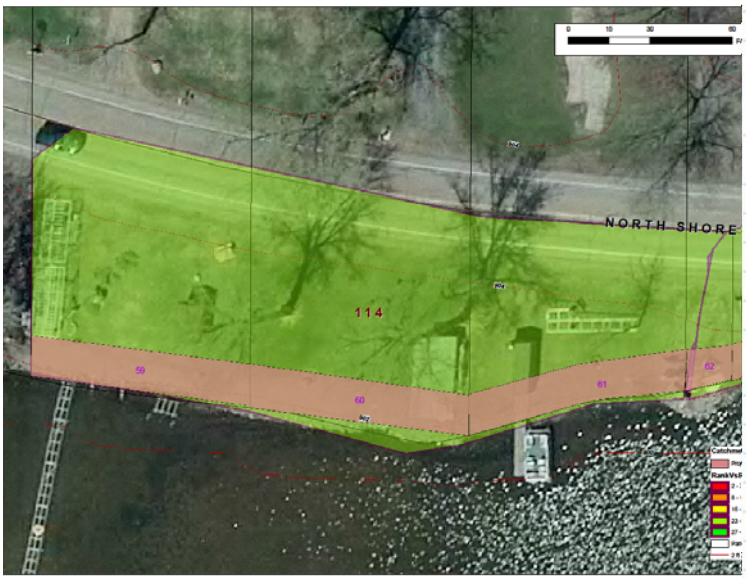
Cost/Removal Analysis		Project ID: BMP 15k - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.7	14%
	TSS (lb/yr)	102.0	6%
	Volume (acre-feet/yr)	0.2	7%
	Number of BMP's	1	
	BMP Size/Description	420	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$6,328.00	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$6,728	
	Annual O&M	$315	
	10-yr Cost/lb-TP/yr	$1,399	
	10-yr Cost/2,000lb-TSS/yr	$19,369	

FL01-N23 – Priority Shoreline Catchments 114

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **47/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **27/30**

Rank 47/64

Drainage Area – 0.466 acres
Location – 3 private residences
Property Ownership – Private
Description – These three parcels are all located on the shore side of North Shore Trail and have no homes built on this portion of the property. These properties exhibited more erosion than the adjacent Priority Shoreline Catchments 115, 116, and 117 (albeit minor). More importantly, these high traffic lots on limited footprints warrant special attention since there is not much room for a substantial buffer but would likely benefit from one in the near future. Additionally, the eroded areas are localized sections of shoreline, meaning a minor adjustment to landuse may make a large difference in shoreline stability. Shore Segment 59 exhibits 6" of vertical loss and 6" of lateral recession while 60 and 61 are half that range. Losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10yrs).



Cost/Removal Analysis		Project ID: Priority Shoreline 114	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.62	12%
	TSS (lb/yr)	376	24%
	Volume (acre-feet/yr)	0.2	6%
	Number of BMP's	3	
	BMP Size/Description	3,659	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$25,237.56	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$26,213	
	Annual O&M	$1,647	
	10-yr Cost/lb-TP/yr	$6,884	
	10-yr Cost/2,000lb-TSS/yr	$22,701	

PRIORITY SHORELINE CATCHMENT 114 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
114	3	0.466	7343	216	0.54	160	0.080	7343	376	0.62
	TOTAL	0.466					TOTAL	7343	376	0.62

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

Catchment FL01-N24



Existing Catchment Summary	
Acres	22.39
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	8.52
TP (lb/yr)	14.32
TSS (lb/yr)	4,863

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	16.5	2.2	13%	**14.3**
	TSS (lb/yr)	5,707	844.0	15%	**4,863**
	Volume (acre-feet/yr)	9.0	0.5	5%	**8.5**
	BMP Type	Street Sweep 2x annually, 2 Shoreline			

CATCHMENT DESCRIPTION

FL01-N24 is a medium sized catchment that sits along North Shore Trail, all medium density residential. Irish Ave is gravel and tends to discharge sediment across the intersection to the lake. Many western parcels have steep slopes that discharge across the road to a patch of small parcels that all have significant ice heave ridges. The remainder of the catchment to the east is more shallow sloped, and also has significant ice heave ridges which do not appear to be losing soil but rather are just pushed and heaved upward.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There are two cost-share BMPs in the catchment. One is a shoreline buffer and the other is a runoff control project (intercepting house and road drainage).

RETROFIT RECOMMENDATIONS

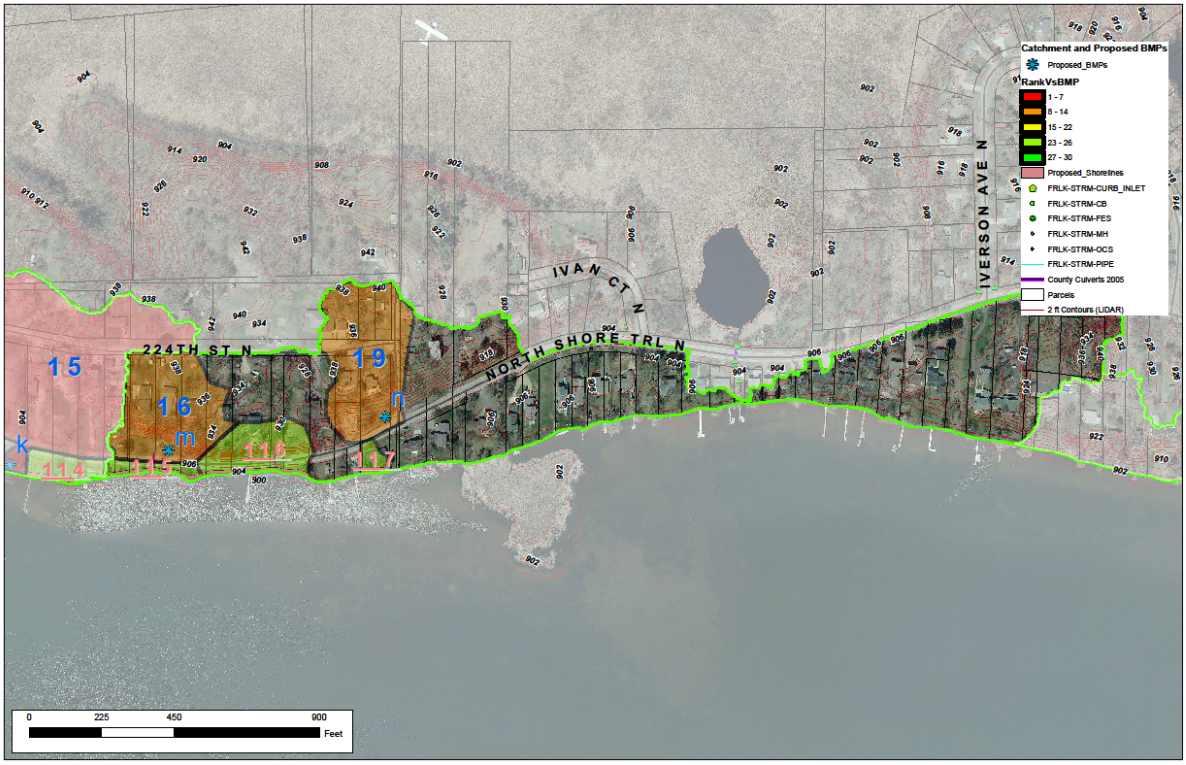
RANK 7/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 26/64 - BMP 19n BioInfiltration Basin: Retrofit lawn depression at intersection of Inman Ave and North Shore Trail to capture gravel road runoff before drainage crosses road to lake. 600 sf basin will pond 3".

RANK 30/64 - BMP 16m BioInfiltration Basin: Retrofit lawn depression to facilitate 3" ponding and a 600sf basin before drainage overflows roadway to lake

RANK 47/64 - Priority Shoreline Catchment 115, 116, 117: 11 properties for enhanced shoreline buffers

RANK 59/64 - Typical Shoreline Restorations: Up to 4 non-priority shorelines with 15' wide enhanced shoreline buffers.

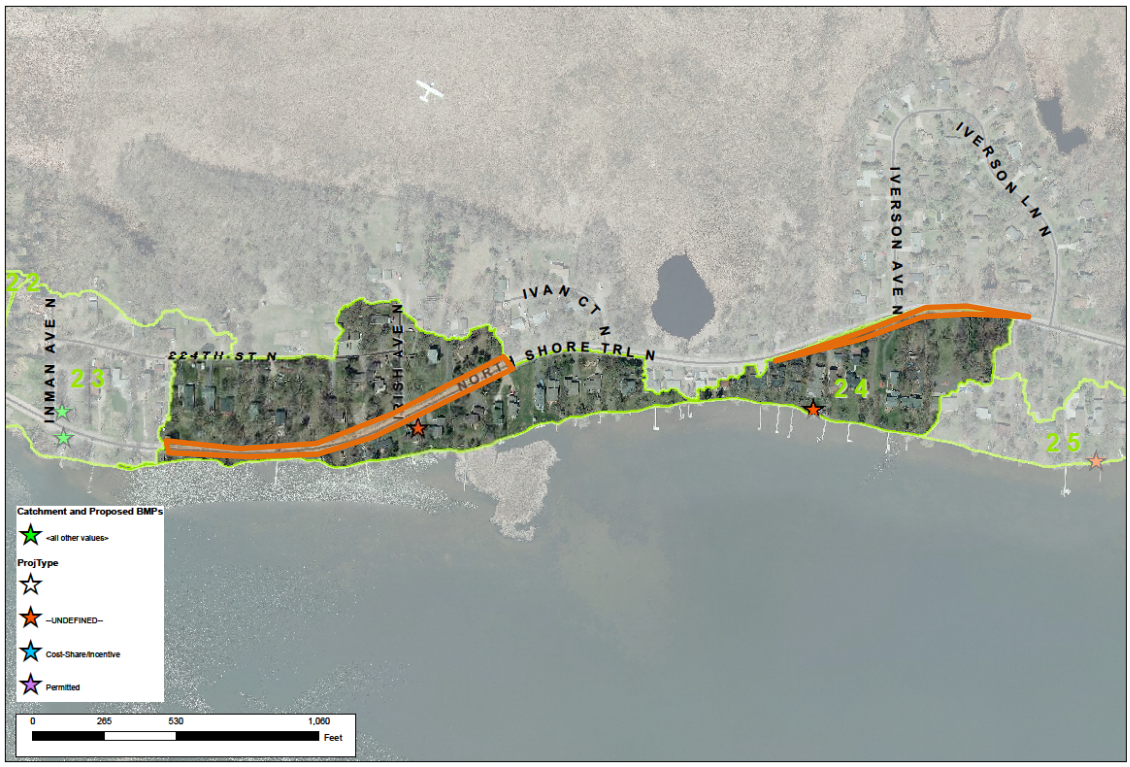


RETROFIT OPTIONS													
Catchment FL01-N24													
Cost/Removal Analysis		BMP 16m - BioInfiltration Simple		BMP 19n - BioInfiltration Simple		Priority Shoreline 115, 116, 117		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.27	2%	0.32	2%	2.04	14%	0.7	5%	0.7	5%	4.0	28%
	TSS (lb/yr)	109	2%	105	2%	1,078	22%	313.0	6%	288.0	6%	1893.0	39%
	Volume (acre-feet/yr)	0.2	3%	0.2	3%	0.6	7%	0.0	0%	0.2	3%	1.3	15%
	Number of BMP's	1		1		11		1		4		18	
	BMP Size/Description	600	sf	600	sf	9,757	sf	0.805	curb miles	4,400	sf	All Practices	
	BMP Type	Simple BioInfiltration		Simple BioInfiltration		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$5,216.00		$5,302.00		$66,947.88		$347.66		$22,782.00		$100,595.54	
	Promotion & Admin Costs	$130		$130		$3,575		$400		$1,300		$5,535	
	Probable Project Cost	$5,346		$5,432		$70,523		$748		$24,082		$106,131	
	Annual O&M	$450		$450		$4,391		$0		$1,980		$7,271	
	10-yr Cost/lb-TP/yr	$3,620		$3,153		$5,612		$101		$6,453		$3,788	
	10-yr Cost/2,000lb-TSS/yr	$18,066		$18,918		$21,230		$478		$30,474		$17,833	

FL01-N24: Increased Street Sweeping

Rank #7/64

Drainage Area – 0.805 curb miles
Location – North Shore Trail (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.

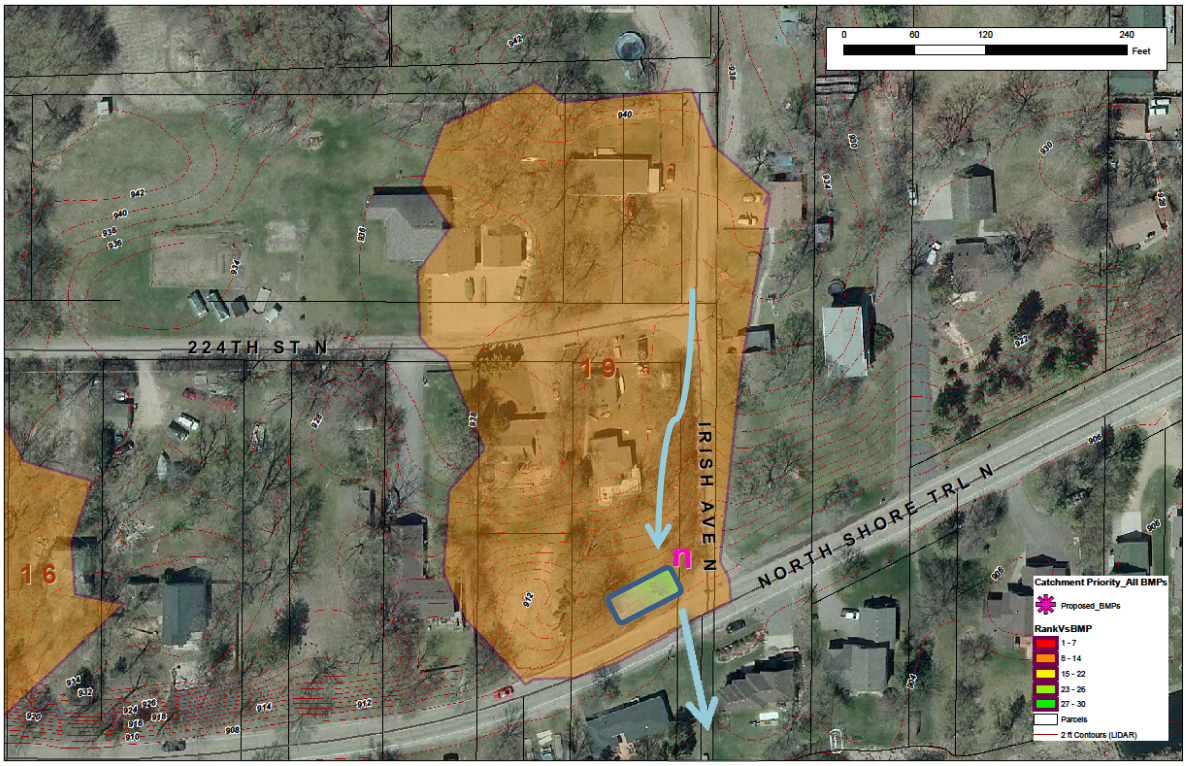


Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.7	5%
	TSS (lb/yr)	313.0	6%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.805	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$347.66	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$748	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$101	
	10-yr Cost/2,000lb-TSS/yr	$478	

FL01-N24: BMP 19n BioInfiltration Basin

Rank 26/64

Drainage Area – 2.658 acres (33% Impervious)
Location – Intersection of Inman Ave and North Shore Trail
Property Ownership – Private/Public, partially in Right of Way
Description – Convert existing mown turf depression at NW corner of intersection to Vegetated BioInfiltration Basin. Basin will act as a filter for gravel runoff from Inman Ave before sediment discharges to lake. Basin ponding area will be 600 sf, will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. The overflow will be the crown of the road (ponding may be deeper than proposed). Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin (sod), or just stop mowing the depression. The cost of $5,432 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates

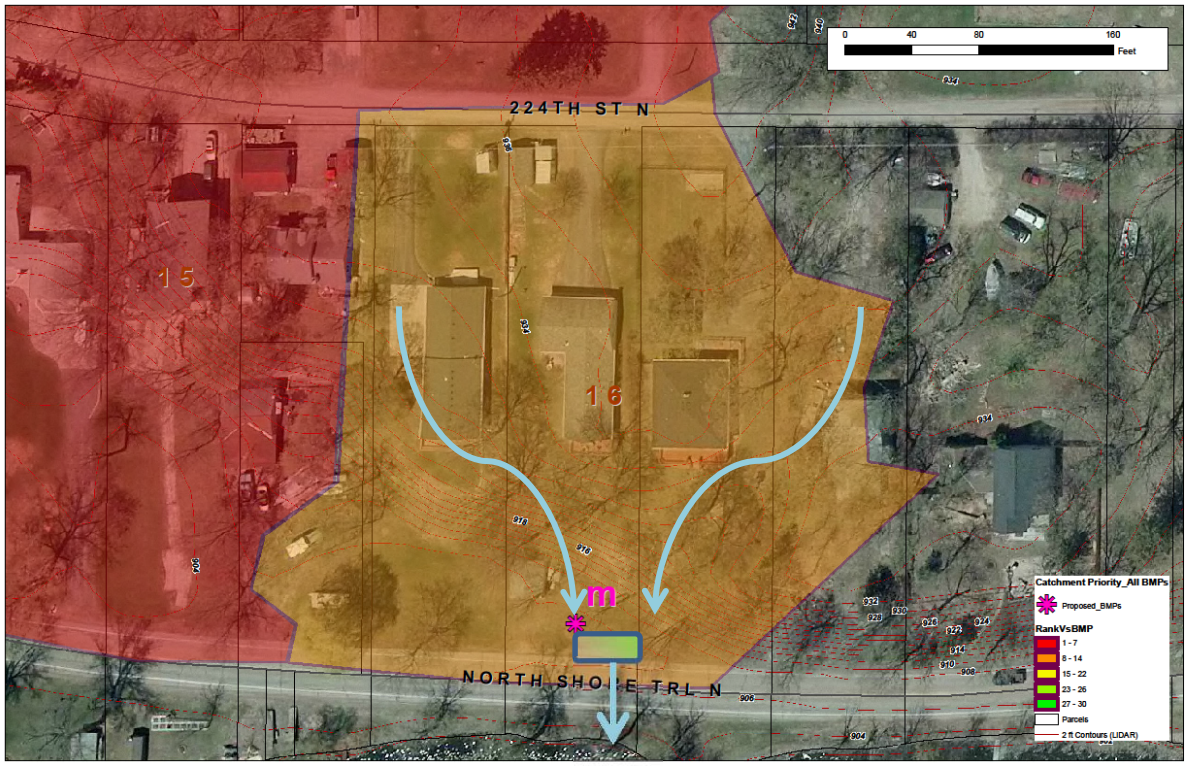


Cost/Removal Analysis		Project ID: BMP 19n - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.32	2%
	TSS (lb/yr)	105	2%
	Volume (acre-feet/yr)	0.2	3%
	Number of BMP's	1	
	BMP Size/Description	600	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$5,302.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$5,432	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$3,153	
	10-yr Cost/2,000lb-TSS/yr	$18,918	

FL01-N24: BMP 16m BioInfiltration Basin

Rank 30/64

Drainage Area – 2.327 acres (33% Impervious)
Location – Tip of Road Loop on North Shore Circle
Property Ownership – Private/Public, partially in Right of Way
Description – Convert existing mown turf depression at corner of residential driveway to Vegetated BioInfiltration Basin. Basin will act as a filter for runoff from yards and North Shore Trail before sediment discharges to lake. Basin ponding area will be 600 sf, will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. The overflow will be the crown of the road (ponding may be deeper than proposed). Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin (sod), or just stop mowing the depression. The cost of $5,346 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



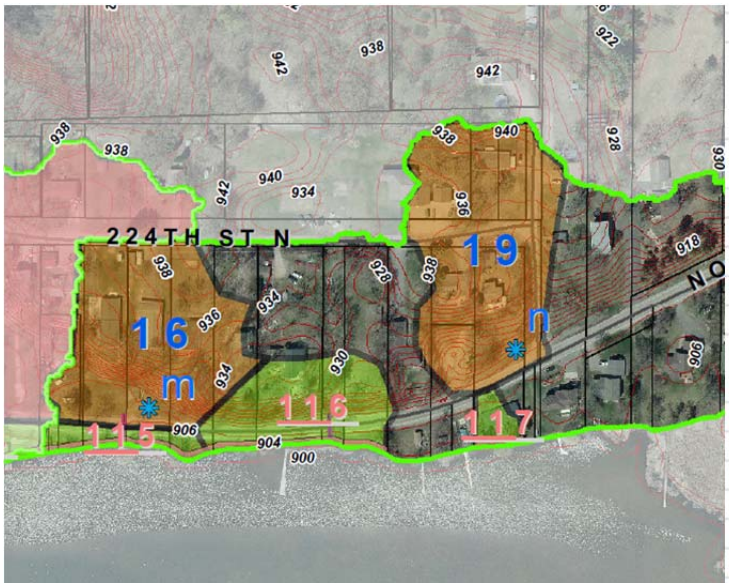
Cost/Removal Analysis		Project ID: BMP 16m - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.27	2%
	TSS (lb/yr)	109	2%
	Volume (acre-feet/yr)	0.2	3%
	Number of BMP's	1	
	BMP Size/Description	600 sf	
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$5,216.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$5,346	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$3,620	
	10-yr Cost/2,000lb-TSS/yr	$18,066	

FL01-N24 – Priority Shoreline Catchments 115, 116, 117

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **42/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **24/30**

Rank 42/64

Drainage Area – 1.585 acres
Location – 11 private residences
Property Ownership – Private
Description – All 11 parcels are all located on the shore side of North Shore Trail and have no homes built on this portion of the property except for Catchment 117. The shorelines in this catchment (except Shore Segments 71 and 72) were chosen for their close proximity to North Shore Trail and their potential to impact the road grade itself if the shorelines were to degrade. As such, these high traffic lots on limited footprints warrant special attention since there is not much room for a substantial buffer and would likely benefit from one in the near future. Shore Segments 71 and 72 (PSC 116 and 117) have localized pockets of soil loss that likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 5 yrs).



Cost/Removal Analysis		Project ID: Priority Shoreline 115, 116, 117	
		New trtmt	Net %
Treatment	TP (lb/yr)	2.04	14%
	TSS (lb/yr)	1,078	22%
	Volume (acre-feet/yr)	0.6	7%
	Number of BMP's	11	
	BMP Size/Description	9,757	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$66,947.88	
	Promotion & Admin Costs	$3,575	
	Probable Project Cost	$70,523	
	Annual O&M	$4,391	
	10-yr Cost/lb-TP/yr	$5,612	
	10-yr Cost/2,000lb-TSS/yr	$21,230	

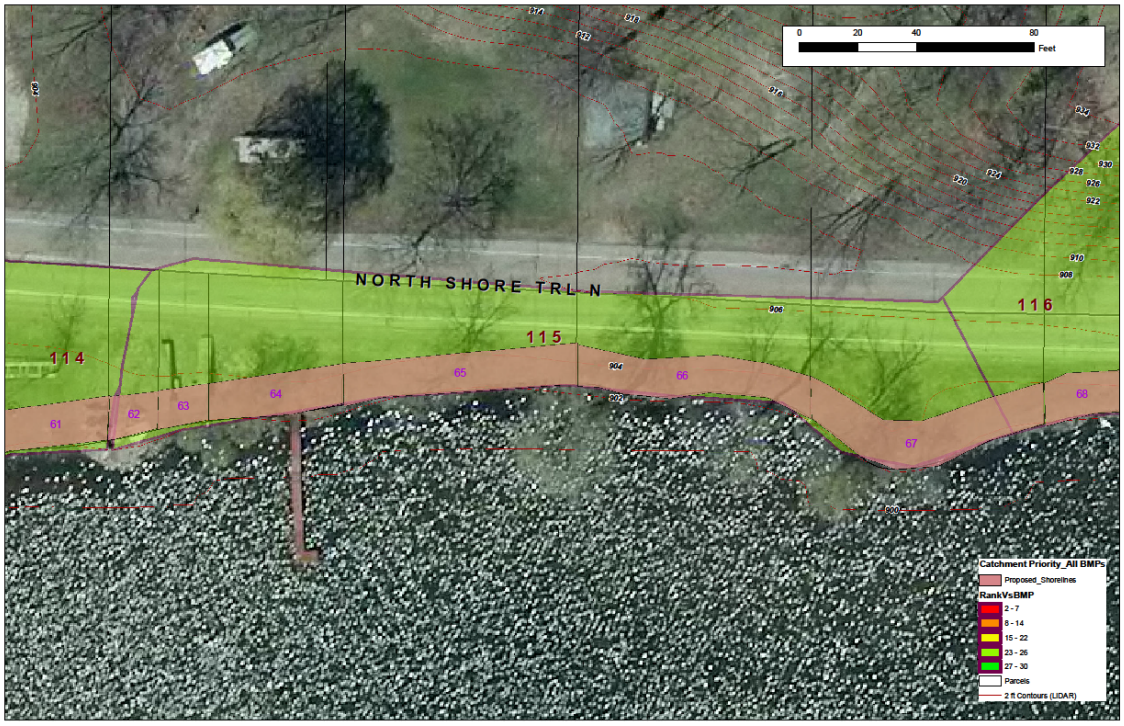
PRIORITY SHORELINE CATCHMENT 115, 116, 117										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
115	6	0.293	7312	278	0.66	0	0.000	7312	278	0.66
116	4	1.127	16217	281	0.68	100	0.050	16217	381	0.73
117	1	0.165	4077	239	0.56	180	0.090	4077	419	0.65
	TOTAL	1.585					TOTAL	27606	1078	2.039

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N24 – MAP of Priority Shoreline Catchment 115

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **42/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **24/30**

Drainage Area – 0.293 acres
Location – 6 private residences
Property Ownership – Private
Description – All 6 parcels are all located on the shore side of North Shore Trail and have no homes built on this portion of the property. The parcels in this catchment were chosen for their close proximity to North Shore Trail and their potential to impact the road grade itself if the shorelines were to degrade. As such, these high traffic lots on limited footprints warrant special attention since there is not much room for a substantial buffer and would likely benefit from one in the near future. Erosion losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 115, 116, 117										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
115	6	0.293	7312	278	0.66	0	0.000	7312	278	0.66
116	4	1.127	16217	281	0.68	100	0.050	16217	381	0.73
117	1	0.165	4077	239	0.56	180	0.090	4077	419	0.65
	TOTAL	1.585					TOTAL	27606	1078	2.039

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N24 – MAP of Priority Shoreline Catchment 116

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **42/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **24/30**

Drainage Area – 1.127 acres
Location – 4 private residences
Property Ownership – Private
Description – All 4 parcels are all located on the shore side of North Shore Trail and have no homes built on this portion of the property. The parcels in this catchment were chosen for their close proximity to North Shore Trail and their potential to impact the road grade itself if the shorelines were to degrade. As such, these high traffic lots on limited footprints warrant special attention since there is not much room for a substantial buffer and would likely benefit from one in the near future. Shore Segment 71 has smaller localized pockets of soil loss that likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 5 yrs).



PRIORITY SHORELINE CATCHMENT 115, 116, 117										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
115	6	0.293	7312	278	0.66	0	0.000	7312	278	0.66
116	4	1.127	16217	281	0.68	100	0.050	16217	381	0.73
117	1	0.165	4077	239	0.56	180	0.090	4077	419	0.65
	TOTAL	1.585					TOTAL	27606	1078	2.039

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N24 – MAP of Priority Shoreline Catchment 117

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **42/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **24/30**

Drainage Area – .0165 acres
Location – 1 private residence
Property Ownership – Private
Description –This Shore Segment 72 has localized pockets of soil loss on the western portion of the property that likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 5 yrs). Overall pollutant load for this parcel only will be 0.2 lbs.



PRIORITY SHORELINE CATCHMENT 115, 116, 117										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
115	6	0.293	7312	278	0.66	0	0.000	7312	278	0.66
116	4	1.127	16217	281	0.68	100	0.050	16217	381	0.73
117	1	0.165	4077	239	0.56	180	0.090	4077	419	0.65
	TOTAL	1.585					TOTAL	27606	1078	2.039

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N24 – Typical Shoreline Restorations

Rank 59/64

Drainage Area – 1.2 acres (0.30 acre average per property)
Location – any 4 Participating Shorelines within FL01-N24 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 50% of the FL01-N24 catchment drainage area is direct discharge from the entirety of each lakefront property. Moderate to heavy ice heaving is present on most properties. The ridges cause pooling and allow for some runoff control on the western properties. The general shoreline character of this catchment is 40% turf mown to edges, 40% turf to riprap, and 20% mix of weedy or native vegetation cover. Eastern-most parcels have the best opportunities for enhanced buffers. Soil losses due only to ice heave were not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 4 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.7	5%
	TSS (lb/yr)	288.0	6%
	Volume (acre-feet/yr)	0.2	3%
	Number of BMP's	4	
	BMP Size/Description	4,400	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$22,782.00	
	Promotion & Admin Costs	$1,300	
	Probable Project Cost	$24,082	
	Annual O&M	$1,980	
	10-yr Cost/lb-TP/yr	$6,453	
	10-yr Cost/2,000lb-TSS/yr	$30,474	

Catchment FL01-N25



Existing Catchment Summary	
Acres	14.36
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	4.60
TP (lb/yr)	8.79
TSS (lb/yr)	3,034

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	10.4	1.6	15%	8.8
	TSS (lb/yr)	3,478	444.0	13%	3,034
	Volume (acre-feet/yr)	4.8	0.2	5%	4.6
	BMP Type	Street Sweep 2x annually, 1 Shoreline			

CATCHMENT DESCRIPTION

FL01-N25 is a larger catchment that sits near the intersection of Jason Ave and North Shore Trail. There is a section of Jason Ave that drains through the lots to the lake, but otherwise there is not much road within the catchment. The southern half is partially-landlocked wet woods. The northern shorelines have moderate to heavy ice heave and it gets less severe moving southward. The southern tip consists of lots 60-90' in width; where shorelines appear to be protected by a mass of aquatic vegetation. Although heaving is prominent in the north, it appears relatively stable.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There is a cost-share shoreline restoration in the northern part of the catchment that accounts for a larger than average TP load reduction. There are no other documented or observed BMPs in the area.

RETROFIT RECOMMENDATIONS

RANK 13/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.
RANK 43/64 - Priority Shoreline Catchment 118: 3 properties for enhanced shoreline buffers
RANK 53/64 - Typical Shoreline Restorations: Up to 15 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N25*							
		Priority Shoreline 118		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.80	9%	0.5	5%	1.8	21%	3.1	35%
	TSS (lb/yr)	993	33%	200	7%	570.0	19%	1763	58%
	Volume (acre-feet/yr)	0.3	7%	0.0	0%	1.6	35%	1.9	42%
	Number of BMP's	3		1		15		19	
	BMP Size/Description	3,877	sf	0.272	curb miles	19,384	sf	All Practices	
	BMP Type	Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Shorelines	
Cost	Materials/Labor/Design	$26,728.68		$256.51		$99,650.95		$126,636.14	
	Promotion & Admin Costs	$975		$400		$4,875		$6,250	
	Probable Project Cost	**$27,704**		**$657**		**$104,526**		$132,886	
	Annual O&M	$1,745		$0		$8,723		$10,468	
	10-yr Cost/lb-TP/yr	**$5,623**		**$139**		**$10,565**		$5,442	
	10-yr Cost/2,000lb-TSS/yr	**$9,094**		**$657**		**$67,282**		$25,678	

FL01-N25: Increased Street Sweeping

Rank 13/64

Drainage Area – 0.272 curb miles
Location – Jason Ave (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.



Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.5	5%
	TSS (lb/yr)	200	7%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.272	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$256.51	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$657	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$139	
	10-yr Cost/2,000lb-TSS/yr	$657	

FL01-N25 – Priority Shoreline Catchment 118

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **43/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **25/30**

Rank 43/64

Drainage Area – 1.311 acres
Location – 3 private residences
Property Ownership – Private
Description – All 3 parcels are all located west of the intersection of Jason Ave and North Shore Trail. All three parcels have eroding sand beaches and are located in an area that experiences higher than average wave action and ice heaving events. Being that the beaches are sandy and showing short term losses, this catchment should be a priority for outreach and restoration. Shore Segments 73 and 74 show 12" lateral recession and 6" vertical loss over 50% of each property. Shore Segment 75 is showing 6" lateral recession and 6" vertical loss over 30% of the property. All shorelines have localized pockets of soil loss that likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 5 yrs).



Cost/Removal Analysis		Project ID: Priority Shoreline 118	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.80	9%
	TSS (lb/yr)	993	33%
	Volume (acre-feet/yr)	0.3	7%
	Number of BMP's	3	
	BMP Size/Description	3,877	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$26,728.68	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$27,704	
	Annual O&M	$1,745	
	10-yr Cost/lb-TP/yr	$5,623	
	10-yr Cost/2,000lb-TSS/yr	$9,094	

PRIORITY SHORELINE CATCHMENT 118 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
118	3	1.311	14174	113	0.36	880	0.440	14174	993	0.80
	TOTAL	1.311					TOTAL	14174	993	0.803

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N25 – Typical Shoreline Restorations

Rank 53/64

Drainage Area – 6.0 acres (0.40 acre average per property)
Location – any 15 Participating Shorelines within FL01-N25 (in addition to Priority Shorelines)
Property Ownership – Private
Description –About 90% of the FL01-N25 catchment drainage area is direct discharge from the entirety of each lakefront property. The general shoreline character of this catchment is 25% turf mown to edges or sandy beach, 60% riprap, 15% mix of weedy or native vegetation. The northern half of the catchment area suffers from moderate to severe ice heaving and wave action and would benefit from immediate targeted outreach to assist with shoreline stabilization and restoration methods. The southern half is 90% riprap and is more stable and less heaved in general. Soil losses due only to ice heavewere not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 15 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		Project ID: Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.8	21%
	TSS (lb/yr)	570.0	19%
	Volume (acre-feet/yr)	1.6	35%
	Number of BMP's	15	
	BMP Size/Description	19,384	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$99,650.95	
	Promotion & Admin Costs	$4,875	
	Probable Project Cost	$104,526	
	Annual O&M	$8,723	
	10-yr Cost/lb-TP/yr	$10,565	
	10-yr Cost/2,000lb-TSS/yr	$67,282	

Catchment FL01-N26



Existing Catchment Summary	
Acres	27.15
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	9.67
TP (lb/yr)	15.90
TSS (lb/yr)	5,559

	Existing Conditions	EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	18.2	2.3	13%	15.9
	TSS (lb/yr)	6,321	762.0	12%	5,559
	Volume (acre-feet/yr)	10.1	0.4	4%	9.7
	BMP Type	Street Sweep 2x annually, 3 shorelines			

CATCHMENT DESCRIPTION

FL01-N26 is a medium sized catchment situated on the peninsula that is adjacent to the outfall channel of Cranberry Lake. Jason Ave and Jeffrey Ave are the main roads, and small part of North Shore Trail drains into a wetland area. Shoreline frontages are larger throughout this stretch and homes are a mixture of sizes and proximities to the shore. Most shores are stable, but typical non-buffered conditions exist. There is an open channel of drainage flowing off the north half of Jason Ave and another open swale that discharges the southern-most portion of Jason Ave.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. There are 3 parcels with shoreline buffers that were cost-share projects. There are several small natural depressions throughout the catchment where ponding and settling of sediment may occur before discharging to the lake.

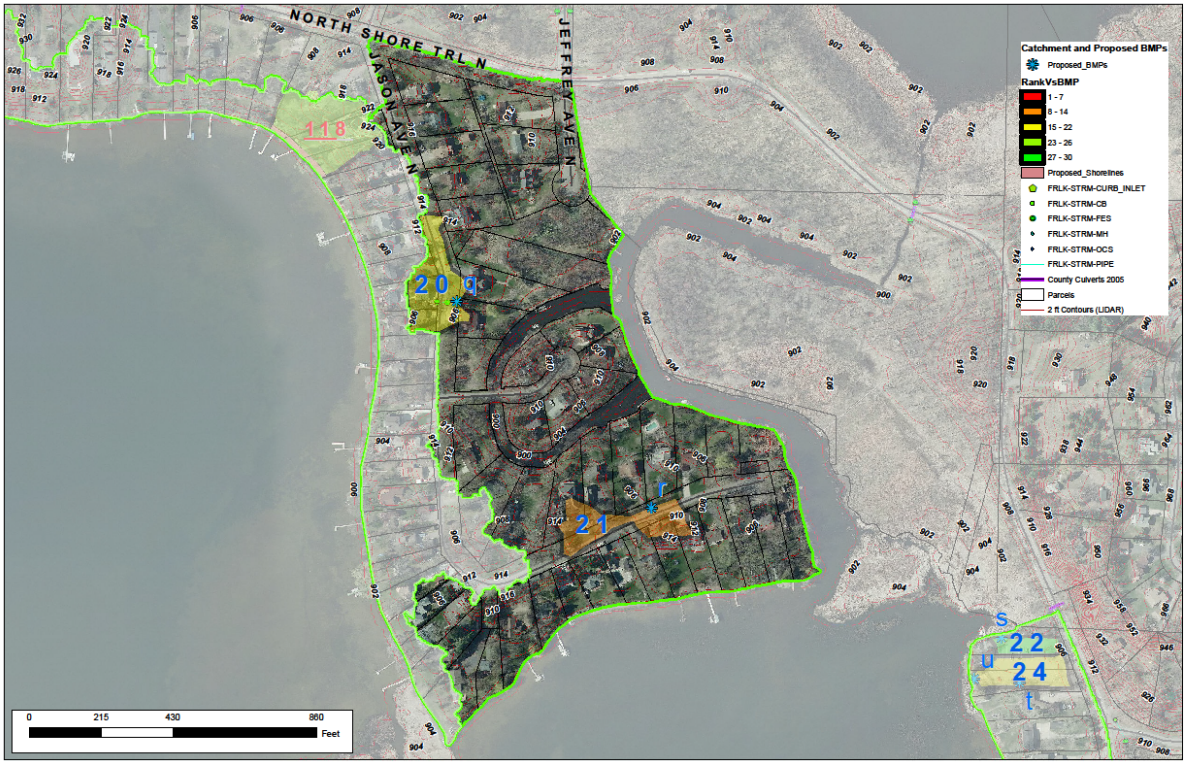
RETROFIT RECOMMENDATIONS

RANK 3/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 29/64 - BMP 21r BioInfiltration Basin: Convert an incised mown swale into an Infiltration Basin (using check dam) above an existing open channel swale. Basin area 250sf with 3" ponding.

RANK 32/64 - BMP 20q BioInfiltration Basin: Turning a mown depression into an Infiltration Basin near an swale, treating runoff prior to discharging to lake. Basin area 500sf with 3" ponding.

RANK 58/64 - Typical Shoreline Restorations: Up to 6 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N26*									
		BMP 20q - BioInfiltration Simple		BMP 21r- BioInfiltration Simple		Increased Street Sweeping to 4x per year		Shoreline Restorations- Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.17	1%	0.31	2%	0.8	5%	0.8	5%	2.1	13%
	TSS (lb/yr)	77.00	1%	137.00	2%	340.5	6%	330.0	6%	884.5	16%
	Volume (acre-feet/yr)	0.11	1%	0.18	2%	0.0	0%	0.3	3%	0.6	6%
	Number of BMP's	1		1		1		6		9	
	BMP Size/Description	250	sf	500	sf	0.819	curb miles	9,000	sf	All Practices	
	BMP Type	Simple BioInfiltration		Simple BioInfiltration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$4,351.36		$6,896.00		$350.05		$46,380.00		$57,977.41	
	Promotion & Admin Costs	$130		$130		$400		$1,950		$2,610	
	Probable Project Cost	$4,481		$7,026		$750		$48,330		$60,587	
	Annual O&M	$188		$375		$0		$4,050		$4,613	
	10-yr Cost/lb-TP/yr	$3,739		$3,454		$94		$11,388		$4,669	
	10-yr Cost/2,000lb-TSS/yr	$16,510		$15,731		$441		$53,836		$21,630	

FL01-N26: Increased Street Sweeping

Rank 3/64

Drainage Area – 0.819 curb miles
Location – All major roads in the catchment (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.

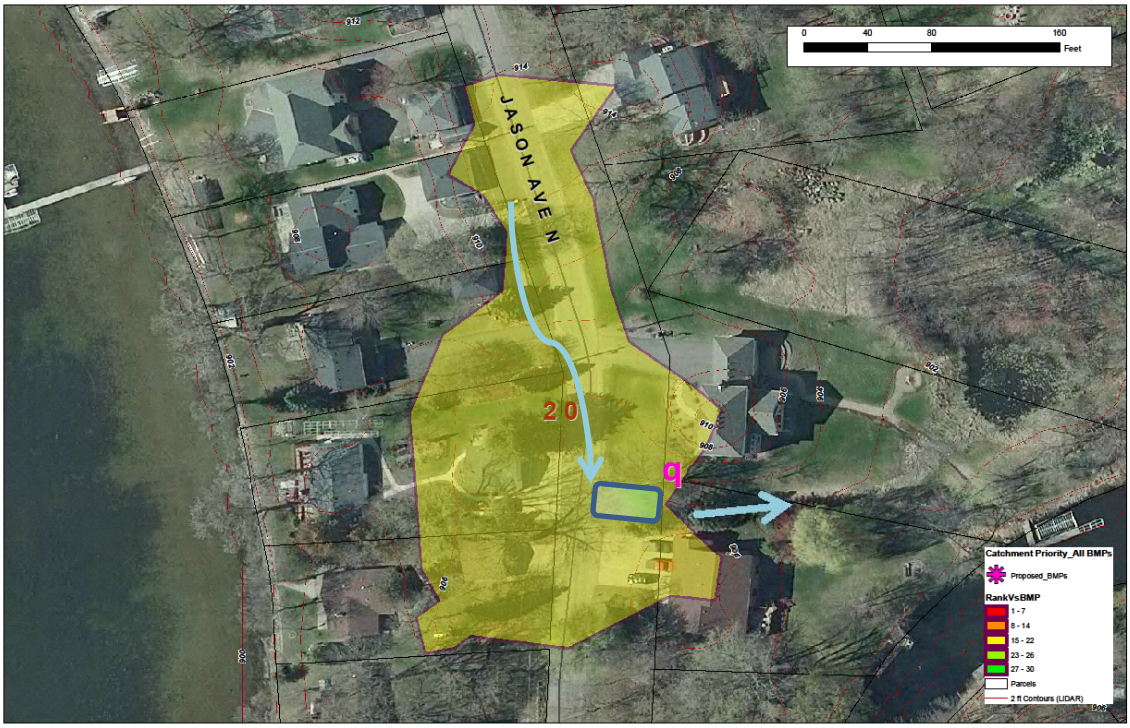


Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N26* Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.8	5%
	TSS (lb/yr)	340.5	6%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.819	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$350.05	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$750	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$94	
	10-yr Cost/2,000lb-TSS/yr	$441	

FL01-N26: BMP 20q BioInfiltration Basin

Rank 29/64

Drainage Area – 1.006 acres (33% Impervious)
Location – Tip of Road Loop on North Shore Circle
Property Ownership – Private/Public, partially in Right of Way
Description – Create a shallow BioInfiltration Basin above the existing open swale east of Jason Ave. Basin ponding area will be 250 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost). Incised channel will be regraded to 4:1 side slopes. The overflow will be a checkdam of riprap, discharging to existing channel. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $4,481 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***

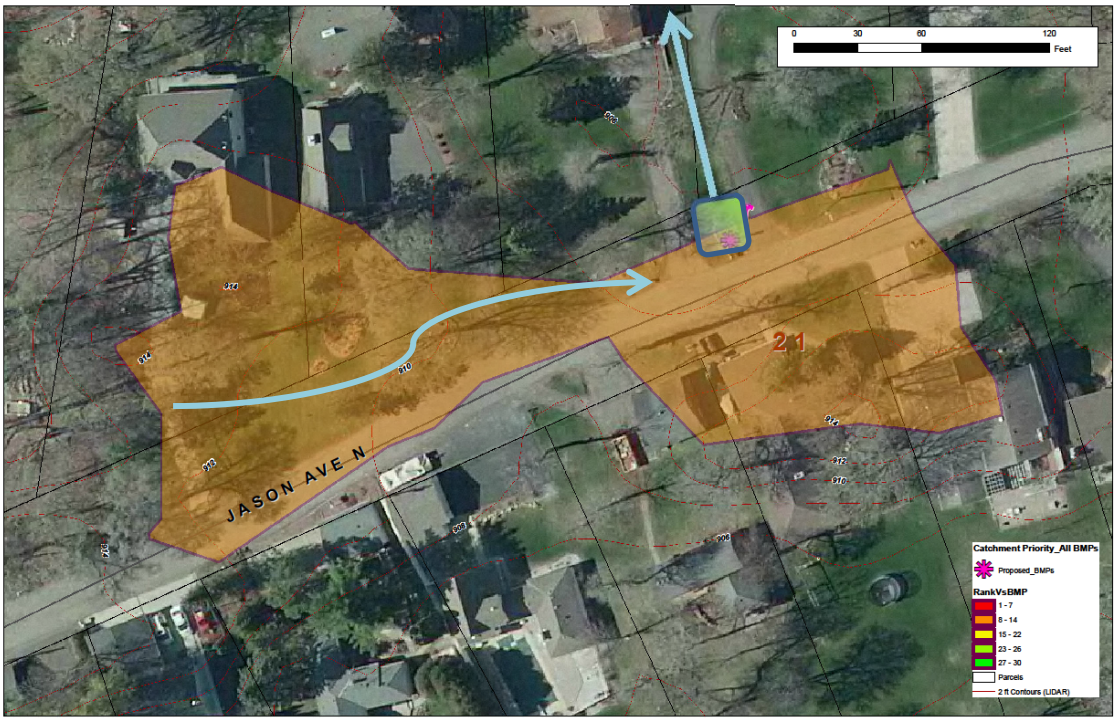


Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N26* BMP 20q - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.17	1%
	TSS (lb/yr)	77.00	1%
	Volume (acre-feet/yr)	0.11	1%
	Number of BMP's	1	
	BMP Size/Description	250	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$4,351.36	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$4,481	
	Annual O&M	$188	
	10-yr Cost/lb-TP/yr	$3,739	
	10-yr Cost/2,000lb-TSS/yr	$16,510	

FL01-N26: BMP 21r BioInfiltration Basin

Rank 32/64

Drainage Area – 0.909 acres (30% Impervious)
Location – South end of Jason Ave
Property Ownership – Private/Public, partially in Right of Way
Description – Create a shallow BioInfiltration Basin above the existing lawn swale north of Jason Ave (between two driveways). Basin ponding area will be 500 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost). The overflow to existing swale will be a berm that will likely have to be armored with riprap since it is a flow-through basin. There is currently no pretreatment in this design. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $7,026 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N26 BMP 21r- BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.31	2%
	TSS (lb/yr)	137.00	2%
	Volume (acre-feet/yr)	0.18	2%
	Number of BMP's	1	
	BMP Size/Description	500	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$6,896.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$7,026	
	Annual O&M	$375	
	10-yr Cost/lb-TP/yr	$3,454	
	10-yr Cost/2,000lb-TSS/yr	$15,731	

FL01-N26 – Typical Shoreline Restorations

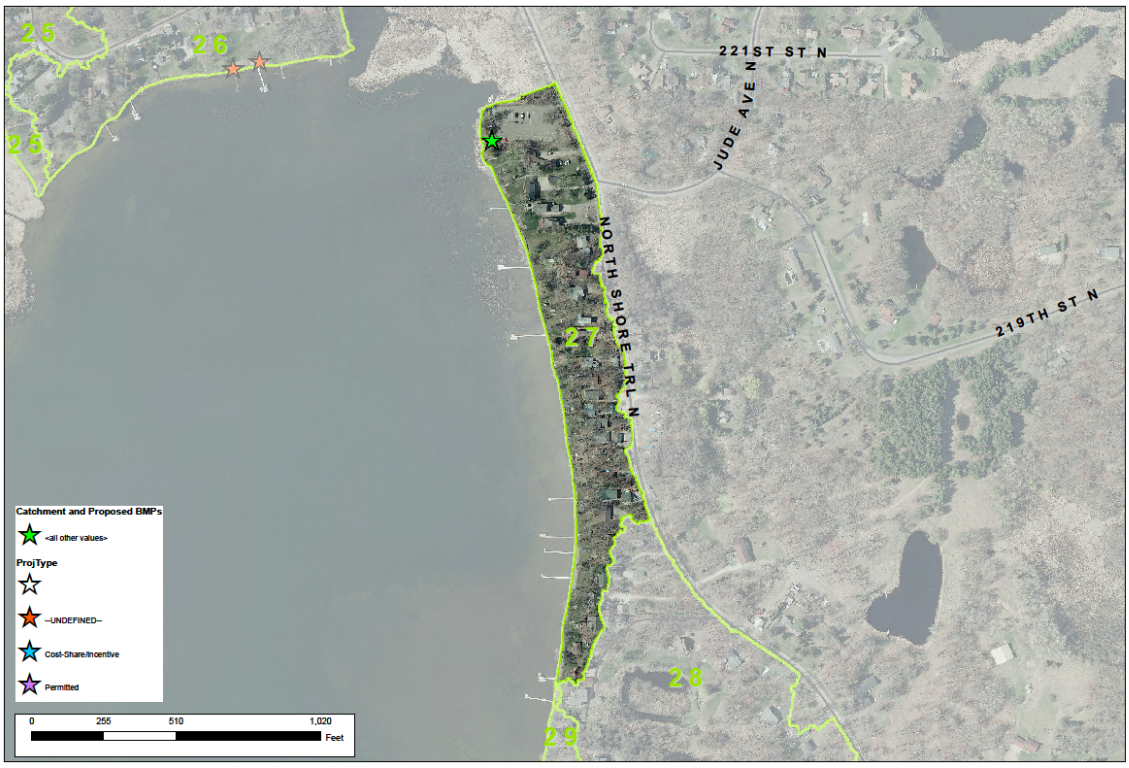
Rank 58/64

Drainage Area – 2.4 acres (0.40 acre average per property)
Location – any 6 Participating Shorelines within FL01-N26
Property Ownership – Private
Description –About 50% of the FL01-N26 shorelines are protected since they are located on a channel off of the lake front. Most lots in the channel are stable but are still mown to the edge of the lake. The lakeside shoreline character of this catchment is 20% turf mown to edges, 70% turf to riprap, and 10% mix of weedy or native vegetation. The southern, lakeside parcels have better opportunities and more space for enhanced buffers. Soil losses due only to ice heavewere not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 6 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		RETROFIT OPTIONS	
		Catchment FL01-N26	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.8	5%
	TSS (lb/yr)	330.0	6%
	Volume (acre-feet/yr)	0.3	3%
	Number of BMP's	6	
	BMP Size/Description	9,000	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$46,380.00	
	Promotion & Admin Costs	$1,950	
	Probable Project Cost	**$48,330**	
	Annual O&M	$4,050	
	10-yr Cost/lb-TP/yr	**$11,388**	
	10-yr Cost/2,000lb-TSS/yr	**$53,836**	

Catchment FL01-N27



Existing Catchment Summary	
Acres	10.82
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	3.91
TP (lb/yr)	7.05
TSS (lb/yr)	2,425

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	7.9	0.8	11%	**7.1**
	TSS (lb/yr)	2,833	408.0	14%	**2,425**
	Volume (acre-feet/yr)	4.2	0.3	7%	**3.9**
	BMP Type	Street Sweep 2x annually, 1 swale to BioInfiltration Basin			

CATCHMENT DESCRIPTION

FL01-N27 is a medium sized catchment situated south of a DNR Public Water Access. It is primarily densely packed ¼ acre to ½ acre residential lots. 100% of this catchment drains through a lakefront lot and overflows into the lake. 50% of lots have riprap or sand beaches, while the other 40% is mown lawn to the edge and 10% vegetated buffer. There are many properties with very steep slopes and minor to moderate stretches of eroded shore. Many properties in this catchment would be great shoreline restoration candidates.

EXISTING STORMWATER TREATMENT

Street sweeping of city streets occurs approximately twice annually. The DNR PWA has a long swale that flows into a BioInfiltration Basin. The overflow weir to this basin has short-circuited and the swale inlets are clogged with grass and sediment buildup. Both of these BMPs are great retrofit candidates. There were no other existing BMPs found within the catchment.

RETROFIT RECOMMENDATIONS

RANK 12/64 - Increased Street Sweeping: Increase Street Sweeping from 2x/year to 4x/year.

RANK 31/64 - Priority Shoreline Catchment 119, 120, 121, 122, 134: 22 properties for enhanced shoreline buffers

RANK 33/64 - BMP 24u BioInfiltration Basin and Swale Modifications: At DNR PWA, repair shore-circuited weir on raingarden and repair swale inlets to accept water again.

RANK 40/64 - Typical Shoreline Restorations: Up to 3 non-priority shorelines with 15' wide enhanced shoreline buffers.

RANK 62/64 - BMP 22s Ponded Swale: Narrow Ponded Swale retrofit on north side of DNR PWA.



RETROFIT OPTIONS													
Catchment FL01-N27													
Cost/Removal Analysis		BMP 22s - Swale with Ponding		BMP 24u - Swale Inlet and Raingarden Outfall Modification		Priority Shoreline 119, 120,121,122,134		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.03	0%	0.07	1%	7.03	100%	0.5	7%	0.6	9%	8.2	117%
	TSS (lb/yr)	31	1%	46	2%	6,914	285%	124.8	5%	240.0	10%	7355.8	303%
	Volume (acre-feet/yr)	0.1	1%	0.1	1%	2.0	51%	0.0	0%	0.3	7%	2.4	60%
	Number of BMP's	1		1		22		1		3		28	
	BMP Size/Description	200	sf	2	Mods	22,172	sf	0.334	curb miles	3,024	sf	All Practices	
	BMP Type	Water Quality Swale6		Pond Retrofits		Priority Lakeshore Restoration		Street Sweeping		Lakeshore Restoration		Sweeping, BioInfiltration, and Shores	
Cost	Materials/Labor/Design	$3,234.00		$2,490.00		$151,866.48		$267.11		$15,723.12		$173,580.71	
	Promotion & Admin Costs	$130		$130		$7,150		$400		$975		$8,785	
	Probable Project Cost	$3,364		$2,620		$159,016		$667		$16,698		$182,366	
	Annual O&M	$150		$0		$9,977		$0		$1,361		$11,488	
	10-yr Cost/lb-TP/yr	$16,213		$3,743		$3,683		$135		$5,051		$5,765	
	10-yr Cost/2,000lb-TSS/yr	$31,381		$11,392		$7,486		$1,069		$25,255		$15,317	

FL01-N27: Increased Street Sweeping

Rank 12/64

Drainage Area – 0.334 curb miles
Location – North Shore Trail (as highlighted in Orange)
Property Ownership – Public
Description – It is assumed that most major roads in Forest Lake are swept 2x yearly (Spring and Fall). This cost/benefit analysis factors in existing equipment and staffing and proposes increasing the sweeping regime to 4x yearly. This will typically result in about a 50% increase in TP/TSS removal rates over the current twice-yearly regime. This load reduction assumes the cleanings are equally spread throughout the season between the first Spring cleaning and the final Fall cleaning.



Cost/Removal Analysis		Project ID: Increased Street Sweeping to 4x per year	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.5	7%
	TSS (lb/yr)	124.8	5%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	0.334	curb miles
	BMP Type	Street Sweeping	
Cost	Materials/Labor/Design	$267.11	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$667	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$135	
	10-yr Cost/2,000lb-TSS/yr	$1,069	

FL01-N27 – Priority Shoreline Catchments 119-122 + 134

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **31/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **14/30**



Drainage Area – 6.47 acres
Location – 22 private residences
Property Ownership – Private
Description – All 22 parcels are all located on the eastern shore of Lake 3. The majority of parcels are located on steep slopes and have minimal buffers. Erosive intensity is highest in Priority Shoreline Catchments 121 and 122. The general makeup of the shoreline is 50% riprap, 40% lawn mown to the shore, and 10% weedy or native vegetative buffer. Much of the soil losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



Cost/Removal Analysis		Project ID: Priority Shoreline 119, 120,121,122,134	
		New trtmt	Net %
Treatment	TP (lb/yr)	7.03	100%
	TSS (lb/yr)	6,914	285%
	Volume (acre-feet/yr)	2.0	51%
	Number of BMP's	22	
	BMP Size/Description	22,172	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$151,866.48	
	Promotion & Admin Costs	$7,150	
	Probable Project Cost	$159,016	
	Annual O&M	$9,977	
	10-yr Cost/lb-TP/yr	$3,683	
	10-yr Cost/2,000lb-TSS/yr	$7,486	

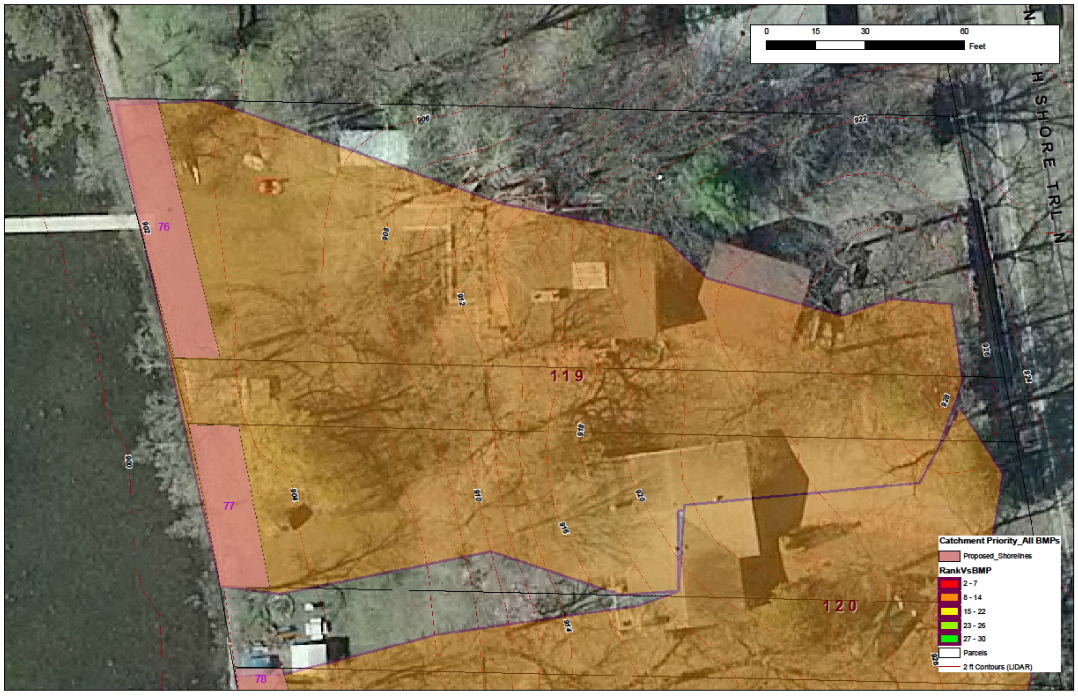
PRIORITY SHORELINE CATCHMENT 119 to 122, and 134										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
119	2	0.55	7207	56	0.16	640	0.320	7207	696	0.48
120	9	2.919	36630	789	1.92	540	0.270	36630	1329	2.19
121	4	1.499	19357	760	1.83	1700	0.850	19357	2460	2.68
122	4	0.826	14864	101	0.31	2080	1.040	14864	2181	1.35
134	3	0.676	8988	68	0.23	180	0.090	8988	248	0.32
	TOTAL	6.47					TOTAL	87046	6914	7.026

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N27 – MAP of Priority Shoreline Catchment 119

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **31/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **14/30**

Drainage Area – 0.55 acres
Location – 2 private residences
Property Ownership – Private
Description –These two parcels show slightly more erosion than the next catchment (PSC 120) and lack any vegetative buffer. Shore Segment 76 shows 12" lateral recession and 12" vertical loss. Shore Segment 77 is showing 6" lateral recession and 12" vertical loss over most of the property. Much of the soil losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 119 to 122, and 134										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
119	2	0.55	7207	56	0.16	640	0.320	7207	696	0.48
120	9	2.919	36630	789	1.92	540	0.270	36630	1329	2.19
121	4	1.499	19357	760	1.83	1700	0.850	19357	2460	2.68
122	4	0.826	14864	101	0.31	2080	1.040	14864	2181	1.35
134	3	0.676	8988	68	0.23	180	0.090	8988	248	0.32
	TOTAL	6.47					TOTAL	87046	6914	7.026

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N27 – MAP of Priority Shoreline Catchment 120

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **31/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **14/30**

Drainage Area – 2.919 acres
Location – 9 private residences
Property Ownership – Private
Description – All 9 parcels are located on steep slopes and have minimal buffers. All parcels were chosen together as a group because they all exhibited equal amounts of minor erosion but also all have very steep slopes leading up to the shore edge. All Shore Segments average 3" lateral recession and 6" vertical loss. Some of the soil losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



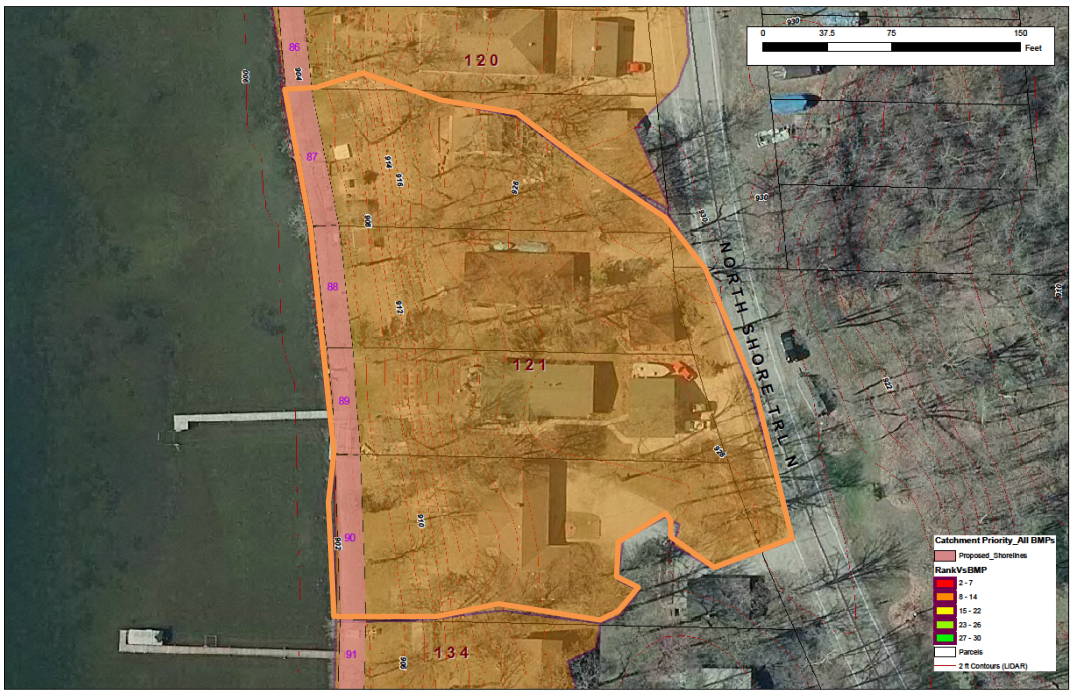
PRIORITY SHORELINE CATCHMENT 119 to 122, and 134										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
119	2	0.55	7207	56	0.16	640	0.320	7207	696	0.48
120	9	2.919	36630	789	1.92	540	0.270	36630	1329	2.19
121	4	1.499	19357	760	1.83	1700	0.850	19357	2460	2.68
122	4	0.826	14864	101	0.31	2080	1.040	14864	2181	1.35
134	3	0.676	8988	68	0.23	180	0.090	8988	248	0.32
	TOTAL	6.47					TOTAL	87046	6914	7.026

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N27 – MAP of Priority Shoreline Catchment 121

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **31/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **14/30**

Drainage Area – 1.499 acres
Location – 4 private residences
Property Ownership – Private
Description – All 4 parcels are located on steep slopes and have minimal buffers. All Shore Segments were chosen together as a group because they all exhibited equal amounts of moderate erosion also all have very steep slopes leading up to the shore edge. ***If ranked independently of the rest of FL01-N27, they would likely rank higher in the cost/benefit analysis.*** All Shore Segments average 12" lateral recession and 12" vertical loss over the majority of each shoreline. Some of the soil losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



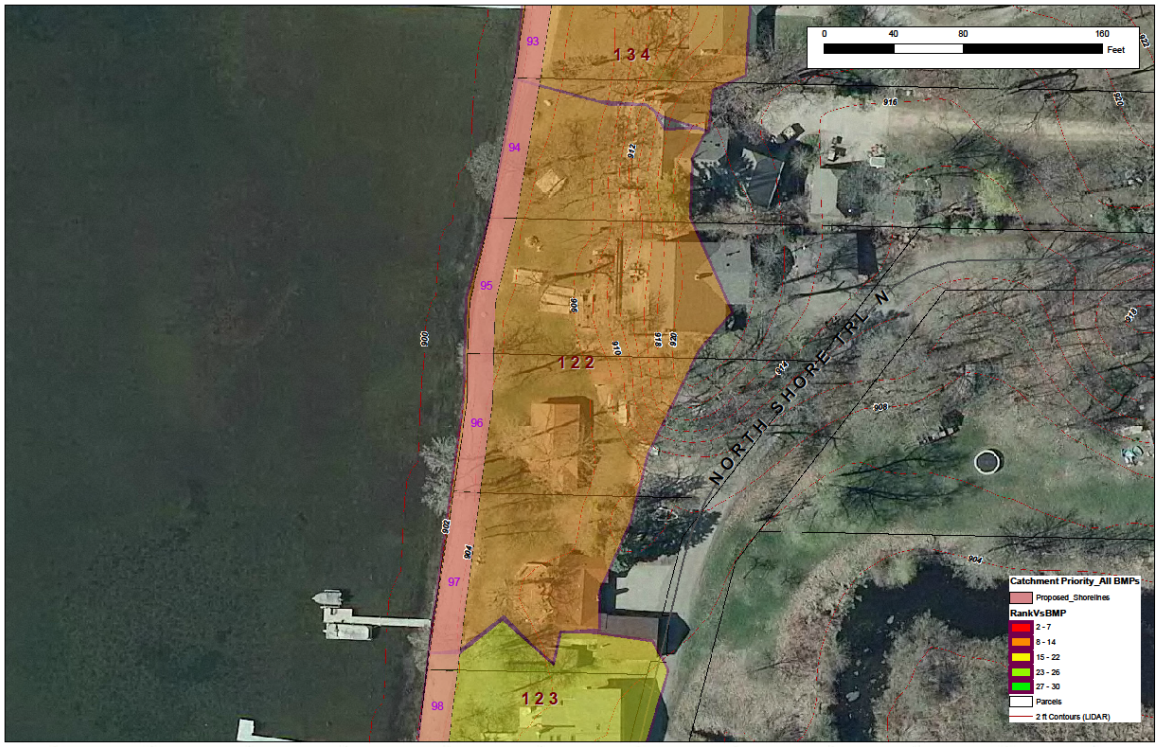
PRIORITY SHORELINE CATCHMENT 119 to 122, and 134										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
119	2	0.55	7207	56	0.16	640	0.320	7207	696	0.48
120	9	2.919	36630	789	1.92	540	0.270	36630	1329	2.19
121	4	1.499	19357	760	1.83	1700	0.850	19357	2460	2.68
122	4	0.826	14864	101	0.31	2080	1.040	14864	2181	1.35
134	3	0.676	8988	68	0.23	180	0.090	8988	248	0.32
	TOTAL	6.47					TOTAL	87046	6914	7.026

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N27 – MAP of Priority Shoreline Catchment 122

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **31/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **14/30**

Drainage Area – 0.826 acres
Location – 4 private residences
Property Ownership – Private
Description – All 4 parcels are located on moderate slopes and have minimal buffers. All Shore Segments were chosen together as a group because they all exhibited equal amounts of moderate erosion. ***If ranked independently of the rest of FL01-N27, they would likely rank higher in the cost/benefit analysis.*** All Shore Segments average 12" lateral recession and 12" vertical loss over the majority of each shoreline. Some of the soil losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



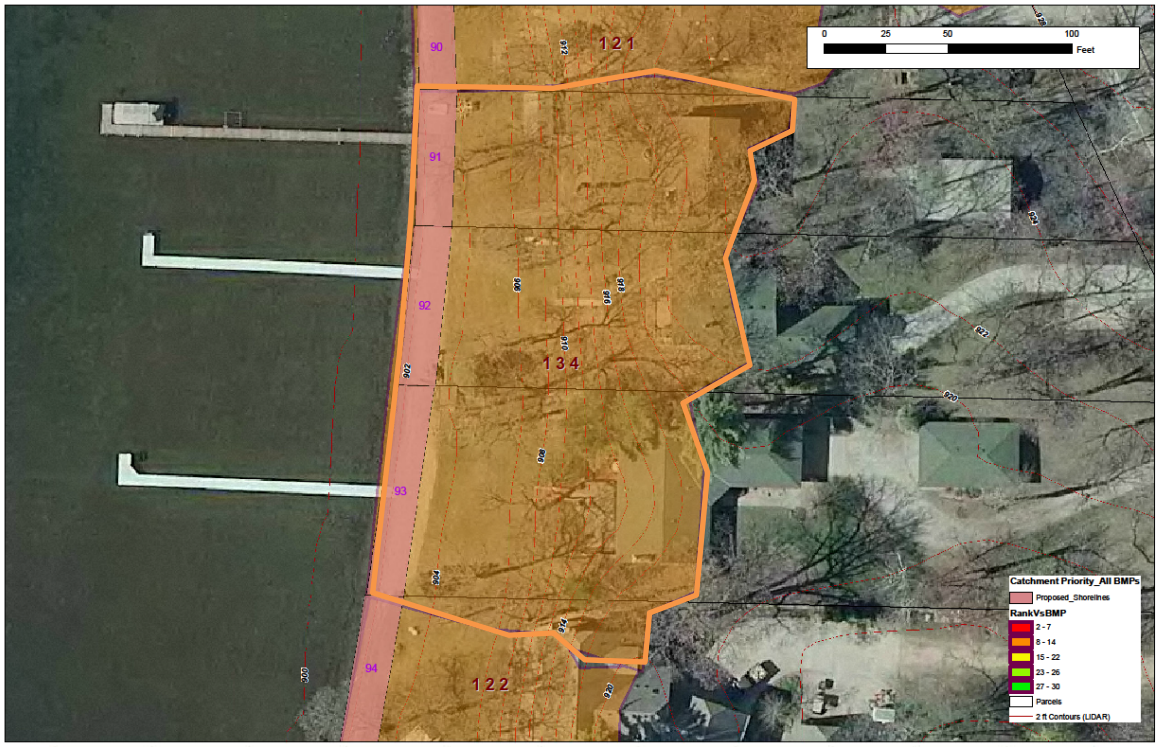
PRIORITY SHORELINE CATCHMENT 119 to 122, and 134										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
119	2	0.55	7207	56	0.16	640	0.320	7207	696	0.48
120	9	2.919	36630	789	1.92	540	0.270	36630	1329	2.19
121	4	1.499	19357	760	1.83	1700	0.850	19357	2460	2.68
122	4	0.826	14864	101	0.31	2080	1.040	14864	2181	1.35
134	3	0.676	8988	68	0.23	180	0.090	8988	248	0.32
	TOTAL	6.47					TOTAL	87046	6914	7.026

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N27 – MAP of Priority Shoreline Catchment 134

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **31/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **14/30**

Drainage Area – 0.676 acres
Location – 3 private residences
Property Ownership – Private
Description – All 3 parcels are located on moderate slopes and have minimal buffers. All Shore Segments were chosen together as a group because they all exhibited equal amounts of minor erosion also all have sandy beaches. All Shore Segments average 6" lateral recession and 3" vertical loss over the majority of each shoreline. Some of the soil losses likely occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 119 to 122, and 134										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	#lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
119	2	0.55	7207	56	0.16	640	0.320	7207	696	0.48
120	9	2.919	36630	789	1.92	540	0.270	36630	1329	2.19
121	4	1.499	19357	760	1.83	1700	0.850	19357	2460	2.68
122	4	0.826	14864	101	0.31	2080	1.040	14864	2181	1.35
134	3	0.676	8988	68	0.23	180	0.090	8988	248	0.32
	TOTAL	6.47					TOTAL	87046	6914	7.026

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N27: BMP 24u Basin and Swale Modifications

Rank 33/64

Drainage Area – 0.943 acres (85% Impervious)
Location – DNR Public Water Access parking lot
Property Ownership –Public (DNR)
Description – Clean out inlets to swale on south side of lot. Replace sod strips that were removed. This will allow swale to receive water again. Fix wood weir at outfall of raingarden at west end of lot. Currently short-circuits and could hold more water for treatment if repaired. Other ideas beyond this concept could include an expanded footprint for the raingarden or swale. The cost of $2,620 has been intentionally overestimated since it is not known if the footings for the weir will have to be replaced or not. The cost could be substantially lower if repairing the weir only required backfilling of soil and minor replacement of the top wood panels. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 24u - Swale Inlet and Raingarden Outfall Modification	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.07	1%
	TSS (lb/yr)	46	2%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	1	
	BMP Size/Description	2	Mods
	BMP Type	Raingarden Retrofits	
Cost	Materials/Labor/Design	$2,490.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$2,620	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$3,743	
	10-yr Cost/2,000lb-TSS/yr	$11,392	

FL01-N27 – Typical Shoreline Restorations

Rank 40/64

Drainage Area – 0.9 acres (0.30 acre average per property)
Location – any 3 Participating Shorelines within FL01-N27 (in addition to Priority Shorelines)
Property Ownership – Private
Description – Not many shorelines were excluded from the Priority designation in this catchment. The northern-most parcels have the best opportunities for enhanced buffers and rank higher than most other Typical shorelines in this analysis due to the steep slopes and similar characteristics to the rest of the catchment. Soil losses due only to ice heavewere not factored into the modelling for Typical Shoreline Restorations.

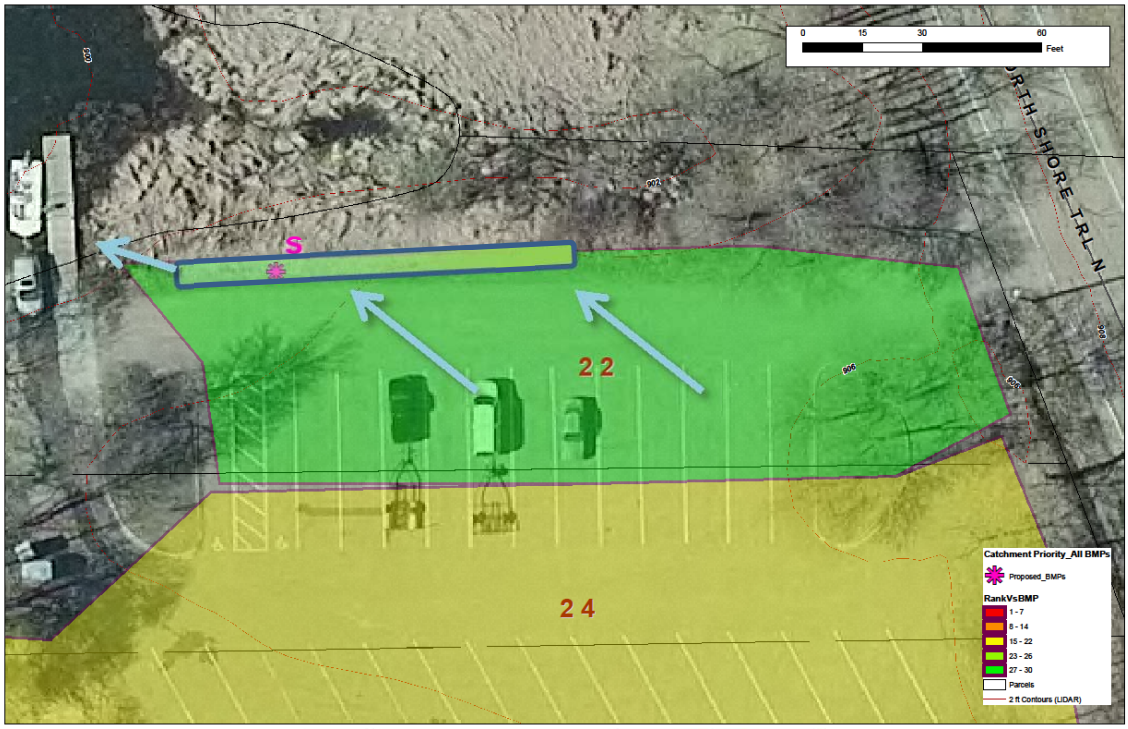
Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 3 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Removal Analysis		Project ID: Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.6	9%
	TSS (lb/yr)	240.0	10%
	Volume (acre-feet/yr)	0.3	7%
	Number of BMP's	3	
	BMP Size/Description	3,024	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$15,723.12	
	Promotion & Admin Costs	$975	
	Probable Project Cost	$16,698	
	Annual O&M	$1,361	
	10-yr Cost/lb-TP/yr	$5,051	
	10-yr Cost/2,000lb-TSS/yr	$25,255	

FL01-N27: BMP 22s Swale with Ponding

Rank 62/64

Drainage Area – 0.259 acres (33% Impervious)
Location – DNR Public Water Access, north side of lot
Property Ownership – Public (DNR)
Description – Convert existing lawn strip along north edge of lot to a shallow swale that can pond up to 3" of stormwater runoff and boat drainage. Swale ponding area will be 200 sf (4'x50'), will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. The overflow will be a riprap checkdam at the end of the swale before it discharges directly to the lake. Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin (sod), or installing a more robust pretreatment device in lieu of an excavated basin. The cost of $3,364 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



Cost/Removal Analysis		Project ID: BMP 22s - Swale with Ponding	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.03	0%
	TSS (lb/yr)	31	1%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	1	
	BMP Size/Description	200	sf
	BMP Type	Water Quality Swale	
Cost	Materials/Labor/Design	$3,234.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$3,364	
	Annual O&M	$150	
	10-yr Cost/lb-TP/yr	$16,213	
	10-yr Cost/2,000lb-TSS/yr	$31,381	

Catchment FL01-N29



Existing Catchment Summary	
Acres	18.10
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	7.56
TP (lb/yr)	11.73
TSS (lb/yr)	4,279

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	13.4	1.7	13%	**11.7**
	TSS (lb/yr)	5,012	733.0	15%	**4,279**
	Volume (acre-feet/yr)	7.6	0.1	1%	**7.6**
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

FL01-N29 is a smaller sized catchment situated at the end of Juniper Ave N. It is primarily wooded lots ½ acre to ¾ acre in size. 100% of this catchment drains through a lakefront lot and overflows into the lake. 30% of lots have riprap or sand beaches, while the other 50% is mown lawn to the edge and 20% weedy or native vegetative buffer. There are a few properties with very steep slopes and minor to moderate stretches of eroded shore. Many properties in this catchment would be great shoreline restoration candidates.

EXISTING STORMWATER TREATMENT

There is no street sweeping known to occur on the few small segments of roadway in this catchment. There are no known documented or observed BMPs either.

RETROFIT RECOMMENDATIONS

RANK 38/64 - Priority Shoreline Catchment 123 to 133: 12 properties for enhanced shoreline buffers

RANK 50/64 - Typical Shoreline Restorations: Up to 1 non-priority shorelines with 15' wide enhanced shoreline buffers.

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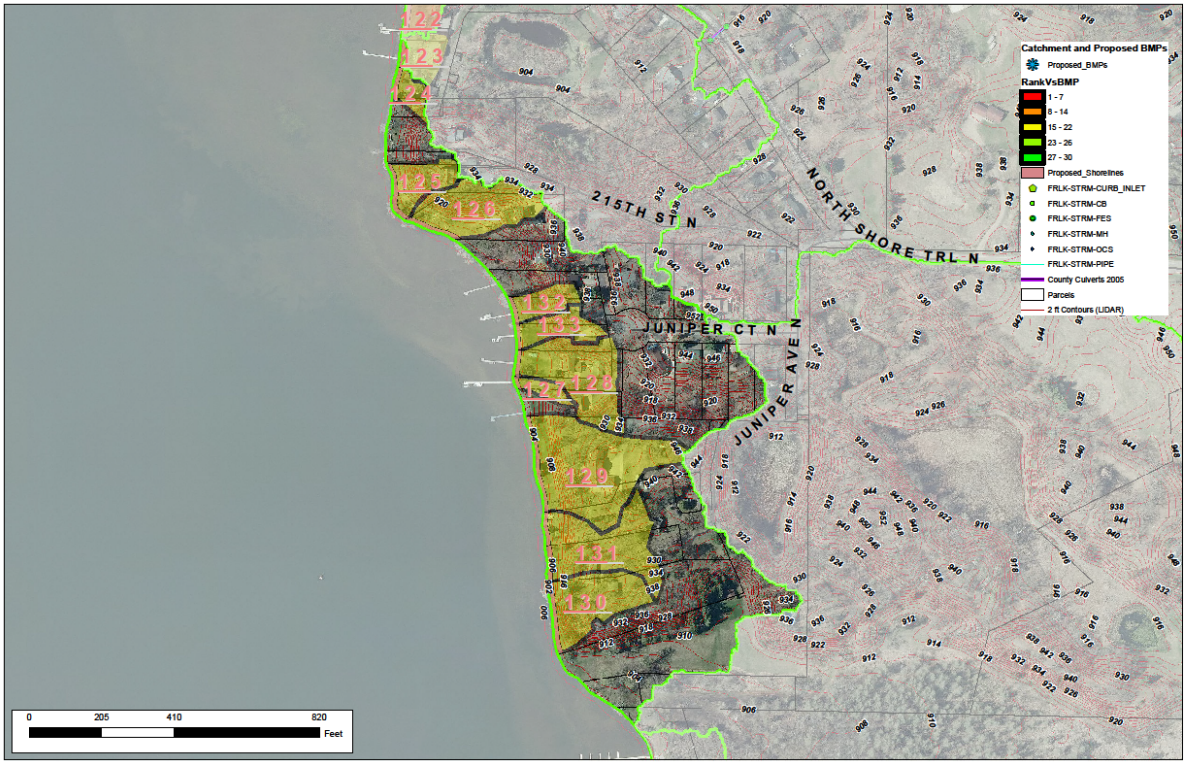


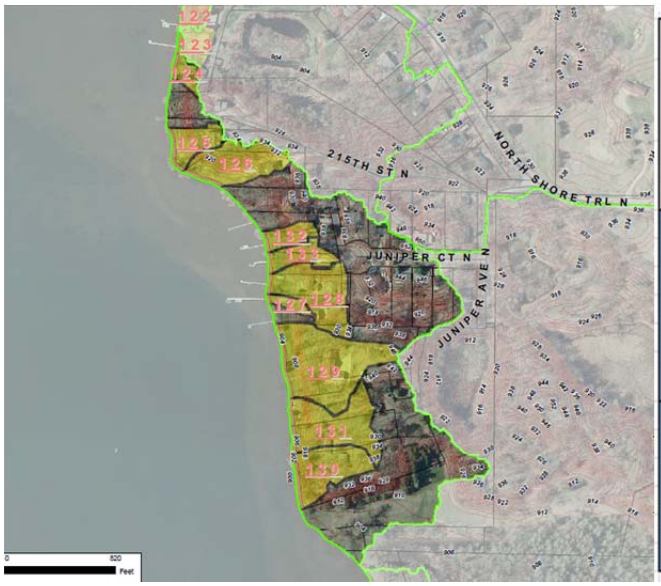
Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N29*					
		Priority Shoreline 123 to 133		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	5.13	44%	0.2	2%	5.3	45%
	TSS (lb/yr)	6,106	143%	60.0	1%	6166	144%
	Volume (acre-feet/yr)	1.8	23%	0.1	1%	2	25%
	Number of BMP's	12		1		13	
	BMP Size/Description	21,432	sf	1,786	sf	All Practices	
	BMP Type	Priority Lakeshore Restoration		Lakeshore Restoration		Shorelines	
Cost	Materials/Labor/Design	$146,804.88		$9,372.18		$156,177.06	
	Promotion & Admin Costs	$3,900		$325		$4,225	
	Probable Project Cost	$150,705		$9,697		$160,402	
	Annual O&M	$9,644		$804		$10,448	
	10-yr Cost/lb-TP/yr	$4,822		$9,852		$7,337	
	10-yr Cost/2,000lb-TSS/yr	$8,095		$59,114		$33,605	

FL01-N29 – Priority Shoreline Catchments 123 to 133

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**



Drainage Area – 8.437 acres
Location – 12 private residences
Property Ownership – Private
Description – All 12 parcels are all located on the eastern shore of Lake 3. The majority of parcels are located on steep slopes and have minimal buffers. Erosive intensity is highest in Priority Shoreline Catchments 124, 125, 128, 132, and 133 all have moderate to severe erosion. There is also a property-wide sheet piling wall on PSC 129 that may need some stabilization (but was unclear through field investigation) The general makeup of the shoreline is 50% riprap, 40% lawn mown to the shore, and 10% weedy or native vegetative buffer.



Cost/Removal Analysis		Project ID: Priority Shoreline 123 to 133	
		New trtmt	Net %
Treatment	TP (lb/yr)	5.13	44%
	TSS (lb/yr)	6,106	143%
	Volume (acre-feet/yr)	1.8	23%
	Number of BMP's	12	
	BMP Size/Description	21,432	sf
	BMP Type	Priority Lakeshore Restoration	
Cost	Materials/Labor/Design	$146,804.88	
	Promotion & Admin Costs	$3,900	
	Probable Project Cost	$150,705	
	Annual O&M	$9,644	
	10-yr Cost/lb-TP/yr	$4,822	
	10-yr Cost/2,000lb-TSS/yr	$8,095	

PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 123

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.371 acres
Location – 1 private residence
Property Ownership – Private
Description –This parcel has some patches of vegetation and steep slopes. Shore Segment 98 exhibits minor erosion with 6" lateral recession and 6" vertical loss. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



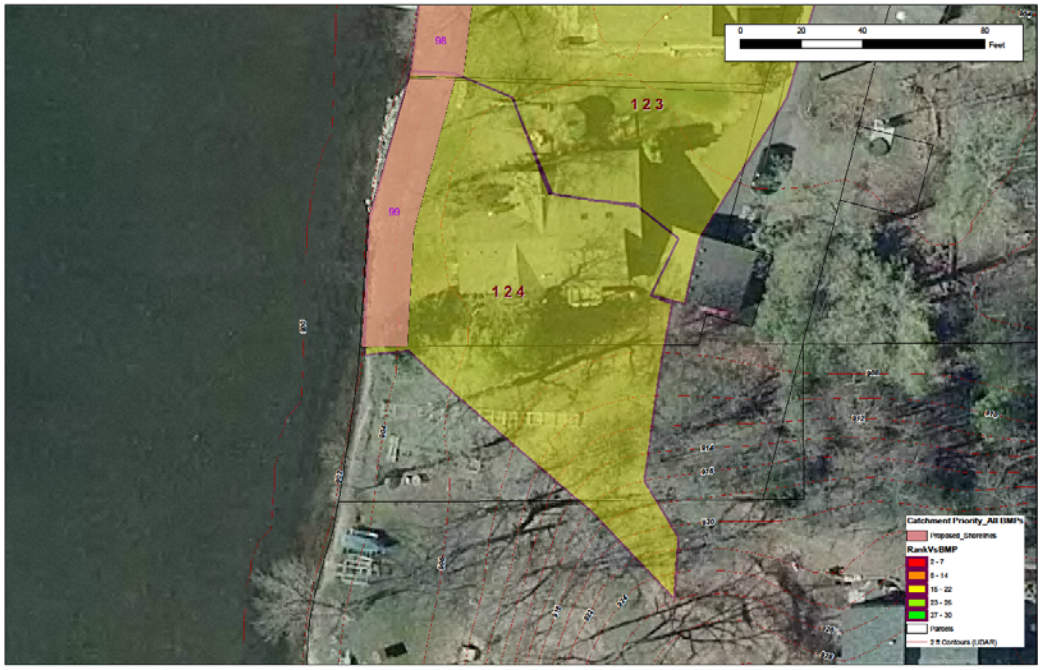
PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 124

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.221 acres
Location – 1 private residence
Property Ownership – Private
Description –This parcel has some patches of vegetation and steep slopes on a relatively small catchment. Shore Segment 99 exhibits moderate erosion with 12" lateral recession and 12" vertical loss over a 60' stretch of shore. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 125

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.484 acres
Location – 1 private residence
Property Ownership – Private
Description –This parcel has some patches of vegetation and steep slopes on a relatively large catchment. Shore Segment 100 exhibits moderate erosion with undercutting occurring in isolated sections, averaging 12" lateral recession and 12" vertical loss over a 60' stretch of shore. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



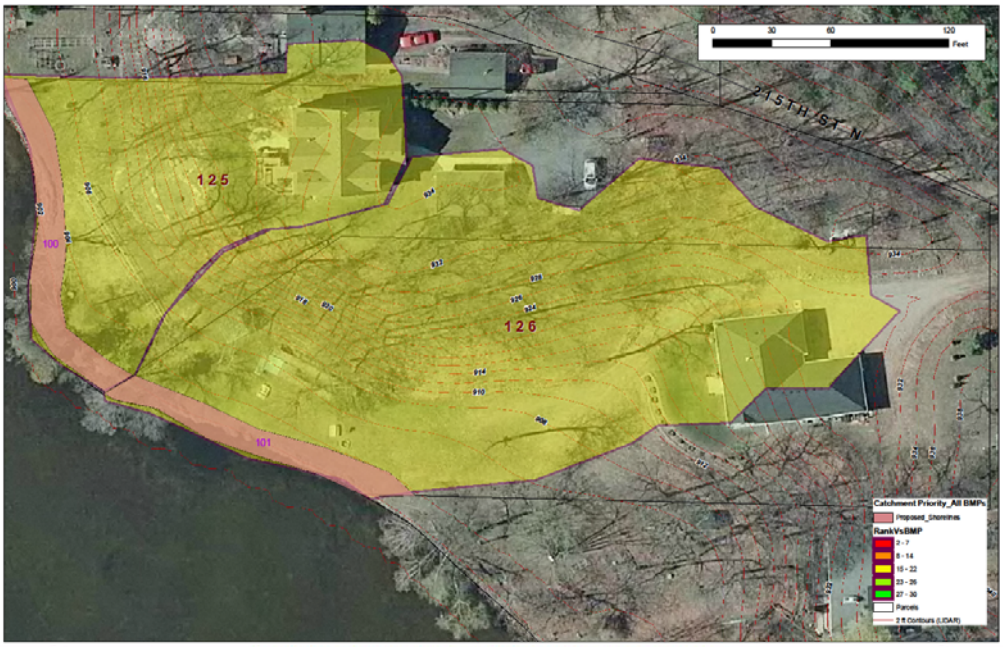
PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 126

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 1.047 acres
Location – 1 private residence
Property Ownership – Private
Description –This parcel has wooded steep slopes on a relatively large catchment and then gradually levels out to a very large mown shoreline. Shore Segment 101 exhibits minor erosion in isolated sections, averaging 6" lateral recession and 3" vertical loss over a 60' stretch of shore. The benefit from this restoration would come from the large area that could be dedicated to volume control (1" ponding over 1,000sf is a significant storage area). Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



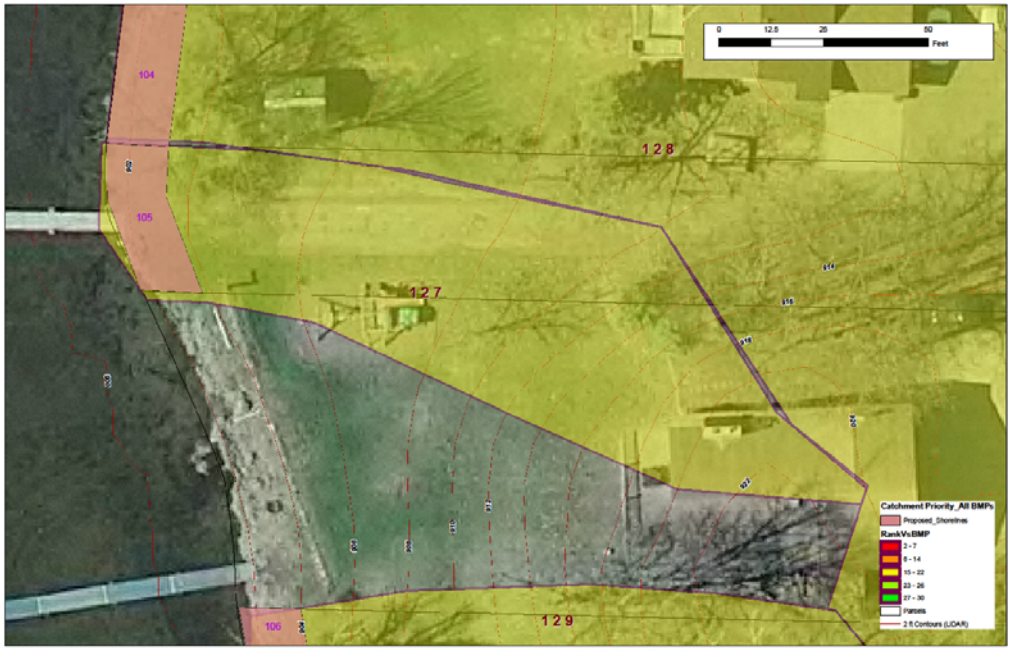
PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 127

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.172 acres
Location – 1 private parcel at end of Juniper Ct N
Property Ownership – Private (Juniper Hills Lake Association)
Description –This parcel is a narrow strip of private access at the end of Juniper Ct N owned by an HOA. Shore Segment 105 exhibits very minor erosion with 3" lateral recession and 3" vertical loss. This restoration would likely be combined with PSC129. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 128

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 1.157 acres
Location – 1 private residence
Property Ownership – Private
Description –This catchment is fairly large with a mix of steep wooded slopes, large amounts of impervious surface, and a large lawn area draining directly to the lake. This Shore Segment is a great candidate for restoration as it could be a 0.72 lb TP load reduction with an enhanced buffer restoration. Shore Segment 104 exhibits moderate erosion with 12" lateral recession and 12" vertical loss in the form of rills and small gullies in localized areas. This is likely due to the large amount of runoff flowing between the homes and from the private access drive. Some of the soil losses likely have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 6 yrs).



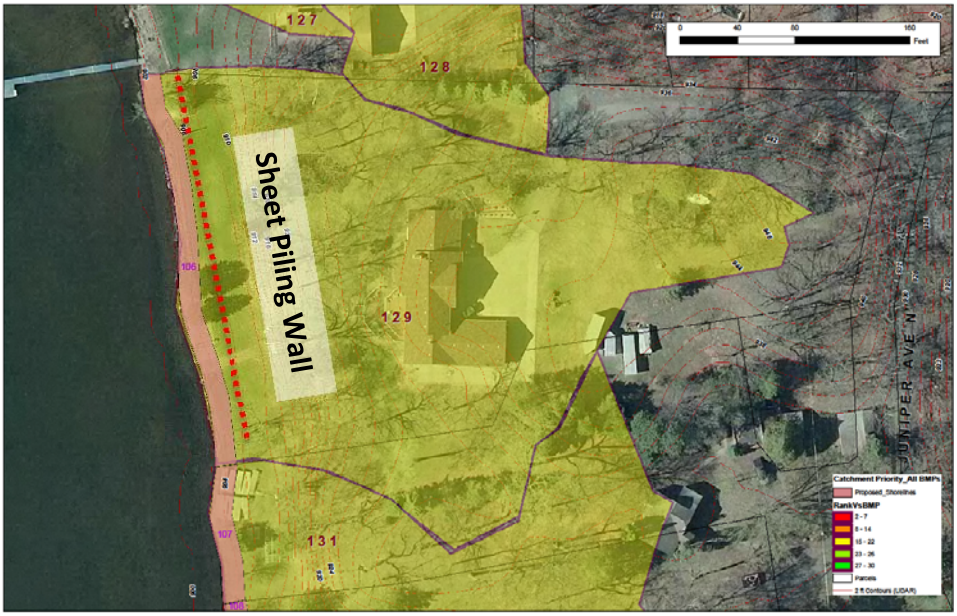
PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
128	1	1.157	7734	120	0.29	860	0.430	7734	980	0.72
129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 129

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 1.986 acres
Location – 1 private residence
Property Ownership – Private
Description –This catchment is fairly large with a mix of steep wooded slopes, large amounts of impervious surface, and a large lawn area draining directly to the lake. There is also a contiguous wall made of metal sheet piling for the length of the property. It is unclear when it was installed, for what reason, and how stable it is currently. Nevertheless, a vegetative buffer behind the wall (or in lieu of the wall) would be a good way to protect the wall or the remaining slope. This Shore Segment is a great candidate for restoration as it could be a 0.60 lb/yr TP load reduction with an enhanced buffer restoration (based mostly on catchment size alone). A conservative estimate of 3" lateral recession and 3" vertical loss was modelled since erosion conditions could not be precisely verified in the field. Some of the soil losses likely have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
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125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
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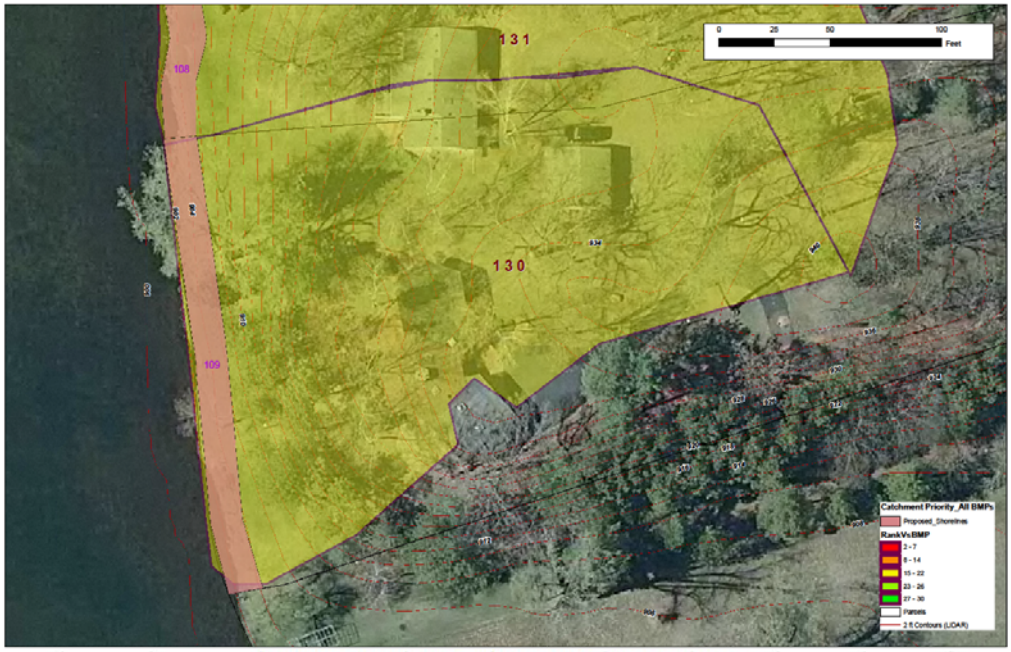
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

FL01-N29 – MAP of Priority Shoreline Catchment 130

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.957 acres
Location – 1 private residence
Property Ownership – Private
Description –This large catchment has steep slopes and some patches of trees and on mostly mown turf. Shore Segment 109 exhibits minor erosion with 3" lateral recession and 3" vertical loss. The combination of large shoreline size and large catchment size make this buffer beneficial. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
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124	1	0.221	2905	23	0.08	520	0.260	2905	543	0.34
125	1	0.484	7394	54	0.17	520	0.260	7394	574	0.43
126	1	1.047	7698	101	0.32	60	0.030	7698	161	0.35
127	1	0.172	2183	22	0.06	20	0.010	2183	42	0.07
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129	1	1.986	16056	174	0.54	120	0.060	16056	294	0.60
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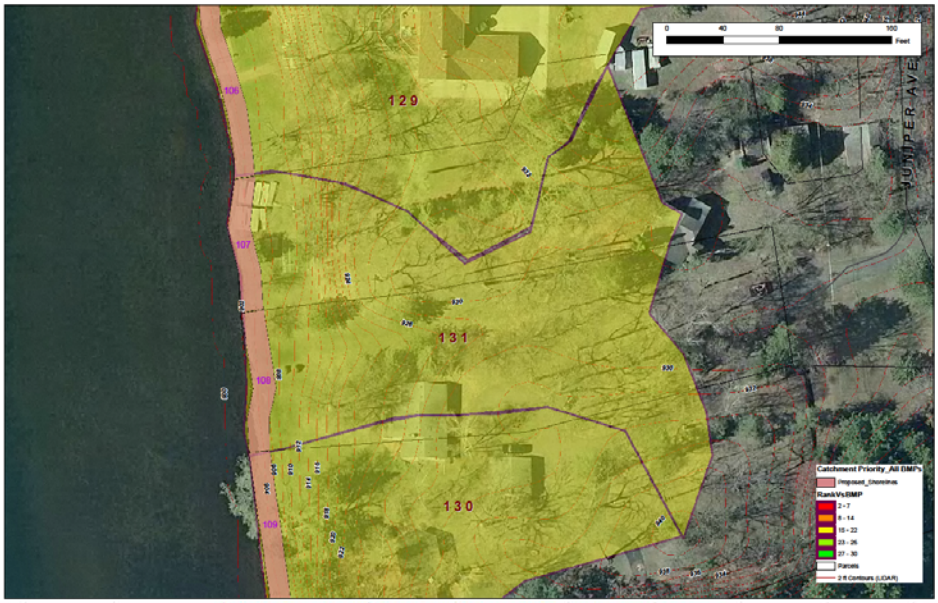
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 131

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 1.271 acres
Location – 2 private residences
Property Ownership – Private
Description –These parcels have steep slopes and a long natural swale draining the catchment. Parcel 107 exhibits moderate erosion with 12" lateral recession and 6" vertical loss. Parcel 108 exhibits minor to moderate erosion with 6" lateral recession and 6" vertical loss. Both parcels show erosion in 40' patches. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
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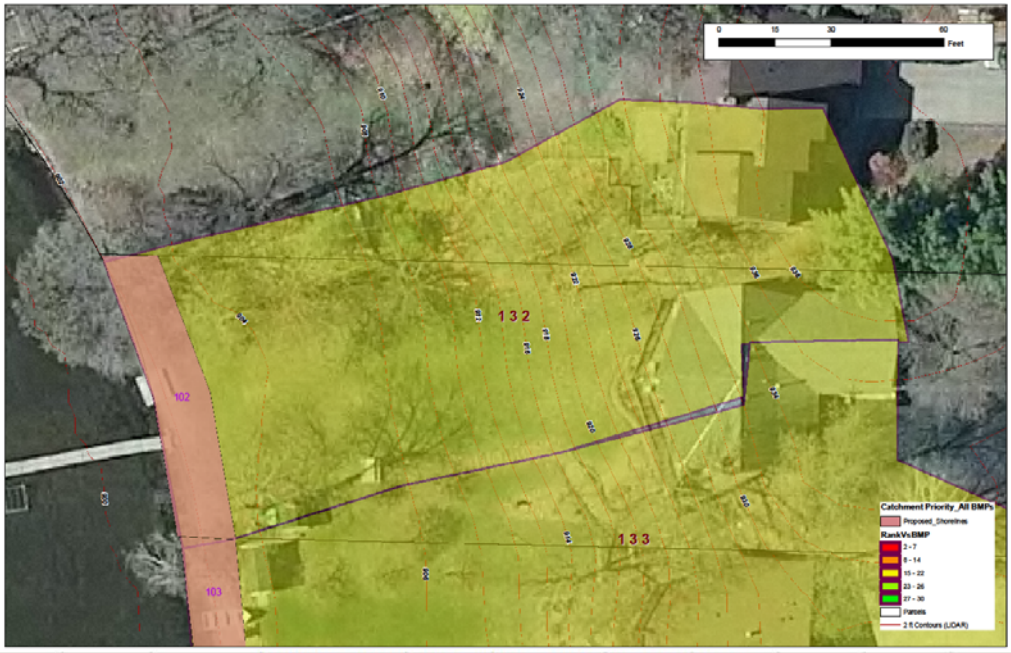
130	1	0.957	11041	98	0.30	60	0.030	11041	158	0.33
131	2	1.271	5646	82	0.36	260	0.130	5646	342	0.49
132	1	0.35	4116	30	0.10	520	0.260	4116	550	0.36
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 132

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.35 acres
Location – 1 private residence
Property Ownership – Private
Description – This parcel has steep partially wooded slopes dropping down to a shallow sloped mown lawn. Parcel 102 exhibits moderate erosion with 12" lateral recession and 12" vertical loss. Some of the soil losses may have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 10 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
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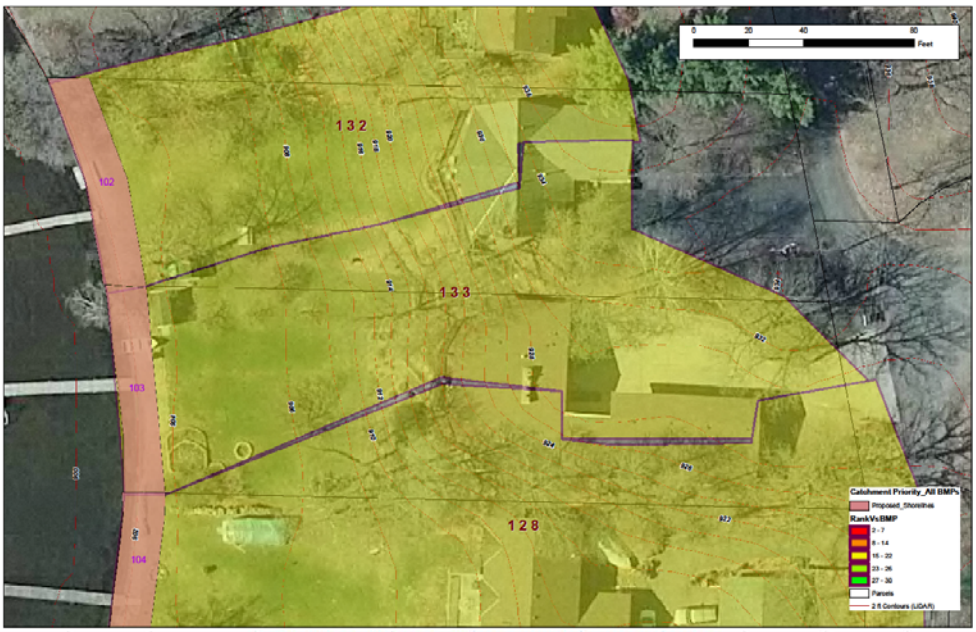
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

FL01-N29 – MAP of Priority Shoreline Catchment 133

Overall Rank (incl. Street Sweeping and Typ. Shorelines): **38/64**
BMP Only Rank (Priority Shorelines and Non-Shoreline BMPs *only*): **21/30**

Drainage Area – 0.421 acres
Location – 1 private residence
Property Ownership – Private
Description – This parcel should be a very high priority since it appears that a large portion of the sand beach has been lost over a very short period of time and would greatly benefit from a shoreline buffer or stabilization practice. ***Shore Segment 103 would qualify as the single largest amount of soil loss observed in the analysis area.*** This parcel has a steep mown lawn flowing directly over a sand beach front. Shore Segment 103 exhibits major erosion losses with 36" to 48" of lateral recession and 6" vertical loss. Some of the soil losses appear to have occurred over a shorter duration than the typical assumption of 10 years, but actual duration of losses cannot be determined without consultation with landowner (modelled at 5 yrs).



PRIORITY SHORELINE CATCHMENT 123 to 133 - SUMMARY										
			WinSLAMM Reductions			BWSR Erosion		TOTAL LOAD REDUCTION		
SubCatch ID	# lots	Subcatch Area (acres)	WQV	TSS	TP	TSS	TP	WQV	TSS	TP
123	1	0.371	6324	53	0.13	120	0.060	6324	173	0.19
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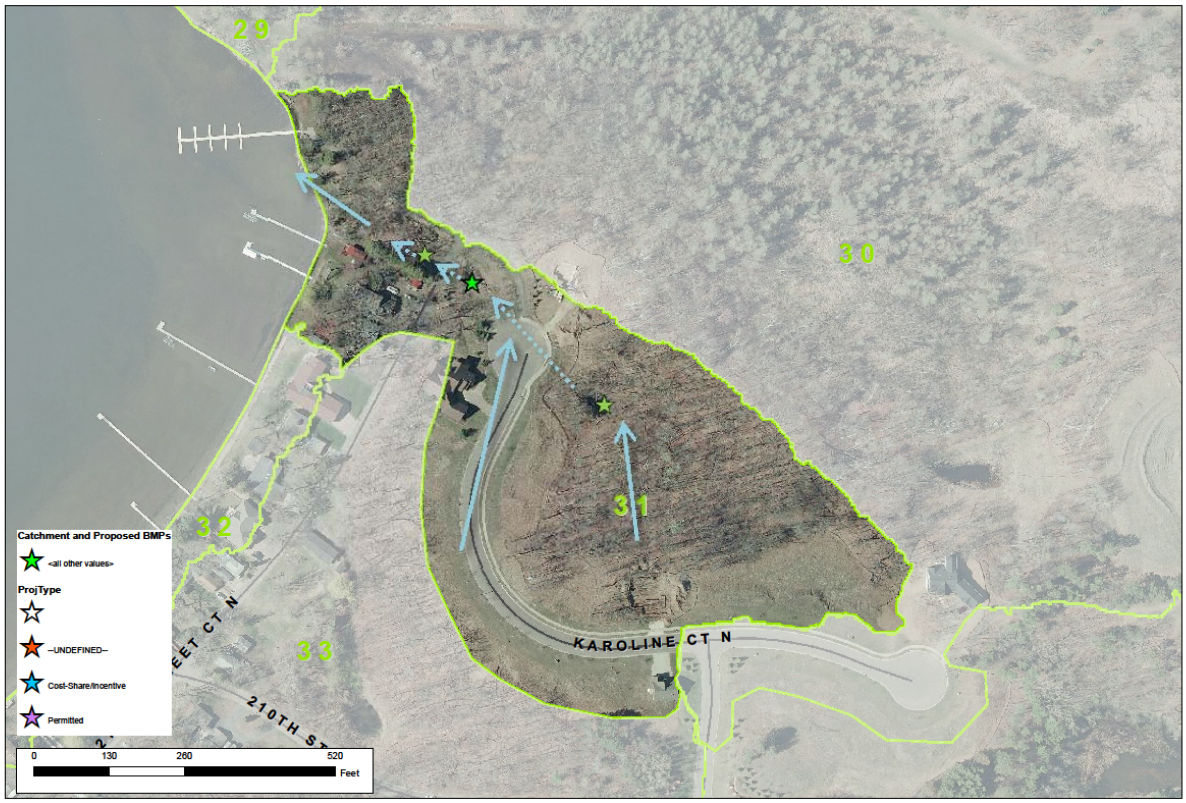
133	1	0.421	5246	49	0.12	2240	1.120	5246	2289	1.24
	TOTAL	8.437					TOTAL	76343	6106	5.125

******NOTE - All Priority Shoreline pollutant reduction values are a composite of WinSLAMM modelling and the BWSR Water Erosion Pollution Reduction Estimator tool. Percent Reductions may exceed 100% as a result. See Shoreline Methods section for explanation of full methodology.***

Catchment FL01-N31



Existing Catchment Summary	
Acres	11.57
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	3.20
TP (lb/yr)	5.25
TSS (lb/yr)	1,788

	Existing Conditions	EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	7.5	2.3	30%	5.3
	TSS (lb/yr)	2,633	845.0	32%	1,788
	Volume (acre-feet/yr)	4.2	1.0	24%	3.2
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

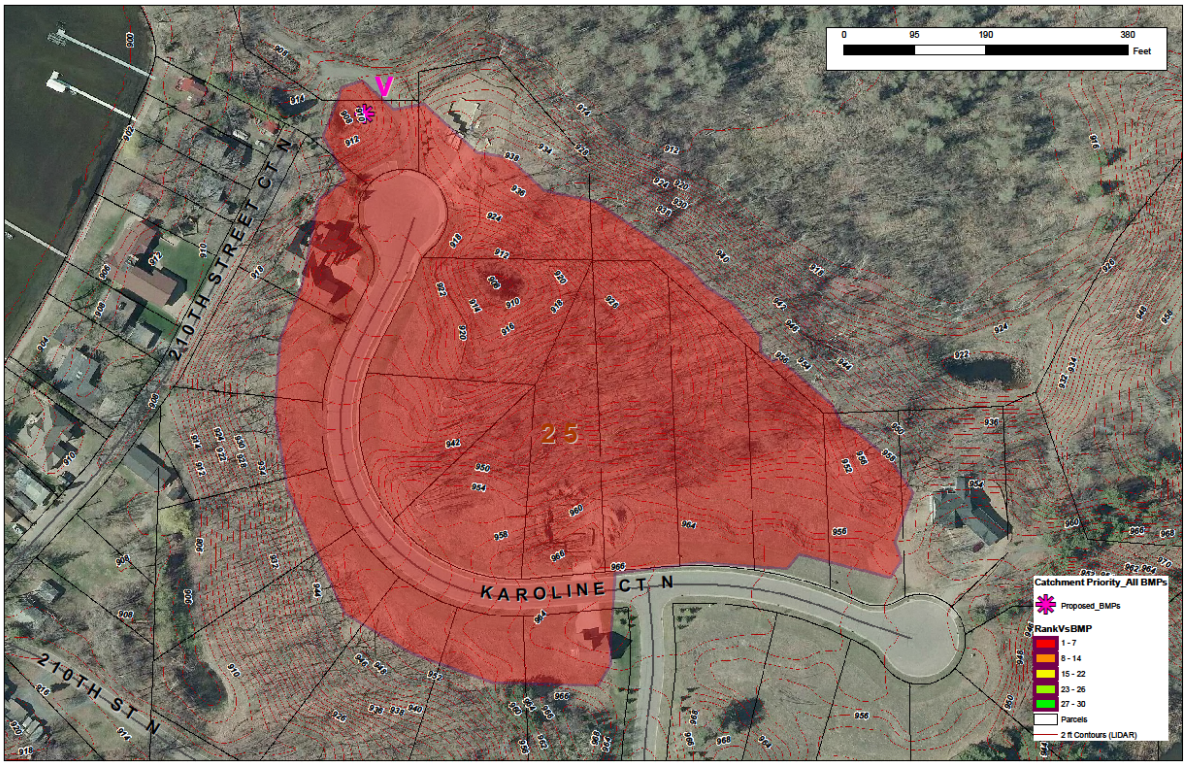
FL01-N31 is a larger sized catchment situated along Karoline Ct N. The 2013 aerial shows 1 home, but as of the report completion, the development is almost fully built out with 17 lots in the catchment. It is primarily wooded on the north half, while the north and south edges of the road are all lawns that are fully sodded.

EXISTING STORMWATER TREATMENT

There is no street sweeping known to occur in this catchment. 100% of this catchment drains through a series of stormponds and bioinfiltration basins, then outlets to a shallow wooded wetland before it drains to the lake.

RETROFIT RECOMMENDATIONS

RANK 23/64 - BMP 25v IESF Bench Retrofit: Iron Enhanced Sand Filter retrofit on existing BioInfiltration Basin

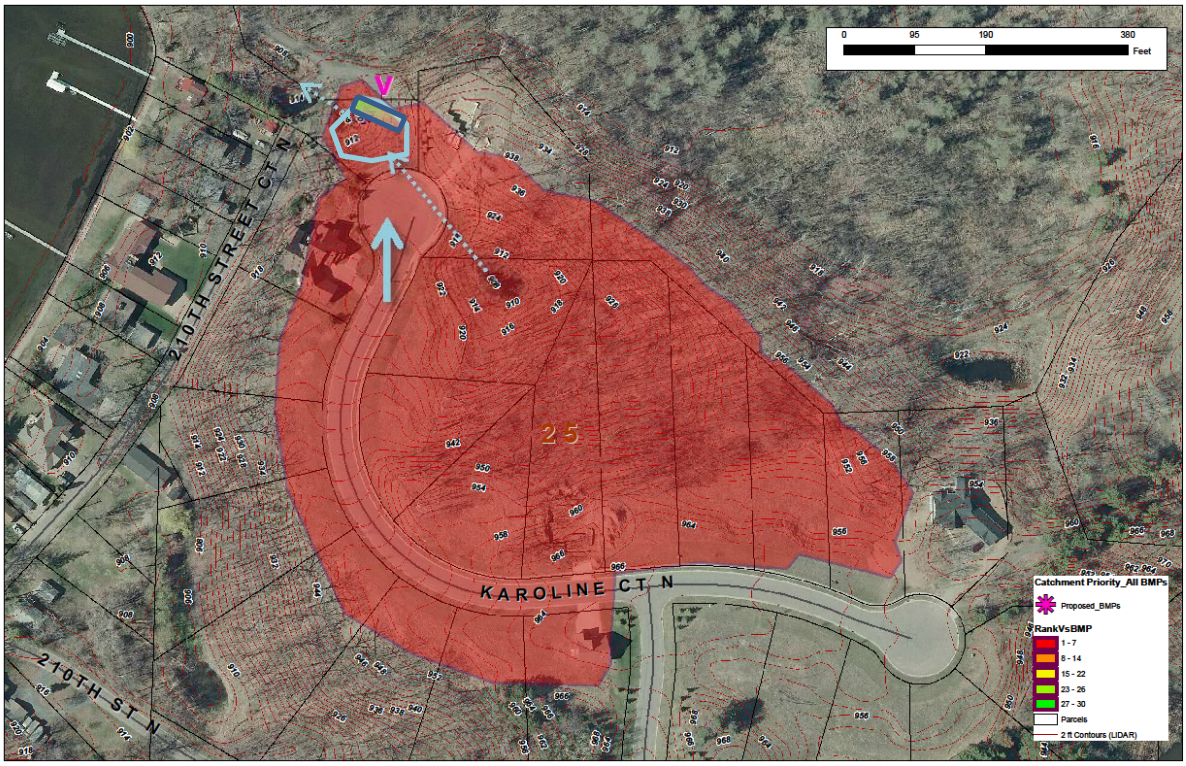


Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N31*			
		BMP 25v - IESF Bench Retrofit		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.83	16%	0.8	16%
	TSS (lb/yr)	15	1%	15.0	1%
	Volume (acre-feet/yr)	0.0	0%	0.0	0%
	Number of BMP's	1		1	
	BMP Size/Description	60	lf	All Practices	
	BMP Type	Perimeter Sand Filter		IESF Retrofit	
Cost	Materials/Labor/Design	$17,939.28		$17,939.28	
	Promotion & Admin Costs	$400		$400	
	Probable Project Cost	$18,339		$18,339	
	Annual O&M	$500		$500	
	10-yr Cost/lb-TP/yr	$2,812		$2,812	
	10-yr Cost/2,000lb-TSS/yr	$311,190		$311,190	

FL01-N31: BMP 25v IESF Bench Retrofit

Rank 23/64

Drainage Area – 9.25 acres (30% Impervious)
Location – BioInfiltration Basin at end of Karoline Ct N
Property Ownership –Private (HOA)
Description – Install a 60' x 4' Iron Enhanced Filter Bench on north side of BioInfiltration Basin. Bench Elevation should be set according to invert elevation of outlet pipe to allow for both the ability to be submerged during a rain event as well as to be completely dry in times between rain events. The cost of $18,339 has been intentionally overestimated since it is not known how deep or wide the soil replacement media can go before having to consider permanent soil saturation and typical ponding elevations. The cost could be substantially lower if smaller amounts of enhanced media will need to be used. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



Cost/Benefit Analysis		Project ID: BMP 25v - IESF Bench Retrofit	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.83	16%
	TSS (lb/yr)	15	1%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	60	lf
	BMP Type	Perimeter Sand Filter	
Cost	Materials/Labor/Design	$17,939.28	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$18,339	
	Annual O&M	$500	
	10-yr Cost/lb-TP/yr	$2,812	
	10-yr Cost/2,000lb-TSS/yr	$311,190	

Catchment FL01-N32



Existing Catchment Summary	
Acres	3.47
Dominant Land Cover	MDRNA
Volume (acre-feet/yr)	1.18
TP (lb/yr)	2.52
TSS (lb/yr)	790

Existing Conditions		EXISTING CONDITIONS			
		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	TP (lb/yr)	2.8	0.2	8%	**2.5**
	TSS (lb/yr)	888	97.6	11%	**790**
	Volume (acre-feet/yr)	1.2	0.0	1%	**1.2**
	BMP Type	Street Sweep 2x annually			

CATCHMENT DESCRIPTION

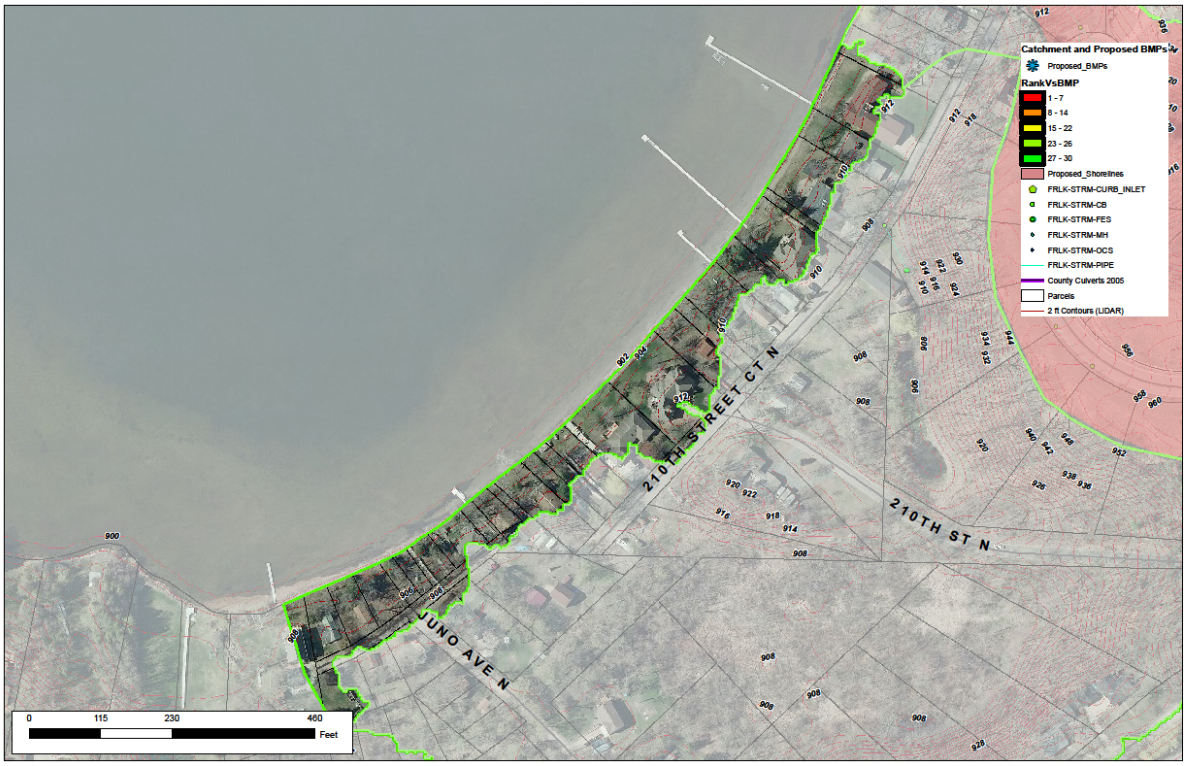
FL01-N32 is a small sized catchment situated along 210th St Ct N. It is primarily residential shoreline lots with minimal road drainage making it to the lake. Parcel widths along the lake range from 50' to 125'. Most shores are mown directly to the edge of the water and most lots have very shallow slopes.

EXISTING STORMWATER TREATMENT

There is no street sweeping known to occur in this catchment. 100% of this catchment directly drains to the lake, untreated, through each parcel. There are no documented or observed BMPs in this catchment

RETROFIT RECOMMENDATIONS

RANK 54/64 - Typical Shoreline Restorations: Up to 8 non-priority shorelines with 15' wide enhanced shoreline buffers.



Cost/Removal Analysis		RETROFIT OPTIONS *Catchment FL01-N32*			
		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	1.1	44%	1.1	44%
	TSS (lb/yr)	344.0	44%	344.0	44%
	Volume (acre-feet/yr)	0.5	44%	0.5	44%
	Number of BMP's	8		8	
	BMP Size/Description	12,000	sf	All Practices	
	BMP Type	Lakeshore Restoration		Shorelines	
Cost	Materials/Labor/Design	$61,770.00		$61,770.00	
	Promotion & Admin Costs	$2,600		$2,600	
	Probable Project Cost	$64,370		$64,370	
	Annual O&M	$5,400		$5,400	
	10-yr Cost/lb-TP/yr	$10,569		$10,569	
	10-yr Cost/2,000lb-TSS/yr	$68,820		$68,820	

FL01-N32 – Typical Shoreline Restorations

Rank 54/64

Drainage Area – 2.4 acres (0.3 acre average per property)
Location – any 8 Participating Shorelines within FL01-N32
Property Ownership – Private
Description –About 80% of the FL01-N32 shorelines are stable but are still mown to the edge of the lake. The lakeside shoreline character of this catchment is 70% turf mown to edges, 20% turf to riprap, and 10% mix of weedy or native vegetation. The northern parcels with larger lot sizes appear to be better opportunities and have more space for enhanced buffers. Soil losses due only to ice heavewere not factored into the modelling for Typical Shoreline Restorations.

Participation Rates: Considering typical landowner participation rates and the number of remaining parcels that were not designated for other Priority Shorelines, it is estimated that 8 individual properties would be a reasonable estimate of participation. This is assuming homeowners were given 75-100% cost share and if maintenance for the first two years was also covered by the cost share funds.

Cost/Benefit Analysis		*Project ID*	
		Shoreline Restorations-Typ Participation Rates	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.1	44%
	TSS (lb/yr)	344.0	44%
	Volume (acre-feet/yr)	0.5	44%
	Number of BMP's	8	
	BMP Size/Description	12,000	sf
	BMP Type	Lakeshore Restoration	
Cost	Materials/Labor/Design	$61,770.00	
	Promotion & Admin Costs	$2,600	
	Probable Project Cost	**$64,370**	
	Annual O&M	$5,400	
	10-yr Cost/lb-TP/yr	**$10,569**	
	10-yr Cost/2,000lb-TSS/yr	**$68,820**	

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Appendix A: Methods

Methods

Selection of Subwatershed

Many factors are considered when choosing which subwatershed to analyze for stormwater 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. Stormwater retrofit 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 stormwater retrofit analysis complements their MS4 stormwater permit. The focus is always on a high priority waterbody.

For this analysis, areas draining directly to Forest Lake with little or no pretreatment of runoff were chosen for study. Forest Lake is not listed on the EPA's 303(d) list of impaired water bodies but it is a high priority for the watershed district because annual water monitoring reports reveal that pollutant levels in the lake (namely phosphorous) are near thresholds for impairment in deep water lakes. Identifying areas that receive little to no pretreatment become a priority as these areas typically have a large impact on lake water quality.

Stormwater runoff from impervious surfaces like pavement and roofs can carry a variety of pollutants. While stormwater treatment to remove these pollutants is adequate in some areas, other areas were built before modern-day stormwater treatment technologies and requirements or have undersized treatment devices.





Stormwater Retrofit Analysis Methods

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, 2005, 2007). Locally relevant design considerations were also incorporated into the process (*Minnesota Stormwater Manual*).

Step 1: Retrofit Scoping

Retrofit scoping includes determining the objectives of the retrofits (volume reduction, target pollutant, etc.) and the level of treatment desired. It involves meeting with local stormwater managers, city staff and watershed management organization members to determine the issues in the subwatershed. This step also helps to define preferred retrofit treatment options and retrofit performance criteria. In order to create a manageable area to analyze in large subwatersheds, a focus area may be determined.

In this analysis, the focus area was all areas that drain directly to Forest Lake. Included are areas of residential, commercial, industrial, and institutional land uses. The subwatershed was divided into 33 catchments using a combination of existing subwatershed mapping data, stormwater infrastructure maps, and observed topography. This study prioritized only 22 of 33 catchments since the remaining 11 catchments were either landlocked or they were predominantly wetland and traditional BMP retrofits were deemed ineffective for the catchment.

The targeted pollutant for this study was total phosphorus, though total suspended solids and volume were also modeled and reported. Total phosphorus (TP) was chosen as the primary target pollutant because long term water quality monitoring has identified elevated levels in Forest Lake. Total suspended solids (TSS) was also reported because many other pollutants, such as heavy metals, are transported by these particles. Volume of stormwater was tracked throughout this study because it is necessary for pollutant loading calculations and potential retrofit project considerations.

Step 2: Desktop Retrofit Analysis

The desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. This step also identifies areas that don't need to be analyzed because of existing stormwater infrastructure 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, hydrology, soils, watershed/subwatershed boundaries, parcel boundaries, high-resolution aerial photography and the stormwater drainage infrastructure (with invert elevations).

Desktop retrofit analysis features to look for and potential stormwater retrofit projects.

Feature	*Potential Retrofit Project*
Existing Ponds	**Add storage and/or improve water Add storage and/or improve water quality by excavating pond bottom, modifying riser, raising embankment, and/or modifying flow routing.**
Open Space	**New regional treatment (pond, bioretention).**
Roadway Culverts	**Add wetland or extended detention water quality treatment upstream.**
Outfalls	**Split flows or add storage below outfalls if open space is available.**

Conveyance system	**Add or improve performance of existing swales, ditches and non-perennial streams.**
Large Impervious Areas (campuses, commercial, parking)	**Stormwater treatment on site or in nearby open spaces.**
Neighborhoods	**Utilize right of way, roadside ditches, curb-cut rain gardens, or filter systems before water enters storm drain network.**

Step 3: Retrofit Reconnaissance Investigation

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

Step 4: Treatment Analysis/Cost Estimates

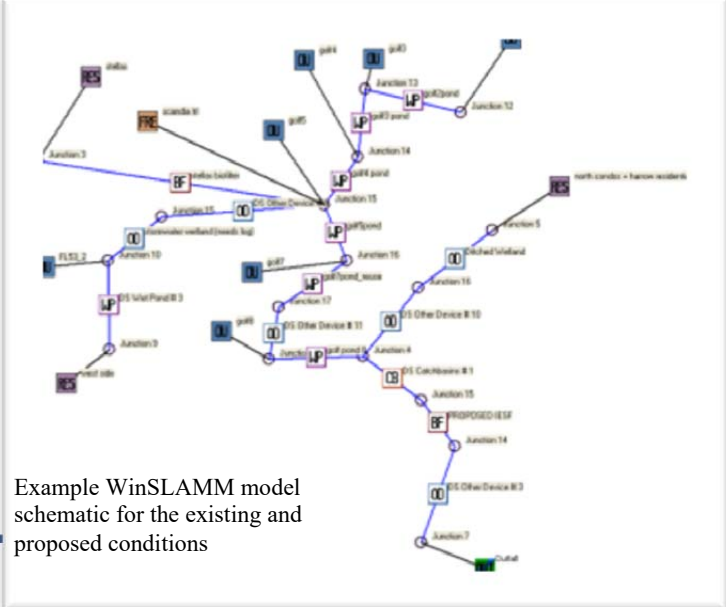
Sites most likely to be conducive to addressing the cities' and watershed district's goals and appear to have simple-to-moderate design, installation, and maintenance were chosen for a cost/benefit analysis. Estimated costs included design, installation, and maintenance annualized across a 10-year period. Estimated benefits included are pounds of phosphorus and total suspended solids removed, though projects were ranked only by cost per pound of phosphorus removed annually.

Treatment analysis

Each proposed project's pollutant removals were estimated using the stormwater model WinSLAMM. WinSLAMM uses an abundance of stormwater data from the upper Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It is useful for determining the effectiveness of proposed stormwater control practices. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model "landscape" that reflects the actual landscape being considered. The user is allowed to place a variety of stormwater treatment practices that treat water from various parts of this landscape. It uses rainfall and temperature data from a typical year, routing stormwater through the user's model for each storm.

The newest version of WinSLAMM (version 10.2), which allows for routing of multiple catchments and stormwater treatment practices, was used for this analysis because of the unique connectivity amongst the catchments identified in the focus area.

The initial step was to create a "base" model which estimated pollutant loading from each catchment in its present-day state without taking into consideration any existing stormwater treatment. To accurately model



Example WinSLAMM model schematic for the existing and proposed conditions

the land uses in each catchment, we
delineated each land use in each catchment
using geographic information systems (specifically, ArcMap), and assigned each a WinSLAMM standard land use file. A site specific land use file was created by adjusting total acreage and accounting for local soil types (all soils were modeled as silt in this analysis). This process resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment. For certain source areas critical to our models we verified that model estimates were accurate by calculating actual acreages in ArcMap, and adjusting the model acreages if needed.

Once the "base" model was established, an "existing conditions" model was created by incorporating any existing stormwater treatment practices in the catchment. For example, street cleaning with mechanical or vacuum street sweepers, rain gardens, stormwater treatment ponds, and others were included in the "existing conditions" model if they were present in the catchment.

Given the difficulty in identifying bioinfiltration practices due to high water tables and lack of available space, it was decided to also document shoreline conditions of each property and prioritize them according to severity of erosion. Additional TP and TSS loads were factored in for shoreline erosion using the BWSR Pollution Reduction Estimator spreadsheet tool (BWSR tool only used in the Proposed Treatment Analysis) Details to this approach of modelling the Priority Shoreline Catchments are given in the Methods Section in the beginning of this report.

Finally, each proposed stormwater treatment practice was added to the "existing conditions" model and pollutant reductions were generated. Because neither a detailed design of each practice nor in-depth site investigation was completed, a generalized design for each practice was used. Whenever possible, site-specific parameters were included. Design parameters were modified to obtain various levels of treatment. It is worth noting that we modeled each practice individually, and the benefits of projects may not be additive, especially if serving the same area. Reported treatment levels are dependent upon optimal site selection and sizing.

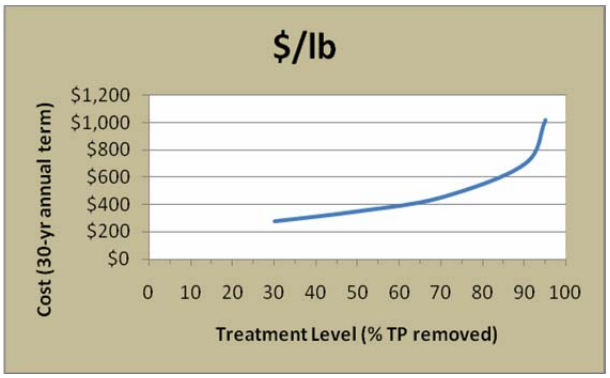
WinSLAMM stormwater computer model inputs

General WinSLAMM Model Inputs	
Parameter	**File/Method**
Land use acreage	ArcMap
Flow/Routing	Municipal Stormsewer data -Approximately 90% complete
Precipitation/Temperature Data	Minneapolis 1959 – the rainfall year that best approximates a typical year.
Winter season	Included in model. Winter dates are 11-4 to 3-13.
Pollutant probability distribution	WI_GEO01.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.

Cost Estimates

All estimates were developed using 2015 dollars. Cost estimates were annualized costs that incorporated design, installation, installation oversight, and maintenance over a 10-year period. 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. It should be understood that no site-specific construction investigations were done as part of this stormwater retrofit analysis, and therefore cost estimates account for only general site considerations.

The costs associated with several different pollution reduction levels were calculated. Generally, more or larger practices result in greater pollution removal. However the costs of obtaining the highest levels of treatment are often prohibitively expensive (see figure). By comparing costs of different treatment levels, the cities and watershed district can best choose the project sizing that meets their goals.



Step 5: Evaluation and Ranking

The cost per pound of phosphorus treated was calculated for each potential retrofit project. Only projects that seemed realistic and feasible were considered. The recommended level was the level of treatment that would yield the greatest benefit per dollar spent while being considered feasible and not falling below a minimal amount needed to justify crew mobilization and outreach efforts. Local officials may wish to revise the recommended level based on water quality goals, finances, or public opinion

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Appendix B:
How to Read Catchment Profiles

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Catchment Profiles and How to Read Them

The analysis contains pages referred to as "Catchment Profiles." These profiles provide the most important details of this report, including:

- Summary of existing conditions, including existing stormwater infrastructure, and estimated pollutant export to Forest Lake
- Map of the catchment
- Recommended stormwater retrofits, pollutant reductions, and costs.

Following all of the catchment profiles (also in the executive summary) is a summary table that ranks all projects in all catchments by cost effectiveness.

To save space and avoid being repetitive, explanations of the catchment profiles are provided below. We strongly recommend reviewing this section before moving forward in the report.

The analyses of each catchment are broken into "base, existing, and proposed" conditions. They are defined as follows:

Existing conditions - Volume and pollutant loadings after already-existing stormwater practices are taken into account.

Proposed conditions - Volume and pollutant loadings after proposed stormwater retrofits.

Analyses were performed at one of two geographic scales, "catchment or network." They are defined as follows:

Sub-catchment level analyses - Volume and pollutant loads of all BMPs proposed in an entire sub-catchment. Sub-catchments are then ranked on a $cost/Lb Tp/10years as if all proposed BMPs are implemented in each sub-catchment. Example: If all BMPs were installed, then Sub-catchment FL01-N24 would rank higher than all BMPs in FL01-N11 and would be a good target neighborhood/sub-catchment for targeted outreach.

BMP Sub-catchment level analyses - Volume and pollutant loads exiting the sub-catchment of the proposed BMP or the proposed Priority Shoreline Catchment. BMP Sub-catchments are then ranked on a cost/Lb Tp/10years and compared to all other proposed practices. This method highlights best BMPs overall, irrespective of sub-catchment location (example; BMP 15k is more cost effective than BMP 3c).

The example catchment profile on the following pages explains important features of each profile.

HOW TO READ THE CATCHMENT PROFILES

EXAMPLE Catchment FL01-Nxx

Existing Catchment Summary	
Acres	58.90
Dominant Land Cover	Residential
Parcels	237
Volume (acre-feet/yr)	18.37
TP (lb/yr)	25.00
TSS (lb/yr)	6461.00

DESCRIPTION

Example Catchment is primarily comprised of medium- density, single-family residential development…

EXISTING STORMWATER TREATMENT

Existing stormwater treatment practices within Example Catchment consist of street cleaning with a mechanical sweeper in the spring and fall and a network of stormwater treatment ponds…

Catchment ID banner.

Volume and pollutants generated from this catchment under existing conditions, and includes existing network-wide treatment practices

HOW TO READ THE CATCHMENT PROFILES

Catchment-level analysis of existing conditions.

Catchment Specific Existing Conditions

Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
TP (lb/yr)	25.2	0.2	1%	**25.0**
TSS (lb/yr)	7,186	725.0	10%	**6,461**
Volume (acre-feet/yr)	18.4	0.0	0%	**18.4**
Number of BMP's	1			
BMP Size/Description	Street cleaning, stormwater pond			

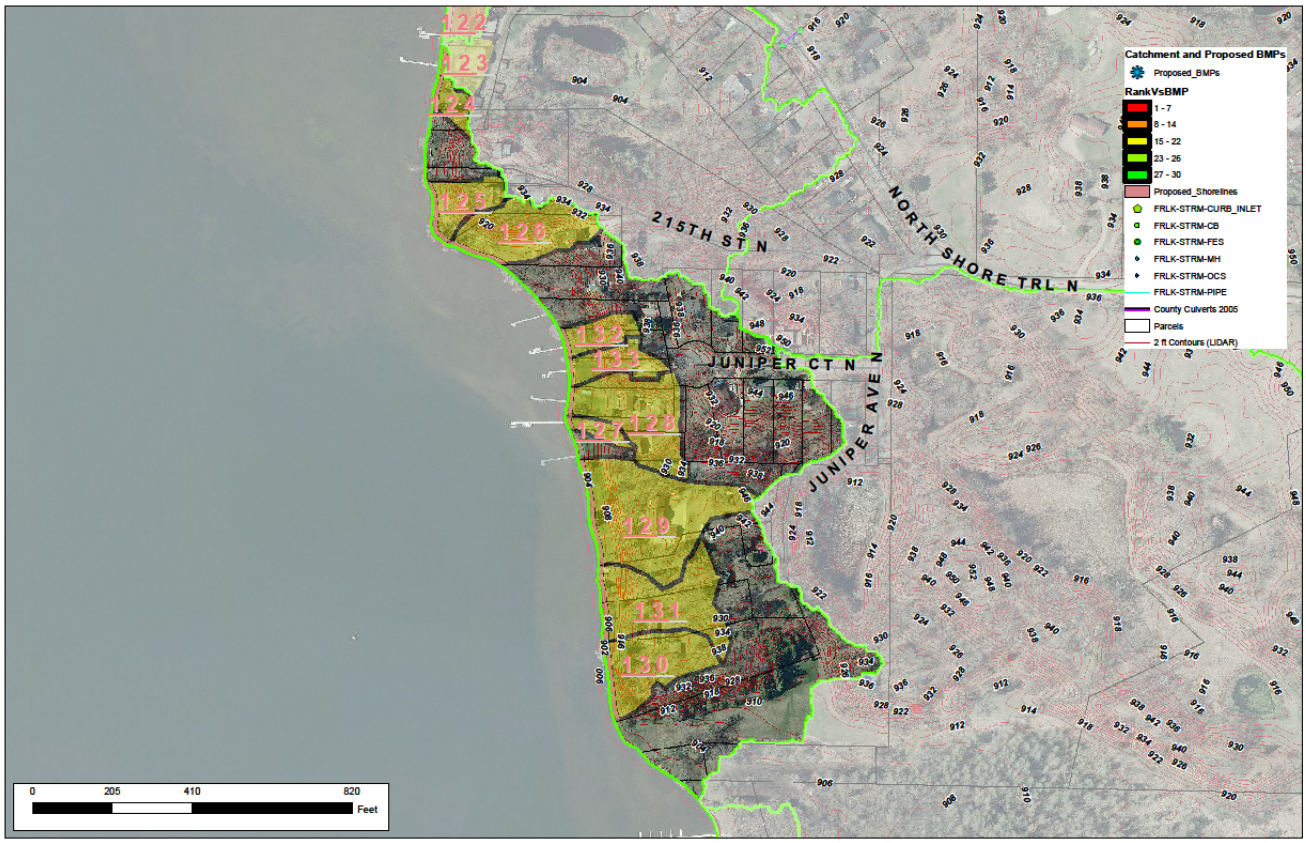
Volume of water and pounds of pollutants generated from the catchment without any stormwater management practices (base conditions).

Pollutants and volume removed by existing stormwater management practices (existing conditions).

Pollutants and volume exiting the catchment after accounting for existing practices.

Percent reductions by existing practices.

HOW TO READ THE CATCHMENT PROFILES



Map shows sub-catchment boundaries and the locations of all proposed stormwater BMPs and their respective drainage areas

HOW TO READ THE CATCHMENT PROFILES

PROPOSED BMP Ranking Summary Page

FL01-N2: RETROFIT RECOMMENDATIONS

RANK 1/64 - **Increased Street Sweeping:** Increase Street Sweeping from 2x/year to 4x/year. This include sweeping the private (but easily accessible) parking areas that are adjacent to the main roads.
RANK 52/62 - **Priority Shoreline 135:** Disconnect Buried Downspouts from Shore and install buffer
RANK 51/62 - **Typical Shoreline Restorations:** Up to 15 properties with 15' shoreline buffers.

Ranking summary of BMPs proposed in this catchment, color coded by ranking group.



Map of all BMPs proposed in catchment. Color masses indicate catchment areas of ranked BMPs, Priority Shoreline Catchments, or Street Sweeping locations

Cost/Benefit Analysis		RETROFIT OPTIONS – Catchment FL01-N2							
		Priority Shoreline 135		Increased Street Sweeping to 4x per year		Shoreline Restorations-Typ Participation Rates		Total Reductions (all implemented)	
		New trtmt	Net %	New trtmt	Net %	New trtmt	Net %	New trtmt	Net %
Treatment	TP (lb/yr)	0.12	1%	1.0	7%	1.5	10%	2.6	17%
	TSS (lb/yr)	74	1%	522.5	7%	600.0	8%	1197	16%
	Volume (acre-feet/yr)	0.1	1%	0.0	0%	1.3	8%	1.4	9%
	Number of BMP's	1		1		15		17	
	BMP Size/Description	1,000	sf	1.224	curb miles	15,000	sf	All Practices	
	BMP Type	Priority Lakeshore restoration		Street Sweeping		Lakeshore Restoration		Sweeping and Shores	
Cost	Materials/Labor/Design	$7,050.00		$419.30		$77,160.00		$84,629.30	
	Promotion & Admin Costs	$325		$50		$4,875		$5,250	
	Probable Project Cost	$7,375		$469		$82,035		$89,879	
	Annual O&M	$450		$0		$6,750		$7,200	
	10-yr Cost/lb-TP/yr	$10,064		$46		$9,969		$6,693	
	10-yr Cost/2,000lb-TSS/yr	$32,095		$180		$49,845		$27,373	

RETROFIT OPTIONS TABLE: summarizes each individual BMP and last column always shows total load reduction and cost benefit if all BMPs were implemented in catchment.

HOW TO READ THE CATCHMENT PROFILES

PROPOSED BMP Individual Catchment Profile Page

Project Overall Rank. Color coded rank by priority (red highest, green lowest)

FL01-N7: BMP 2b Vegetated Swale

Rank #20/62

Drainage Area – 0.873 acres
Location – Intersection of North Shore Trail and 236th St Ct N
Property Ownership – Public (City of Forest Lake)
Description – Currently a 12" pipe drains the catchment through a mown swale that is approx. 110' long and directly outlets to Forest Lake/Sunrise River above the Forest Lake outlet dam. With minimal plantings of native plugs, some erosion control blanket, and twice yearly maintenance a very inexpensive retrofit can be achieved. This practice would be even less expensive (increasing its #20 rank) if the area were just left unmown and periodically checked for noxious weeds. *See Appendix XXX for detailed cost estimates*

Project Title and Brief Summary of site-specific parameters. Includes details related to existing drainage issues, constructability, cost of project, and alternatives to design to lower cost or improve practice outcomes.



Map of proposed BMP. Color mass indicates catchment area of ranked BMP, Priority Shoreline Catchment, or Street Sweeping location.

Cost/Removal Analysis		Project ID: BMP 2b - Vegetated Swale	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.14	1%
	TSS (lb/yr)	53	1%
	Volume (acre-feet/yr)	0.0	1%
	Number of BMP's	1	
	BMP Size/Description	1,320 sf	
	BMP Type	Unmown Swale Minimal Veg	
Cost	Materials/Labor/Design	$1,489.80	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$1,620	
	Annual O&M	$132	
	10-yr Cost/lb-TP/yr	$2,085	
	10-yr Cost/2,000lb-TSS/yr	$11,094	

Cost/Removal Analysis Individual Practice analysis, including percent removal of pollutants, design, install, and promotion costs, and final cost/removal of TP and TSS.

See Methods section at front of report for how to interpret shoreline analysis

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Appendix C:
Cost Estimates for Non-Shoreline BMP Projects

BMP 1a – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N7_BMP 1a

Project Address: FLN SWA

COMFORT LAKE WATERSHED DISTRICT FOREST LAKE

Job Description	Cost Summary
Apartment BMP 1a, 6' x 40' = 240sqft BMP, 3" Deep, plant only BMP, not both swales coming to BMP	Project Cost = $ 19,273.71 Phosphorus Reduction (lbs/yr) OVERALL BMP ONLY TP= 0.44 Rank = 44 Rank = 26

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
Erosion Control Blanket SC-150BN BioNet	80	sy	$ 1.10	$ 88.00
			Erosion Control Subtotal	$ 123.00
Compost, Mulch, and Rock				
Kasota 2" Flagstone, approx 20"-48" wide	12	sqft	$ 6.59	$ 79.08
Trench Drain (Drive Aisle, ADS heavy duty, 12" grate, incl deliver	20	lf	$ 210.00	$ 4,200.00
			Compost Mulch and Rock Subtotal	$ 4,279.08
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug (by berm)	36	each	$ 1.00	$ 36.00
#1 Pot	36	each	$ 8.00	$ 288.00
4" Pot	36	each	$ 3.00	$ 108.00
			Plants Subtotal	$ 432.00
Excavation and Grading				
Grading	8	hrs	$ 150.00	$ 1,200.00
Off-Site Disposal of Soil (3")	3	cy	$ 8.00	$ 20.00
Sod (both swales)	53	sy	$ 2.50	$ 132.50
			Excavation and Grading Subtotal	$ 1,352.50
Misc				
Watering	1	job	$ 500.00	$ 500.00
Soil Delivery		job	$ 100.00	$ -
Rock Delivery	1	job	$ 100.00	$ 100.00
Mulch Delivery (14cy/load)		job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 700.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 4,402.08
	Plants	$ 432.00
	Excavation/Grading	$ 1,352.50
	Misc	$ 700.00
	Materials Estimate	$ 4,834.08
	Labor Estimate	$ 12,687.48
	Contingency 10%	$ 1,752.16
	Project Estimate	**$ 19,273.71**

BMP 1a – Cost Estimate and Concept Plan

FL01-N7: BMP 1a Parking Lot Retrofit

Rank #44/64

Drainage Area – 0.835 acres (90% Impervious)
Location – Intersection of North Shore Trail and Sunrise River/Forest Lake Dam @ North Shore Apts.
Property Ownership – Private
Description – Create a shallow filtration basin with an underdrain and lined bottom. Sod will be the plant media in the swale zones since these areas are the primary snow storage zone for the parking lot and will need to withstand harsh conditions and also be easily maintainable and replaceable over the life of the project. Basin will be 600 sf, will have 6" of ponding, and 1' of replacement soils (70/30 sand /compost) and will be planted with natives. A level spreader or multiple pretreatment inlets will have to be installed to intercept gross solids. An overflow of limestone steppers is also included in the concept. Other ideas beyond this concept could include an expanded footprint (removing parking stalls), alternative snow storage scenarios, or different vegetation for the basin (sod). The cost of $22,506 could be substantially lower if alternatives to using a 12" deep channel drain as pretreatment are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for cost estimate***



Cost/Removal Analysis		Project ID: BMP 1a - Parking Lot Retrofit	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.44	5%
	TSS (lb/yr)	53	1%
	Volume (acre-feet/yr)	0.8	13%
	Number of BMP's	1	
	BMP Size/Description	600 sf	
	BMP Type	Highly Complex BioFiltration	
Cost	Materials/Labor/Design	$22,181.22	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$22,506	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$6,082	
	10-yr Cost/2,000lb-TSS/yr	$101,910	

BMP 2b – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N7_BMP 2b Swale

Project Address: FLN SWA



Job Description	Cost Summary
Total Planted Area= 12' x 110' = 1,320 sqft ; Center of Swale for ponding 6' x 110' = 660 sqft	Project Cost = $ 1,185.25 Phosphorus Reduction (lbs/yr) TP= 0.14 OVERALL BMP ONLY Rank = 20 Rank = 3

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
			Erosion Control Subtotal	$ -
Compost, Mulch, and Rock				
			Compost Mulch and Rock Subtotal	$ -
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug (2' O.C.)	165	each	$ 1.00	$ 165.00
Native plug (3' O.C.)	66	each	$ 1.00	$ 66.00
			Plants Subtotal	$ 231.00
Excavation and Grading				
			Excavation and Grading Subtotal	$ -
Misc				
Soil Delivery	0	job	$ 100.00	$ -
Signs saying don't mow	4	each	$ 50.00	$ 200.00
Watering	1	job	$ 500.00	$ 200.00
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 500.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ -
	Plants	$ 231.00
	Excavation/Grading	$ -
	Misc	$ 500.00
	Materials Estimate	$ 231.00
	Labor Estimate	$ 846.50
	Contingency 10%	$ 107.75
	Project Estimate	$ 1,185.25

BMP 2b – Cost Estimate and Concept Plan

FL01-N7: BMP 2b Vegetated Swale

Rank 20/62

Drainage Area – 0.873 acres
Location – Intersection of North Shore Trail and 236th St Ct N
Property Ownership – Public (City of Forest Lake)
Description – Currently a 12" pipe drains the catchment through a mown swale that is approx. 110' long and directly outlets to Forest Lake/Sunrise River above the Forest Lake outlet dam. With minimal plantings of native plugs, some erosion control blanket, and twice yearly maintenance a very inexpensive retrofit can be achieved. This practice would be even less expensive (increasing its #20 rank) if the area were just left unmown and periodically checked for noxious weeds. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 2b - Vegetated Swale	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.14	1%
	TSS (lb/yr)	53	1%
	Volume (acre-feet/yr)	0.0	1%
	Number of BMP's	1	
	BMP Size/Description	1,320 sf	
	BMP Type	Unmown Swale Minimal Veg	
Cost	Materials/Labor/Design	$1,489.80	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$1,620	
	Annual O&M	$132	
	10-yr Cost/lb-TP/yr	$2,085	
	10-yr Cost/2,000lb-TSS/yr	$11,094	

BMP 3c – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N12_3c Bioinfiltration Basin

Project Address: FLN SWA



Job Description	Cost Summary		
"THIS COST ESTIMATE REFLECTS CHANGES TO THE DESIGN AFTER THE REPORT WAS COMPLETED. This estimate lowers the cost by $5,457 and increases its OVERALL RANK to #29 and BMP ONLY rank to #11. Pollutant load reductions do not change. BMP Sizing - 500 sqft BMP + 300 sqft planting outside basin as pretreatment	Project Cost = $ 7,713.18	Phosphorus Reduction (lbs/yr)	
	Overall Rank = 39*	BMP Only Rank = 22*	TP= 0.36

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket SC-150BN BioNet	124	sy	$ 1.10	$ 136.40
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 171.40
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	150	each	$ 1.20	$ 180.00
	0	lf	$ 30.00	$ -
			Compost Mulch and Rock Subtotal	$ 180.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	125	each	$ 1.00	$ 125.00
#1 Pot	125	each	$ 8.00	$ 1,000.00
4" Pot	100	each	$ 3.00	$ 300.00
			Plants Subtotal	$ 1,425.00
Excavation and Grading				
Grading	4	hrs	$ 150.00	$ 600.00
Off-Site Disposal of Soil (3" ponding only in 500 sqft bmp)	5	cy	$ 8.00	$ 40.00
Sod	35	sy	$ 2.50	$ 87.50
			Excavation and Grading Subtotal	$ 727.50
Misc				
Watering	1	job	$ 500.00	$ 500.00
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 600.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 351.40
	Plants	$ 1,425.00
	Excavation/Grading	$ 727.50
	Misc	$ 600.00
	Materials Estimate	$ 1,776.40
	Labor Estimate	$ 5,235.58
	Contingency 10%	$ 701.20
	Project Estimate	**$ 7,713.18**

BMP 3c – Cost Estimate and Concept Plan

FL01-N11: BMP 3c BioInfiltration Basin

Rank 39/64

Drainage Area – 0.879 acres (50% Impervious)
Location – South of Intersection of North Shore Trail and 233rd St N
Property Ownership – Private/Public, in Right of Way
Description – This catchment has a new house built in the northernmost lot in the catchment that was not accounted for in the analysis, thus increasing the potential runoff and capture opportunities. Catchment may actually be larger now. Create a shallow BioInfiltration basin adjacent to the existing catchbasin on the shoulder of North Shore Trail. Basin ponding area will be 500 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand /compost). A 200sf planted zone on the outsides of the basin area will act as a pretreatment device to extend life of the practice. The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $14,305 could be substantially lower if alternatives planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N11 BMP 3c - BioInfiltration Mod Complex	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.36	3%
	TSS (lb/yr)	152	3%
	Volume (acre-feet/yr)	0.2	2%
	Number of BMP's	1	
	BMP Size/Description	500	sf
	BMP Type	Moderately Complex BioInfiltration	
Cost	Materials/Labor/Design	$14,175.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$14,305	
	Annual O&M	$375	
	10-yr Cost/lb-TP/yr	$4,951	
	10-yr Cost/2,000lb-TSS/yr	$23,757	

BMP 4d – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N12_4d Bioinfiltration Basin

Project Address: FLN SWA

COMFORT LAKE
WATERSHED DISTRICT
FOREST LAKE

Protecting Your Water Resources

[illegible] Lake Street South, Suite A
Forest Lake, MN 55025
Phone: [illegible]

Job Description	Cost Summary
800 sqft BMP + 300 sqft planting outside basin as pretreatment	Project Cost = $ 7,537.18 Phosphorus Reduction (lbs/yr) OVERALL Rank = 27 BMP ONLY Rank = 10 TP= 0.45

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket SC-150BN BioNet	124	sy	$ 1.10	$ 136.40
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 171.40
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	150	each	$ 1.20	$ 180.00
Engineered Soil Mix B (70% ASTM C-33 Coarse Wash Sand and 30% Sphagnum Peat, NO TOPSOIL) (6" replacement)	0	cy	$ 52.40	$ -
			Compost Mulch and Rock Subtotal	$ 180.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	250	each	$ 1.00	$ 250.00
#1 Pot	90	each	$ 8.00	$ 720.00
4" Pot	120	each	$ 3.00	$ 360.00
			Plants Subtotal	$ 1,330.00
Excavation and Grading				
Grading	4	hrs	$ 150.00	$ 600.00
Off-Site Disposal of Soil (3" ponding + 6" room for replacement soil, only in 800 sqft bmp)	23	cy	$ 8.00	$ 184.00
Sod	35	sy	$ 2.50	$ 87.50
			Excavation and Grading Subtotal	$ 871.50
Misc				
Watering	1	job	$ 500.00	$ 500.00
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 600.00

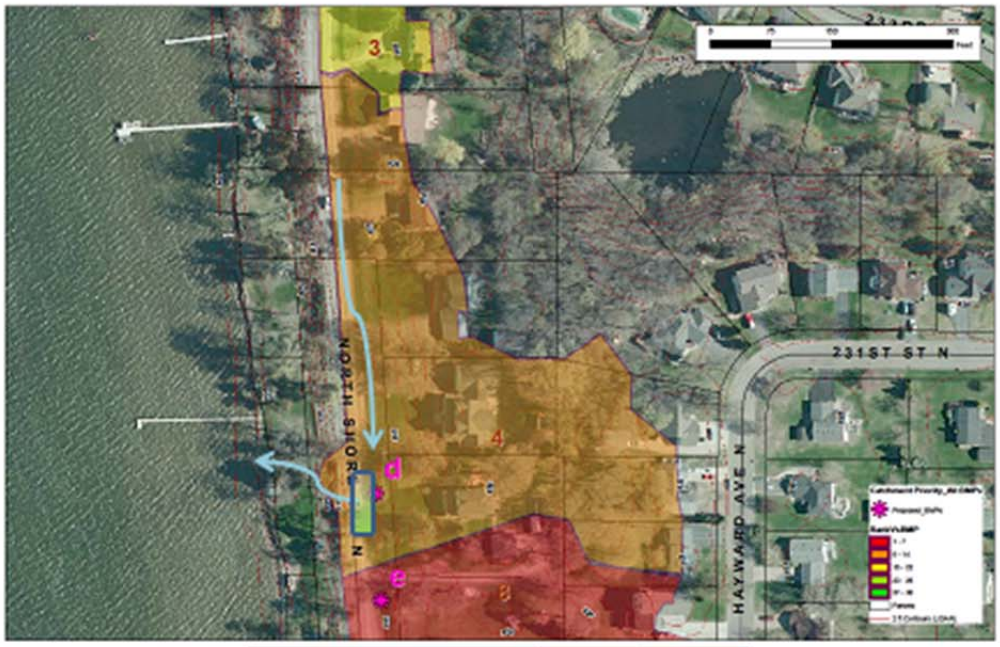
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 351.40
	Plants	$ 1,330.00
	Excavation/Grading	$ 871.50
	Misc	$ 600.00
	Materials Estimate	$ 1,681.40
	Labor Estimate	$ 5,170.58
	Contingency 10%	$ 685.20
	Project Estimate	$ 7,537.18

BMP 4d – Cost Estimate and Concept Plan

FL01-N12: BMP 4d BioInfiltration Basin

Rank 27/64

Drainage Area – 3.198 acres (25% Impervious)
Location – West of Intersection of North Shore Trail and Hayward Ave N
Property Ownership – Private/Public, in Right of Way
Description – Create a shallow BioInfiltration Basin adjacent to the existing catchbasin on the shoulder of North Shore Trail. Basin ponding area will be 800 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand /compost). Up to 300sf planted zone on the outsides of the basin area will act as a pretreatment device to extend life of the practice. The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $9,049 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 4d- BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.45	38%
	TSS (lb/yr)	182.0	36%
	Volume (acre-feet/yr)	0.3	6%
	Number of BMP's	1	
	BMP Size/Description	800 sf	
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$8,649.20	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$9,049	
	Annual O&M	$600	
	10-yr Cost/lb-TP/yr	$3,322	
	10-yr Cost/2,000lb-TSS/yr	$16,538	

BMP 6g, 7f, 8e – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT
CLFLWD Cost-Share

Catchment N12_6g, 7f, 8e Combined Swale and BioInfiltration

Project Address: FLN SWA

COMFORT LAKE WATERSHED DISTRICT FOREST LAKE

Protecting Your Water Resources

44 Lake Street South, Suite A
Forest Lake, MN 55025
Phone: 651-275-5650

Job Description	Cost Summary		
1500 sqft, 3" deep swale ponding and 6" basin ponding. Remove soils then plant.	Project Cost =	$ 17,211.08	Phosphorus Reduction (lbs/yr) TP= 1.14
	OVERALL Rank = 24	BMP ONLY Rank = 7	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-3 NAG S-150	180	sy	$ 0.40	$ 72.00
Securing Staples (6", 1000/ctn)	3	carton	$ 35.00	$ 105.00
			Erosion Control Subtotal	$ 177.00
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	270	each	$ 1.20	$ 324.00
Engineered Soil Mix B (70% ASTM C-33 Coarse Wash Sand and 30% Sphagnum Peat, NO TOPSOIL) 6" deep	9	cy	$32.40	$ 484.70
Fieldstone Boulders 4 (12"-24")	2	ton	$ 73.00	$ 146.00
			Compost Mulch and Rock Subtotal	$ 954.70
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	225	each	$ 1.00	$ 225.00
#1 Pot	225	each	$ 8.00	$ 1,800.00
4" Pot	225	each	$ 3.00	$ 675.00
			Plants Subtotal	$ 2,700.00
Excavation and Grading				
Grading	12	hrs	$ 150.00	$ 1,800.00
Off-Site Disposal of Soil (6" ponding)	20	cy	$ 8.00	$ 160.00
Sod	90	sy	$ 2.50	$ 225.00
			Excavation and Grading Subtotal	$ 2,185.00
Misc				
Watering	1	job	$ 450.00	$ 450.00
Herbicide	1	each	$ 150.00	$ 150.00
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	1	job	$ 300.00	$ 300.00
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 300.00	$ 300.00
			Misc Subtotal	$ 1,200.00

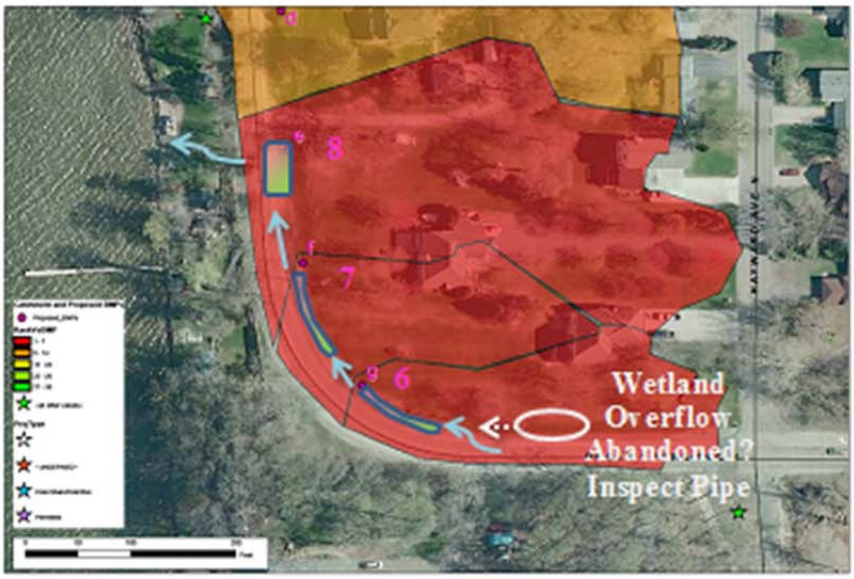
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 1,131.70
	Plants	$ 2,700.00
	Excavation/Grading	$ 2,185.00
	Misc	$ 1,200.00
	Materials Estimate	$ 3,831.70
	Labor Estimate	$ 11,814.74
	Contingency 10%	$ 1,564.64
	Project Estimate	$ 17,211.08

BMP 6g, 7f, 8e – Cost Estimate and Concept Plan

FL01-N12: BMP 6g, 7f, 8e Swales and BioInfiltration

Rank 24/64

Drainage Area – 3.319 acres (25% Impervious)
Location – West of Intersection of North Shore Trail and Hayward Ave N
Property Ownership – Private/Public, in Right of Way
Description – Convert two existing mown turf ditches to Vegetated Swales (max area 500sf each). Swale bottoms will be excavated 3" below inverts of existing culvert pipes that connect under pedestrian/mower access ramps on each lot. Create a shallow BioInfiltration Basin adjacent to the existing catchbasin at end of swale run. Basin ponding area will be 500 sf, will have 6" of ponding, and 1' of replacement soils (70/30 sand /compost). Presence of swales will act as pretreatment for basin. The overflow will be the invert elevation of the existing pipe under the road. *Verify actual catchment area by inspecting whether ditch pipe is still an active overflow for a wetland area upstream. Currently this area is not being considered as part of the catchment area.* Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin, or just stop mowing the ditches. There is also the potential to amend the existing swale below the outfall of 8e to increase treatment. The cost of $21,022 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 6g,7f,8e - Retention Swales and BioInfiltration Mod	
		New trtmt	Net %
Treatment	TP (lb/yr)	1.14	14%
	TSS (lb/yr)	455.0	15%
	Volume (acre-feet/yr)	0.6	11%
	Number of BMP's	3	
	BMP Size/Description	1,500	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$20,021.68	
	Promotion & Admin Costs	$1,000	
	Probable Project Cost	$21,022	
	Annual O&M	$1,125	
	10-yr Cost/lb-TP/yr	$2,831	
	10-yr Cost/2,000lb-TSS/yr	$14,185	

BMP 9h – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N18 _9h BioInfiltration Basin

Project Address: FLN SWA
Mailing Address: Same
Property PIN: xxxxxxxxxxx
2/9/2016

Job Description	Cost Summary
750 sqft BMP	Project Cost = $ 3,667.91 Phosphorus Reduction (lbs/yr) OVERALL BMP ONLY TP= 0.43 Rank = 21 Rank = 4

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-2 NAG S-75	84	sy	$ 0.28	$ 23.52
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 58.52
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	120	each	$ 1.20	$ 144.00
			Compost Mulch and Rock Subtotal	$ 144.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	236	each	$ 1.00	$ 236.00
#1 Pot	0	each	$ 8.00	$ -
4" Pot	112	each	$ 3.00	$ 336.00
			Plants Subtotal	$ 572.00
Excavation and Grading				
Grading	4	hrs	$ 150.00	$ 600.00
Off-Site Disposal of Soil	7	cy	$ 8.00	$ 56.00
Sod	40	sy	$ 2.50	$ 100.00
			Excavation and Grading Subtotal	$ 756.00
Misc				
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 100.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 202.52
	Plants	$ 572.00
	Excavation/Grading	$ 756.00
	Misc	$ 100.00
	Materials Estimate	$ 774.52
	Labor Estimate	$ 2,559.94
	Contingency 10%	$ 333.45
	Project Estimate	$ 3,667.91

BMP 9h – Cost Estimate and Concept Plan

FL01-N18: BMP 9h BioInfiltration Basin

Rank 21/64

Drainage Area – 3.042 acres (33% Impervious)
Location – Tip of Road Loop on North Shore Circle
Property Ownership – Private/Public, partially in Right of Way
Description – Create a shallow BioInfiltration Basin adjacent to the existing 4" drain pipe on the north side of North Shore Circle. Basin ponding area will be 750 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost). The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $4,567 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N18 BMP 9h - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.42	5%
	TSS (lb/yr)	185	6%
	Volume (acre-feet/yr)	0.3	5%
	Number of BMP's	1	
	BMP Size/Description	750	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$4,242.00	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$4,567	
	Annual O&M	$563	
	10-yr Cost/lb-TP/yr	$2,409	
	10-yr Cost/2,000lb-TSS/yr	$11,018	

BMP 10i – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N19_BMP 10i

Project Address: FLN SWA
Mailing Address: Same
Property PIN: xxxxxxxxxxx
2/9/2016

Job Description	Cost Summary
1600 sqft basin at North Shore Circle Park.	Project Cost = $ 12,262.56 Phosphorus Reduction (lbs/yr) OVERALL BMP ONLY TP= 0.69 Rank = 22 Rank = 5

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 35.00
Compost, Mulch, and Rock				
Engineered Soil Mix B (60% ASTM C-33 Coarse Wash Sand and 40% Sphagnum Peat, NO TOPSOIL) (40x40 x 3 pit plus 4' x 40' x 6" strip)	33	cy	$ 52.40	$ 1,729.20
Erosion Control Blanket SC-150BN BioNet	24	sy	$ 1.10	$ 26.40
			Compost Mulch and Rock Subtotal	$ 1,755.60
Drainage Accessories				
Catchbasin (NDS) - 12"x12"	0	each	$ 41.95	$ -
Draintile, HDPE Perforated w/o sock- 4"	90	lf	$ 0.39	$ 35.10
T Connector- 4"	1	each	$ 6.28	$ 6.28
Grate, Atrium Grate	1	each	$ 14.00	$ 14.00
Gate Valve	1	each	$ 400.00	$ 400.00
Plug- 4"	2	each	$ 2.21	$ 4.42
Clean Out Parts	1	Ls	$ 150.00	$ 150.00
			Drainage Subtotal	$ 609.80
Plants, Shrubs, and Trees				
Native plug (by berm)	50	each	$ 1.00	$ 50.00
#1 Pot	0	each	$ 8.00	$ -
4" Pot	0	each	$ 3.00	$ -
			Plants Subtotal	$ 50.00
Excavation and Grading				
Grading	8	hrs	$ 150.00	$ 1,200.00
Off-Site Disposal of Soil (3") + Underdrain trench	18	cy	$ 8.00	$ 144.00
Sod	225	sy	$ 2.50	$ 562.50
			Excavation and Grading Subtotal	$ 1,906.50
Misc				
Fix berm with cut soils	1	job	$ 500.00	$ 500.00
Watering	1	job	$ 500.00	$ 500.00
Soil Delivery	3	job	$ 100.00	$ 300.00
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 1,400.00

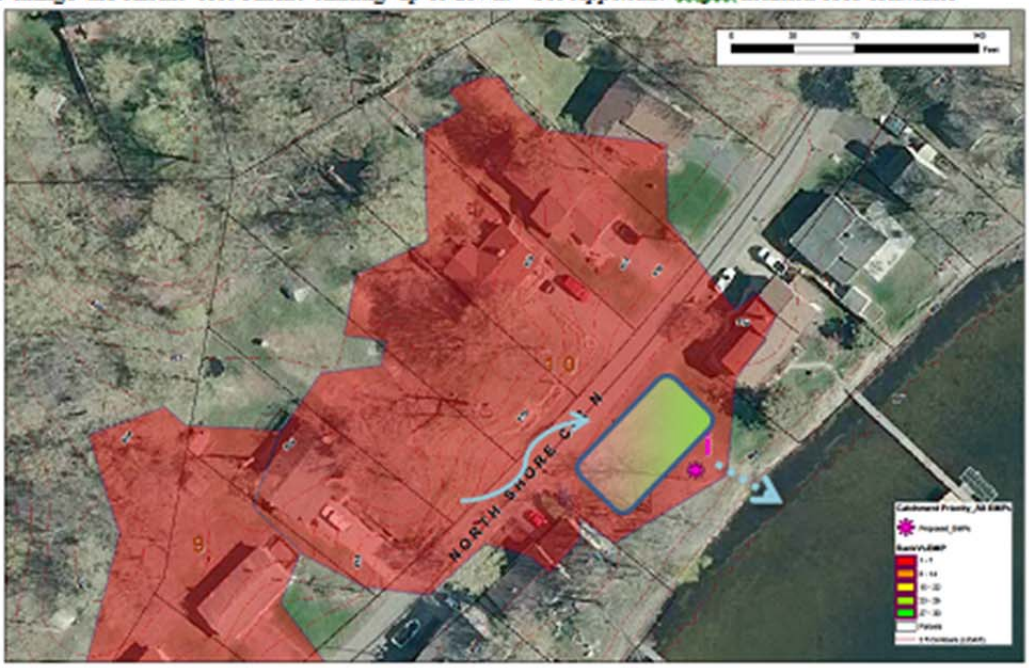
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 2,400.40
	Plants	$ 50.00
	Excavation/Grading	$ 1,906.50
	Misc	$ 1,400.00
	Materials Estimate	$ 2,450.40
	Labor Estimate	$ 8,697.38
	Contingency 10%	$ 1,114.78
	Project Estimate	$ 12,262.56

BMP 10i – Cost Estimate and Concept Plan

FL01-N19: BMP 10i BioInfiltration Basin

Rank 21/64

Drainage Area – 1.16 acres (33% Impervious)
Location – North Shore Circle Park
Property Ownership –Public (City of Forest Lake)
Description – Create a shallow BioInfiltration Basin on the west side of North Shore Circle Park. Basin ponding area will be 1600 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost) and will be vegetated with regular sod. Sod cover is to be used so that park can remain usable in between rain events. The overflow will be a shallow berm that then will flow towards the restored 'unofficial' canoe access point. The basin will be underdrained, and depending on lake elevation relative to the bottom of the treatment cell, underdrain will either be a 4" typical underdrain system or just a narrow vein of buried pea rock (dry well) that weeps to the shore. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $15,206 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 10i - BioInfiltration Mod Complex	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.69	41%
	TSS (lb/yr)	279	47%
	Volume (acre-feet/yr)	0.5	44%
	Number of BMP's	1	
	BMP Size/Description	1,600	sf
	BMP Type	Moderately Complex BioInfiltration	
Cost	Materials/Labor/Design	$14,701.30	
	Promotion & Admin Costs	$325	
	Probable Project Cost	$15,026	
	Annual O&M	$200	
	10-yr Cost/lb-TP/yr	$2,451	
	10-yr Cost/2,000lb-TSS/yr	$12,205	

BMP 11j – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N22 BMP 11j BioInfiltration Basins

Project Address: FLN SWA



Job Description	Cost Summary		
600 sqft BMP x 2 Basins = 1200 sq ft - Pretreatment plantings of 300 ss ft for each basin = 600 sq ft TOTAL Practice area = 1800sf	Project Cost =	$ 15,458.56	Phosphorus Reduction (lbs/yr)
	OVERALL	BMP ONLY	TP= 0.66
	Rank = 37	Rank = 20	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket SC-150BN BioNet	134	sy	$ 1.10	$ 147.40
Securing Staples (6", 1000/ctn)	2	carton	$ 35.00	$ 70.00
			Erosion Control Subtotal	$ 217.40
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	200	each	$ 1.20	$ 240.00
Compost (2")	8	cy	$ 35.10	$ 280.80
			Compost Mulch and Rock Subtotal	$ 520.80
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	360	each	$ 1.00	$ 380.00
#1 Pot	180	each	$ 8.00	$ 1,440.00
4" Pot	380	each	$ 3.00	$ 1,140.00
			Plants Subtotal	$ 2,960.00
Excavation and Grading				
Grading	8	hrs	$ 150.00	$ 1,200.00
Off-Site Disposal of Soil (3" ponding + 2" removal for compost)	18	cy	$ 8.00	$ 144.00
Sod	70	sy	$ 2.50	$ 175.00
			Excavation and Grading Subtotal	$ 1,519.00
Misc				
Watering	1	job	$ 500.00	$ 500.00
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 200.00	$ 200.00
			Misc Subtotal	$ 700.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 738.20
	Plants	$ 2,960.00
	Excavation/Grading	$ 1,519.00
	Misc	$ 700.00
	Materials Estimate	$ 3,698.20
	Labor Estimate	$ 10,355.04
	Contingency 10%	$ 1,405.32
	Project Estimate	$ 15,458.56

BMP 11j – Cost Estimate and Concept Plan

FL01-N22: BMP 11j BioInfiltration Basins

Rank 28/64

Drainage Area – 2.977 acres (25% Impervious)
Location – North side North Shore Trail, west of Acqua Restaurant
Property Ownership – Private/Public, in Right of Way
Description – Convert two existing mown turf depressions to Vegetated BioInfiltration Basins. Depression bottoms will be excavated 3" below inverts of existing culvert pipes that connect under driveways and roads on each lot. Basin ponding area will be 600 sf, will have 3" of ponding, and amended with 70/30 sand /compost mix. The overflow to then lake will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin, or just stop mowing the ditches. The cost of $18,113 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N22 BMP 11j - BioInfiltration Mod Complex New trtmt	Net %
Treatment	TP (lb/yr)	0.66	7%
	TSS (lb/yr)	247	7%
	Volume (acre-feet/yr)	0.4	6%
	Number of BMP's	1	
	BMP Size/Description	1,800	sf
	BMP Type	Moderately Complex BioInfiltration	
Cost	Materials/Labor/Design	$17,712.96	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$18,113	
	Annual O&M	$1,350	
	10-yr Cost/lb-TP/yr	$4,790	
	10-yr Cost/2,000lb-TSS/yr	$25,598	

BMP 15k – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N23_BMP 15k

Project Address: FLN SWA



Job Description	Cost Summary		
Front yard Bioinfiltration basin, 14' x 30' = 420 sqft basin, 3" deep, ponding typically extends further into yard due to location constraints.	**Project Cost =** $ 5,393.08	**Phosphorus Reduction (lbs/yr)**	
	OVERALL Rank = 18	**BMP ONLY Rank = 1**	TP= 0.70

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket SC-150BN BioNet	50	sy	$ 1.10	$ 55.00
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 90.00
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	90	each	$ 1.20	$ 108.00
			Compost Mulch and Rock Subtotal	$ 108.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	63	each	$ 1.00	$ 63.00
#1 Pot	63	each	$ 8.00	$ 504.00
4" Pot	63	each	$ 3.00	$ 189.00
			Plants Subtotal	$ 756.00
Excavation and Grading				
Grading	8	hrs	$ 150.00	$ 1,200.00
Sod	20	sy	$ 2.50	$ 50.00
			Excavation and Grading Subtotal	$ 1,250.00
Misc				
Watering	1	job	$ 500.00	$ 500.00
Herbicide	0	each	$ 50.00	$ -
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 600.00

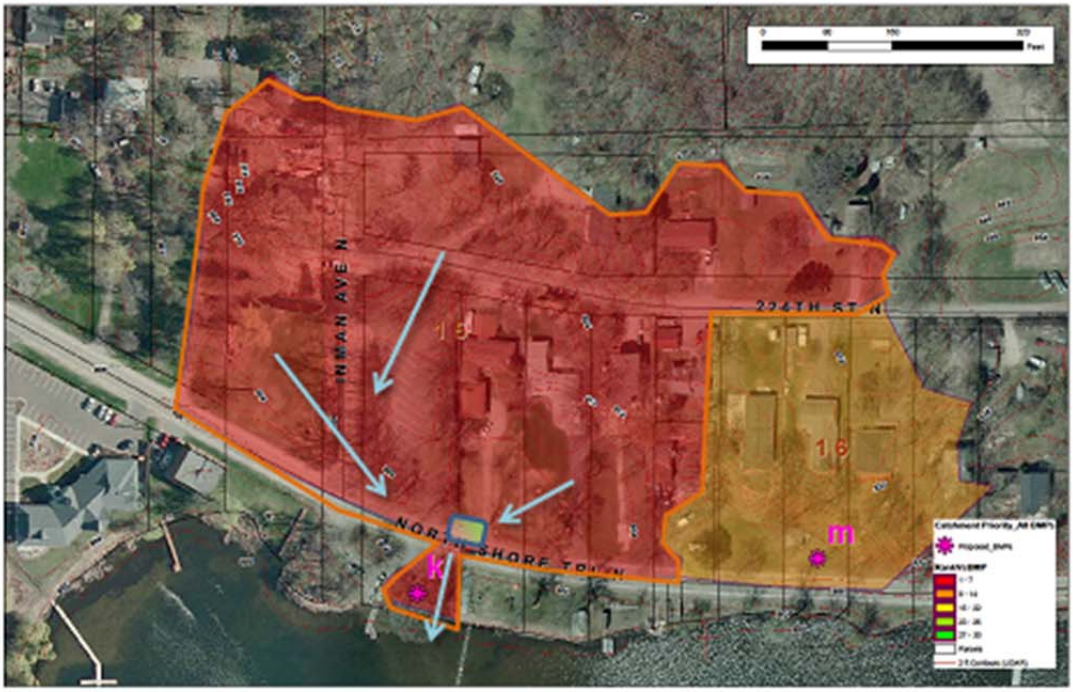
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 196.00
	Plants	$ 756.00
	Excavation/Grading	$ 1,250.00
	Misc	$ 600.00
	Materials Estimate	$ 954.00
	Labor Estimate	$ 3,948.80
	Contingency 10%	$ 490.28
	Project Estimate	**$ 5,393.08**

BMP 15k – Cost Estimate and Concept Plan

FL01-N23: BMP 15k BioInfiltration Basin

Rank 18/64

Drainage Area – 7.611 acres (30% Impervious)
Location – East of Intersection of North Shore Trail and Inman Ave N
Property Ownership – Private/Public, in Right of Way
Description – Convert existing mown turf depression to Vegetated BioInfiltration Basin adjacent to the existing 12" pipe at end of swale run. Basin ponding area will be 500 sf, will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. Presence of existing swales will act as pretreatment for basin. The overflow will be the invert elevation of the existing pipe under the road. Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin, or just stop mowing the depression. The cost of $6,728 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 15k - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.7	14%
	TSS (lb/yr)	102.0	6%
	Volume (acre-feet/yr)	0.2	7%
	Number of BMP's	1	
	BMP Size/Description	420 sf	
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$6,328.00	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$6,728	
	Annual O&M	$315	
	10-yr Cost/lb-TP/yr	$1,399	
	10-yr Cost/2,000lb-TSS/yr	$19,369	

BMP 16m – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N24_BMP 16m

Project Address: FLN SWA



Job Description	Cost Summary		
600 sqft, 3" ponding depth	Project Cost =	$ 4,343.24	Phosphorus Reduction (lbs/yr)
	OVERALL	BMP Only	TP= 0.27
	Rank = 30	Rank = 13	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-3 NAG S-150	90	sy	$ 0.40	$ 36.00
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	**$ 71.00**
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	80	each	$ 1.20	$ 96.00
			Compost Mulch and Rock Subtotal	**$ 96.00**
Drainage Accessories				
			Drainage Subtotal	**$ -**
Plants, Shrubs, and Trees				
Native plug	125	each	$ 1.00	$ 125.00
#1 Pot	40	each	$ 8.00	$ 320.00
4" Pot	100	each	$ 3.00	$ 300.00
			Plants Subtotal	**$ 745.00**
Excavation and Grading				
Grading	4	hrs	$ 150.00	$ 600.00
Off-Site Disposal of Soil (3" ponding)	5	cy	$ 8.00	$ 40.00
Sod	16	sy	$ 2.50	$ 40.00
			Excavation and Grading Subtotal	**$ 680.00**
Misc				
Watering	1	job	$ 500.00	$ 250.00
Herbicide	0	each	$ 50.00	$ -
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cyload)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	**$ 350.00**

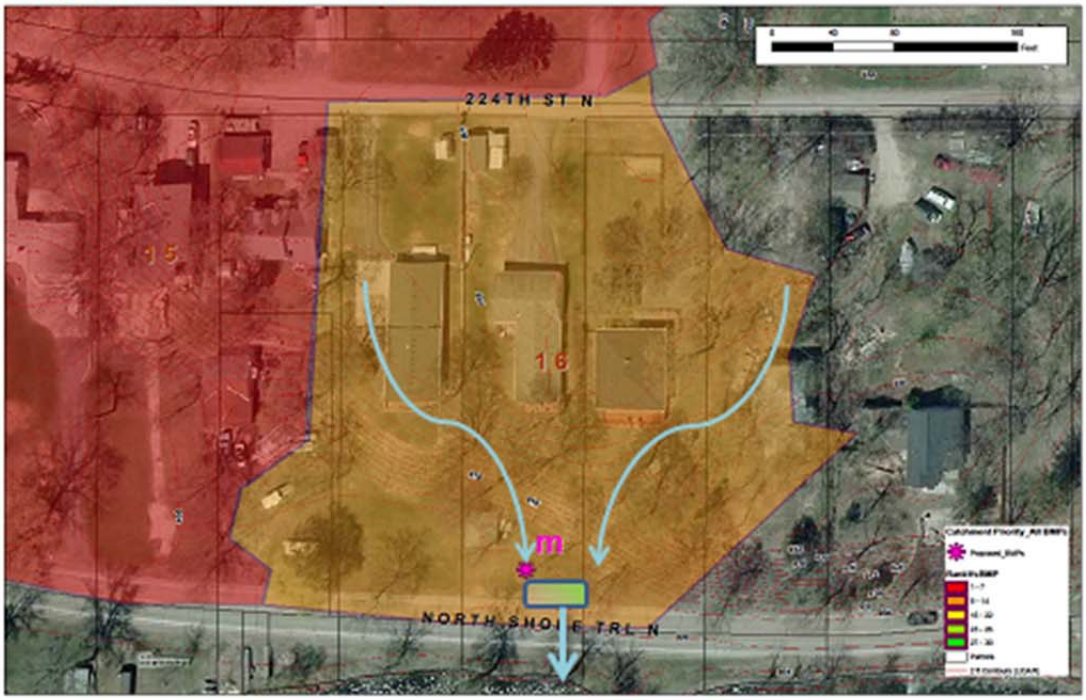
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 167.00
	Plants	$ 745.00
	Excavation/Grading	$ 680.00
	Misc	$ 350.00
	Materials Estimate	$ 912.00
	Labor Estimate	$ 3,036.40
	Contingency 10%	$ 394.84
	Project Estimate	**$ 4,343.24**

BMP 16m – Cost Estimate and Concept Plan

FL01-N24: BMP 16m BioInfiltration Basin

Rank 30/64

Drainage Area – 2.327 acres (33% Impervious)
Location – Tip of Road Loop on North Shore Circle
Property Ownership – Private/Public, partially in Right of Way
Description – Convert existing mown turf depression at corner of residential driveway to Vegetated BioInfiltration Basin. Basin will act as a filter for runoff from yards and North Shore Trail before sediment discharges to lake. Basin ponding area will be 600 sf, will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. The overflow will be the crown of the road (ponding may be deeper than proposed). Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin (sod), or just stop mowing the depression. The cost of $5,346 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



Cost/Removal Analysis		Project ID: BMP 16m - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.27	2%
	TSS (lb/yr)	109	2%
	Volume (acre-feet/yr)	0.2	3%
	Number of BMP's	1	
	BMP Size/Description	600 sf	
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$5,216.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$5,346	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$3,620	
	10-yr Cost/2,000lb-TSS/yr	$18,066	

BMP 19n – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N24_BMP 19N

Project Address: FLN SWA

COMFORT LAKE
WATERSHED DISTRICT
FOREST LAKE

44 Lake Street South, Suite A
Forest Lake, MN 55025
Phone: 651-385-5930

Job Description	Cost Summary		
600 sqft, 3" ponding depth	Project Cost =	$ 4,343.24	Phosphorus Reduction (lbs/yr)
	OVERALL	BMP ONLY	TP= 0.32
	Rank = 26	Rank = 9	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-3 NAG S-150	90	sy	$ 0.40	$ 36.00
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 71.00
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	80	each	$ 1.20	$ 96.00
			Compost Mulch and Rock Subtotal	$ 96.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	125	each	$ 1.00	$ 125.00
#1 Pot	40	each	$ 8.00	$ 320.00
4" Pot	100	each	$ 3.00	$ 300.00
			Plants Subtotal	$ 745.00
Excavation and Grading				
Grading	4	hrs	$ 150.00	$ 600.00
Off-Site Disposal of Soil (3" ponding)	5	cy	$ 8.00	$ 40.00
Sod	16	sy	$ 2.50	$ 40.00
			Excavation and Grading Subtotal	$ 680.00
Misc				
Watering	1	job	$ 500.00	$ 250.00
Herbicide	0	each	$ 50.00	$ -
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cyload)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 350.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 167.00
	Plants	$ 745.00
	Excavation/Grading	$ 680.00
	Misc	$ 350.00
	Materials Estimate	$ 912.00
	Labor Estimate	$ 3,036.40
	Contingency 10%	$ 394.84
	Project Estimate	$ 4,343.24

BMP 19n – Cost Estimate and Concept Plan

FL01-N24: BMP 19n BioInfiltration Basin

Rank 26/64

Drainage Area – 2.658 acres (33% Impervious)
Location – Intersection of Inman Ave and North Shore Trail
Property Ownership – Private/Public, partially in Right of Way
Description – Convert existing mown turf depression at NW corner of intersection to Vegetated BioInfiltration Basin. Basin will act as a filter for gravel runoff from Inman Ave before sediment discharges to lake. Basin ponding area will be 600 sf, will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. The overflow will be the crown of the road (ponding may be deeper than proposed). Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin (sod), or just stop mowing the depression. The cost of $5,432 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



Cost/Removal Analysis		Project ID: BMP 19n - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.32	2%
	TSS (lb/yr)	105	2%
	Volume (acre-feet/yr)	0.2	3%
	Number of BMP's	1	
	BMP Size/Description	600 sf	
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$5,302.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$5,432	
	Annual O&M	$450	
	10-yr Cost/lb-TP/yr	$3,153	
	10-yr Cost/2,000lb-TSS/yr	$18,918	

BMP 20q – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N26_20q Ponded Swale

Project Address: FLN SWA



Job Description	Cost Summary		
Swale Amendement. Kill turf and re-grade incised channel to 4:1 slope. Berm downhill edge of swale to facilitate ponding. Erosion Control Blanket in basin and to protect overflow berm.	Project Cost =	$ 3,525.89	Phosphorus Reduction (lbs/yr)
	OVERALL	BMP ONLY	TP= 0.17
	Rank = 32	Rank = 15	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-3 NAG AEC Wood Fiber Curlex II Doul	40	sy	$ 0.56	$ 22.40
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 57.40
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	100	each	$ 1.20	$ 120.00
			Compost Mulch and Rock Subtotal	$ 120.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	60	each	$ 1.00	$ 60.00
#1 Pot	60	each	$ 8.00	$ 480.00
4" Pot	60	each	$ 3.00	$ 180.00
			Plants Subtotal	$ 720.00
Excavation and Grading				
Grading	3	hrs	$ 150.00	$ 450.00
Sod Repair	15	sy	$ 2.50	$ 37.50
			Excavation and Grading Subtotal	$ 487.50
Misc				
Watering	1	job	$ 250.00	$ 250.00
			Misc Subtotal	$ 250.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 177.40
	Plants	$ 720.00
	Excavation/Grading	$ 487.50
	Misc	$ 250.00
	Materials Estimate	$ 897.40
	Labor Estimate	$ 2,307.95
	Contingency 10%	$ 320.54
	Project Estimate	**$ 3,525.89**

BMP 20q– Cost Estimate and Concept Plan

FL01-N26: BMP 20q BioInfiltration Basin

Rank 29/64

Drainage Area – 1.006 acres (33% Impervious)
Location – Tip of Road Loop on North Shore Circle
Property Ownership – Private/Public, partially in Right of Way
Description – Create a shallow BioInfiltration Basin above the existing open swale east of Jason Ave. Basin ponding area will be 250 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost). Incised channel will be regraded to 4:1 side slopes. The overflow will be a checkdam of riprap, discharging to existing channel. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $4,481 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N26 BMP 20q - BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.17	1%
	TSS (lb/yr)	77.00	1%
	Volume (acre-feet/yr)	0.11	1%
	Number of BMP's	1	
	BMP Size/Description	250	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$4,351.36	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$4,481	
	Annual O&M	$188	
	10-yr Cost/lb-TP/yr	$3,739	
	10-yr Cost/2,000lb-TSS/yr	$16,510	

BMP 21r – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N26_21r BioInfiltration

Project Address: FLN SWA

COMFORT LAKE WATERSHED DISTRICT FOREST LAKE

Job Description	Cost Summary		
west of city parcel at site between houses 2 and 3 from corner...by power pole between driveways	Project Cost =	$ 5,811.30	Phosphorus Reduction (lbs/yr)
	OVERALL	BMP ONLY	TP= 0.31
	Rank = 29	Rank = 12	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket SC-150BN BioNet	50	sy	$ 1.10	$ 55.00
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 90.00
Compost, Mulch, and Rock				
Edging (Bullet Paver Edger- Interloc 3.375"x11.75")	100	each	$ 1.20	$ 120.00
			Compost Mulch and Rock Subtotal	$ 120.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	85	each	$ 1.00	$ 85.00
#1 Pot	70	each	$ 8.00	$ 560.00
4" Pot	70	each	$ 3.00	$ 210.00
			Plants Subtotal	$ 855.00
Excavation and Grading				
Grading	8	hrs	$ 150.00	$ 1,200.00
Sod	30	sy	$ 2.50	$ 75.00
			Excavation and Grading Subtotal	$ 1,275.00
Misc				
Watering	1	job	$ 500.00	$ 500.00
Herbicide	0	each	$ 50.00	$ -
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 600.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 210.00
	Plants	$ 855.00
	Excavation/Grading	$ 1,275.00
	Misc	$ 600.00
	Materials Estimate	$ 1,065.00
	Labor Estimate	$ 4,218.00
	#N/A	$ 528.30
	Project Estimate	$ 5,811.30

BMP 21r – Cost Estimate and Concept Plan

FL01-N26: BMP 21r BioInfiltration Basin

Rank 32/64

Drainage Area – 0.909 acres (30% Impervious)
Location – South end of Jason Ave
Property Ownership – Private/Public, partially in Right of Way
Description – Create a shallow BioInfiltration Basin above the existing lawn swale north of Jason Ave (between two driveways). Basin ponding area will be 500 sf, will have 3" of ponding, and 1' of replacement soils (70/30 sand/compost). The overflow to existing swale will be a berm that will likely have to be armored with riprap since it is a flow-through basin. There is currently no pretreatment in this design. Other ideas beyond this concept could include an expanded footprint or different vegetation for the basin. The cost of $7,026 could be lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		RETROFIT OPTIONS Catchment FL01-N26 BMP 21r- BioInfiltration Simple	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.31	2%
	TSS (lb/yr)	137.00	2%
	Volume (acre-feet/yr)	0.18	2%
	Number of BMP's	1	
	BMP Size/Description	500	sf
	BMP Type	Simple BioInfiltration	
Cost	Materials/Labor/Design	$6,896.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$7,026	
	Annual O&M	$375	
	10-yr Cost/lb-TP/yr	$3,454	
	10-yr Cost/2,000lb-TSS/yr	$15,731	

BMP 22s – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N27 BMP 22s Ponded Swale

Project Address: FLN SWA
Mailing Address: Same
Property PIN: xxxxxxxxxxxx
2/9/2016

Job Description	Cost Summary		
22 U, pre-treatment system, vegetated swale	Project Cost =	$ 2,708.99	Phosphorus Reduction (lbs/yr)
	OVERALL	BMP ONLY	TP= 0.03
	Rank = 62	Rank = 30	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-3 NAG S-150	9	sy	$ 0.40	$ 3.60
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 38.60
Compost, Mulch, and Rock				
				$ -
			Compost Mulch and Rock Subtotal	$ -
Drainage Accessories				
RipRap Limestone (4-9")	1	ton	$ 65.25	$ 65.25
			Drainage Subtotal	$ 65.25
Plants, Shrubs, and Trees				
Native plug	63	each	$ 1.00	$ 63.00
#1 Pot	0	each	$ 8.00	$ -
4" Pot	63	each	$ 3.00	$ 189.00
			Plants Subtotal	$ 252.00
Excavation and Grading				
Grading	4	hrs	$ 150.00	$ 600.00
Off-Site Disposal of Soil (3" clean out)	3	cy	$ 8.00	$ 24.00
				$ -
			Excavation and Grading Subtotal	$ 624.00
Misc				
Watering	1	job	$ 500.00	$ 500.00
Herbicide	0	each	$ 50.00	$ -
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	1	job	$ 100.00	$ 100.00
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 700.00

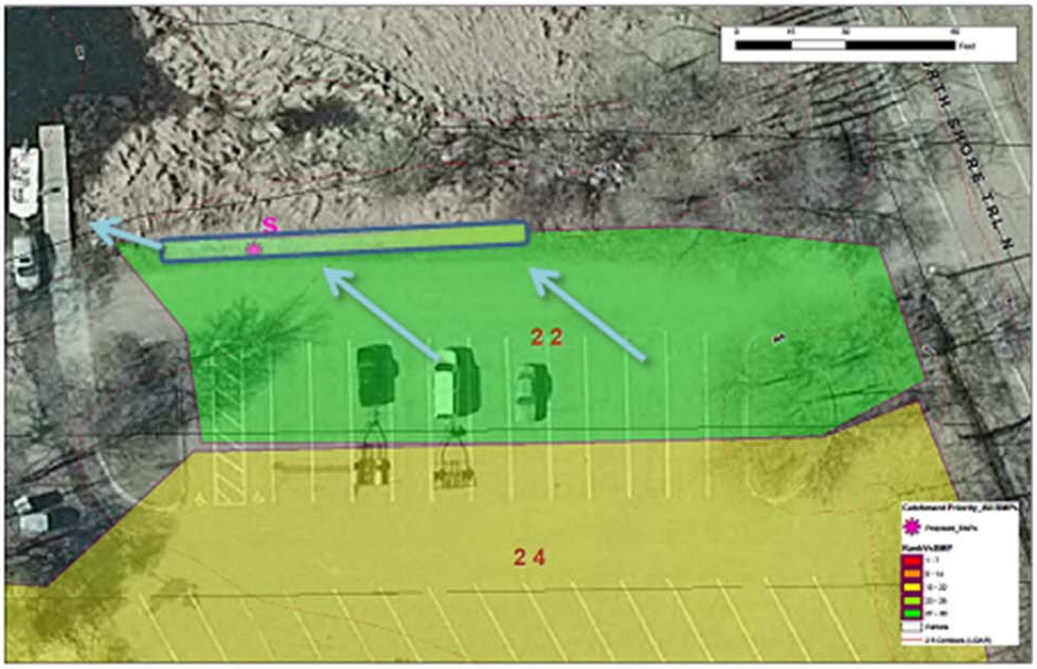
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 103.85
	Plants	$ 252.00
	Excavation/Grading	$ 624.00
	Misc	$ 700.00
	Materials Estimate	$ 355.85
	Labor Estimate	$ 2,106.87
	Contingency 10%	$ 246.27
	Project Estimate	$ 2,708.99

BMP 22s – Cost Estimate and Concept Plan

FL01-N27: BMP 22s Swale with Ponding

Rank 62/64

Drainage Area – 0.259 acres (33% Impervious)
Location – DNR Public Water Access, north side of lot
Property Ownership – Public (DNR)
Description – Convert existing lawn strip along north edge of lot to a shallow swale that can pond up to 3" of stormwater runoff and boat drainage. Swale ponding area will be 200 sf (4'x50'), will have 3" of ponding, and 1' of ripped soil amended with 70/30 sand/compost mix. The overflow will be a riprap checkdam at the end of the swale before it discharges directly to the lake. Other ideas beyond this concept could include an expanded footprint, different vegetation for the basin (sod), or installing a more robust pretreatment device in lieu of an excavated basin. The cost of $3,364 could be substantially lower if alternatives to planting design and subsoil replacement are considered. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



Cost/Removal Analysis		Project ID: BMP 22s - Swale with Ponding	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.03	0%
	TSS (lb/yr)	31	1%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	1	
	BMP Size/Description	200 sf	
	BMP Type	Water Quality Swale	
Cost	Materials/Labor/Design	$3,234.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	**$3,364**	
	Annual O&M	$150	
	10-yr Cost/lb-TP/yr	**$16,213**	
	10-yr Cost/2,000lb-TSS/yr	**$31,381**	

BMP 24u – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N27_24u

Project Address: FLN SWA



Job Description	Cost Summary		
Clean out swale inlets and replace sod (8x8 sections x 4). Repair wood weir in raingarden to stop short-circuit of raingarden overflow. Estimate accounts for flex in weir repair since it is unknow if minor fill and some wood will fix it or if footings and entire weir need to be replaced.	Project Cost = $ 2,620.00 OVERALL Rank = 33 BMP ONLY Rank = 16	Phosphorus Reduction (lbs/yr) TP= 0.07	

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
			Erosion Control Subtotal	$ -
Compost, Mulch, and Rock				
Wood, fix wier	1	job	$ 600.00	$ 600.00
			Compost Mulch and Rock Subtotal	$ 600.00
Drainage Accessories				
			Drainage Subtotal	$ -
Plants, Shrubs, and Trees				
Native plug	100	each	$ 1.00	$ 100.00
			Plants Subtotal	$ 100.00
Excavation and Grading				
Sod Replacememnt at Inlets	40	sy	$ 6.00	$ 240.00
Off-Site Disposal of Soil (3" clean out)	4	cy	$ 8.00	$ 32.00
				$ -
			Excavation and Grading Subtotal	$ 272.00
Misc				
Watering	1	job	$ 200.00	$ 200.00
Herbicide	0	job	$ 50.00	$ -
Soil Delivery	0	job	$ 100.00	$ -
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	0	job	$ 100.00	$ -
			Misc Subtotal	$ 200.00

ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 600.00
	Plants	$ 100.00
	Excavation/Grading	$ 272.00
	Misc	$ 200.00
	Materials Estimate	$ 700.00
	Labor Estimate	$ 1,697.00
	Contingency 10%	$ 223.00
	Project Estimate	$ 2,620.00

BMP 24u – Cost Estimate and Concept Plan

FL01-N27: BMP 24u Basin and Swale Modifications

Rank 33/64

Drainage Area – 0.943 acres (85% Impervious)
Location – DNR Public Water Access parking lot
Property Ownership – Public (DNR)
Description – Clean out inlets to swale on south side of lot. Replace sod strips that were removed. This will allow swale to receive water again. Fix wood weir at outfall of raingarden at west end of lot. Currently short-circuits and could hold more water for treatment if repaired. Other ideas beyond this concept could include an expanded footprint for the raingarden or swale. The cost of $2,620 has been intentionally overestimated since it is not known if the footings for the weir will have to be replaced or not. The cost could be substantially lower if repairing the weir only required backfilling of soil and minor replacement of the top wood panels. All alternatives would change the current cost/benefit ranking up or down. ***See Appendix C for detailed cost estimates***



Cost/Removal Analysis		Project ID: BMP 24u - Swale Inlet and Raingarden Outfall Modification	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.07	1%
	TSS (lb/yr)	46	2%
	Volume (acre-feet/yr)	0.1	1%
	Number of BMP's	1	
	BMP Size/Description	2	Mods
	BMP Type	Raingarden Retrofits	
Cost	Materials/Labor/Design	$2,490.00	
	Promotion & Admin Costs	$130	
	Probable Project Cost	$2,620	
	Annual O&M	$0	
	10-yr Cost/lb-TP/yr	$3,743	
	10-yr Cost/2,000lb-TSS/yr	$11,392	

BMP 25v – Cost Estimate and Concept Plan

Cost Estimate

COMFORT LAKE FOREST LAKE WATERSHED DISTRICT

CLFLWD Cost-Share

Catchment N31_25v IESF bench

Project Address: FLN SWA



Job Description	Cost Summary
60 LF Iron Enhanced Sand Filter, 5% iron by weight. 60x1.5x6	Project Cost = $ 15,553.64 Phosphorus Reduction (lbs/yr) OVERALL BMP ONLY TP= 0.83 Rank = 23 Rank = 6

Job Estimate

Erosion Control Materials	Qty	Unit	Unit Cost	Amount
Erosion Control Blanket Cat-2 NAG S-75	100	sy	$ 0.33	$ 33.00
Securing Staples (6", 1000/ctn)	1	carton	$ 35.00	$ 35.00
			Erosion Control Subtotal	$ 68.00
Compost, Mulch, and Rock				
Iron Enhanced sand 5% by weight, premixed	20	cy	$ 75.00	$ 1,500.00
			Compost Mulch and Rock Subtotal	$ 1,500.00
Drainage Accessories				
draintile and cleanout assemblies	1	unit	$ 400.00	$ 400.00
gatevalve assembly	1	unit	$ 350.00	$ 350.00
45 mil geomembrane liner for trench, 10' wide	70	lf	$ 10.91	$ 763.70
			Drainage Subtotal	$ 1,513.70
Plants, Shrubs, and Trees				
Native plug (as restoration for access and near trench areas)	400	each	$ 1.00	$ 400.00
shrubs	4	each	$ 15.00	$ 60.00
			Plants Subtotal	$ 460.00
Excavation and Grading				
Trench Excavation and Grading for outfall retrofit	10	hrs	$ 150.00	$ 1,500.00
Pneumatic bore under pathway for 4" draintile, 60ft run	1	job	$ 2,500.00	$ 2,500.00
				$ -
			Excavation and Grading Subtotal	$ 4,000.00
Misc				
Soil Delivery	2	job	$ 150.00	$ 300.00
Rock Delivery	0	job	$ 100.00	$ -
Mulch Delivery (14cy/load)	0	job	$ 100.00	$ -
Plant Delivery	1	job	$ 100.00	$ 100.00
			Misc Subtotal	$ 400.00

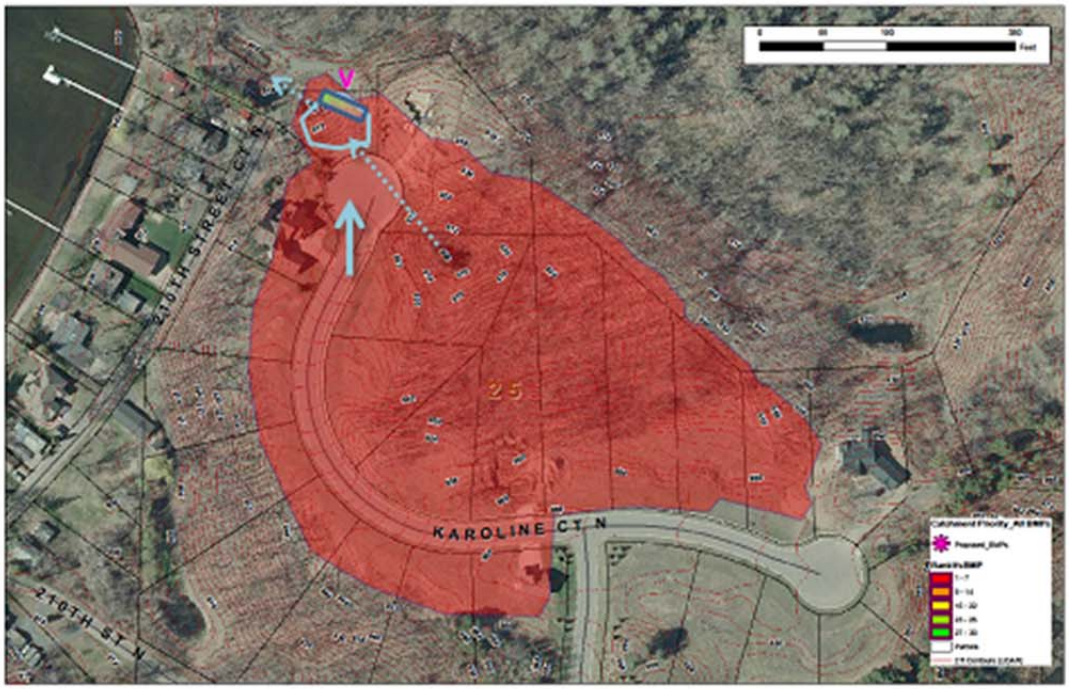
ADDITIONAL NOTES	PROJECT SUBTOTALS	
	Materials	$ 3,081.70
	Plants	$ 460.00
	Excavation/Grading	$ 4,000.00
	Misc	$ 400.00
	Materials Estimate	$ 3,541.70
	Labor Estimate	$ 10,597.98
	Contingency 10%	$ 1,413.97
	Project Estimate	$ 15,553.64

BMP 25v – Cost Estimate and Concept Plan

FL01-N31: BMP 25v IESF Bench Retrofit

Rank 23/64

Drainage Area – 9.25 acres (30% Impervious)
Location – BioInfiltration Basin at end of Karoline Ct N
Property Ownership –Private (HOA)
Description – Install a 60' x 4' Iron Enhanced Filter Bench on north side of BioInfiltration Basin. Bench Elevation should be set according to invert elevation of outlet pipe to allow for both the ability to be submerged during a rain event as well as to be completely dry in times between rain events. The cost of $18,339 has been intentionally overestimated since it is not known how deep or wide the soil replacement media can go before having to consider permanent soil saturation and typical ponding elevations. The cost could be substantially lower if smaller amounts of enhanced media will need to be used. All alternatives would change the current cost/benefit ranking up or down.
See Appendix C for detailed cost estimates



Cost/Benefit Analysis		Project ID: BMP 25v - IESF Bench Retrofit	
		New trtmt	Net %
Treatment	TP (lb/yr)	0.83	16%
	TSS (lb/yr)	15	1%
	Volume (acre-feet/yr)	0.0	0%
	Number of BMP's	1	
	BMP Size/Description	60 lf	
	BMP Type	Perimeter Sand Filter	
Cost	Materials/Labor/Design	$17,939.28	
	Promotion & Admin Costs	$400	
	Probable Project Cost	$18,339	
	Annual O&M	$500	
	10-yr Cost/lb-TP/yr	$2,812	
	10-yr Cost/2,000lb-TSS/yr	$311,190	

Appendix D:
Ranking Tables and Maps for all BMPs
(ranked per scenario)

RANKING TABLE: All Proposed Practices

The following ranking table is for all proposed practices in this report, ranked by Cost/lbTP/year over 10 years. See page 220 for map of prioritized rank of catchments based on best BMP locations. Practices are grouped and color coded by priority, with 5 breaks determined by ArcGIS (using Natural Breaks (Jenks) selection method).

RANKED BY

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	# Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	$Cost/ lb-TP/year (10-year)
1	N2	Increased Street Sweeping to 4x per year	1	1.01	523	0.00	$469	$46
2	N5	Increased Street Sweeping to 4x per year	1	1.58	600	0.00	$812	$52
3	N26	Increased Street Sweeping to 4x per year	1	0.80	341	0.00	$750	$94
4	N7	Increased Street Sweeping to 4x per year	1	0.72	307	0.00	$694	$96
5	N22	Increased Street Sweeping to 4x per year	1	0.77	337	0.00	$745	$97
6	N3	Increased Street Sweeping to 4x per year	1	0.81	491	0.00	$790	$98
7	N24	Increased Street Sweeping to 4x per year	1	0.74	313	0.00	$748	$101
8	N13	Increased Street Sweeping to 4x per year	1	0.61	261	0.00	$646	$106
9	N18	Increased Street Sweeping to 4x per year	1	0.62	268	0.00	$711	$114
10	N12	Increased Street Sweeping to 4x per year	1	0.60	256	0.00	$692	$116
11	N11	Increased Street Sweeping to 4x per year	1	0.52	217	0.00	$701	$135
12	N27	Increased Street Sweeping to 4x per year	1	0.49	125	0.00	$667	$135
13	N25	Increased Street Sweeping to 4x per year	1	0.47	200	0.00	$657	$139
14	N16	Increased Street Sweeping to 4x per year	1	0.45	191	0.00	$675	$152
15	N23	Increased Street Sweeping to 4x per year	1	0.40	144	0.00	$653	$164
16	N20	Increased Street Sweeping to 4x per year	1	0.35	150	0.00	$657	$188
17	N19	Increased Street Sweeping to 4x per year	1	0.12	51	0.00	$625	$517
18	N23	BMP 15k - BioInfiltration Simple	1	0.71	102	0.20	$6,728	$1,399
19	N11	Priority Shoreline 102,103,104,105	15	8.69	15449	0.95	$96,850	$1,810
20	N7	BMP 2b - Vegetated Swale	1	0.14	53	0.04	$1,620	$2,085

RANKING TABLE: All Proposed Practices *(continued)*

RANKED BY

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	# Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	$Cost/ lb-TP/year (10-year)
21	N18	BMP 9h - BioInfiltration Simple	1	0.42	185	0.29	$4,567	$2,409
22	N19	BMP 10i - BioInfiltration Mod Complex	1	0.69	279	0.46	$15,026	$2,451
23	N31	BMP 25v - IESF Bench Retrofit	1	0.83	15	0.00	$18,339	$2,812
24	N12	BMP 6g,7f,8e - Retention Swales and BioInfiltration Mod Complex	3	1.14	455	0.61	$21,022	$2,831
25	N20	Priority Shoreline 108, 109	7	2.49	2588	0.86	$47,479	$3,094
26	N24	BMP 19n - BioInfiltration Simple	1	0.32	105	0.23	$5,432	$3,153
27	N12	BMP 4d- BioInfiltration Simple	1	0.45	182	0.33	$9,049	$3,322
28	N22	Priority Shoreline 110, 111, 112, 113	18	8.21	10892	1.65	$167,549	$3,334
29	N26	BMP 21r- BioInfiltration Simple	1	0.31	137	0.18	$7,026	$3,454
30	N24	BMP 16m - BioInfiltration Simple	1	0.27	109	0.23	$5,346	$3,620
31	N27	Priority Shoreline 119, 120,121,122,134	22	7.03	6914	2.00	$159,016	$3,683
32	N26	BMP 20q - BioInfiltration Simple	1	0.17	77	0.11	$4,481	$3,739
33	N27	BMP 24u - Swale Inlet and Raingarden Outfall Modification	1	0.07	46	0.05	$2,620	$3,743
34	N10	Priority Shoreline 101	3	1.12	1543	0.42	$29,489	$4,296
35	N5	Priority Shoreline 136-140	10	2.15	2735	1.05	$61,600	$4,655
36	N12	Priority Shoreline 106	3	0.97	1535	0.10	$27,704	$4,674
37	N22	BMP 11j - BioInfiltration Mod Complex	1	0.66	247	0.38	$18,113	$4,790
38	N29	Priority Shoreline 123 to 133	12	5.13	6106	1.75	$150,705	$4,822
39	N11	BMP 3c - BioInfiltration Mod Complex	1	0.36	152	0.16	$14,305	$4,951
40	N27	Shoreline Restorations-Typ Participation Rates	3	0.60	240	0.27	$16,698	$5,051
41	N7	Priority Shoreline 100 & 141	3	0.87	1243	0.33	$27,403	$5,138
42	N24	Priority Shoreline 115, 116, 117	11	2.04	1078	0.63	$70,523	$5,612
43	N25	Priority Shoreline 118	3	0.80	993	0.33	$27,704	$5,623
44	N7	BMP 1a - Parking Lot Retrofit	1	0.44	53	0.77	$22,506	$6,082

RANKING TABLE: All Proposed Practices *(continued)*

RANKED BY

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	# Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	$Cost/ lb-TP/year (10-year)
45	N22	Shoreline Restorations-Typ Participation Rates	2	0.38	156	0.18	$12,967	$6,207
46	N24	Shoreline Restorations-Typ Participation Rates	4	0.68	288	0.23	$24,082	$6,453
47	N23	Priority Shoreline 114	3	0.62	376	0.17	$26,213	$6,884
48	N18	Priority Shoreline 107	10	1.51	1832	0.58	$84,206	$9,077
49	N20	Shoreline Restorations-Typ Participation Rates	3	0.48	156	0.22	$24,270	$9,275
50	N29	Shoreline Restorations-Typ Participation Rates	1	0.18	60	0.11	$9,697	$9,852
51	N2	Shoreline Restorations-Typ Participation Rates	15	1.50	600	1.31	$82,035	$9,969
52	N2	Priority Shoreline 135	1	0.12	74	0.13	$7,375	$10,064
53	N25	Shoreline Restorations-Typ Participation Rates	15	1.82	570	1.62	$104,526	$10,565
54	N32	Shoreline Restorations-Typ Participation Rates	8	1.12	344	0.52	$64,370	$10,569
55	N10	Shoreline Restorations-Typ Participation Rates	3	0.42	162	0.24	$24,270	$10,600
56	N5	Shoreline Restorations-Typ Participation Rates	15	1.35	540	1.31	$82,035	$11,077
57	N7	Shoreline Restorations-Typ Participation Rates	15	1.35	540	1.31	$82,035	$11,077
58	N26	Shoreline Restorations-Typ Participation Rates	6	0.78	330	0.30	$48,330	$11,388
59	N13	Shoreline Restorations-Typ Participation Rates	5	0.60	220	0.34	$40,310	$12,343
60	N16	Shoreline Restorations-Typ Participation Rates	4	0.48	160	0.28	$32,290	$12,352
61	N12	Shoreline Restorations-Typ Participation Rates	2	0.16	64	0.06	$14,116	$16,090
62	N27	BMP 22s - Swale with Ponding	1	0.03	31	0.05	$3,364	$16,213
63	N18	Shoreline Restorations-Typ Participation Rates	5	0.35	115	0.29	$32,102	$16,758
64	N11	Shoreline Restorations-Typ Participation Rates	10	0.80	320	1.05	$175,520	$40,806

RANKING TABLE: BMPs and Priority Shoreline Catchment Only

The following ranking table is only for non-shoreline BMPs and Priority Shoreline Catchments. This table eliminates Street Sweeping and Typical Shoreline Restorations so that these selected BMPs can be seen ranked against only each other. See page 221 for map of prioritized rank of best individual BMP locations.

RANKED BY

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2012 Dolla	Estimated cost/ lb-TP/year (10-year)	Estimated cost/ ton-TSS/year (10-year)
1	N23	BMP 15k - BioInfiltration Simple	1	0.7	102.0	0.2	$6,728	$315	$1,399.15	$19,369
2	N11	Priority Shoreline 102,103,104,105	15	8.69	15,449	1.0	$96,850	$6,037	$1,810.07	$2,035
3	N7	BMP 2b - Vegetated Swale	1	0.14	53	0.0	$1,620	$132	$2,084.96	$11,094
4	N18	BMP 9h - BioInfiltration Simple	1	0.42	185	0.3	$4,567	$563	$2,409.46	$11,018
5	N19	BMP 10i - BioInfiltration Mod Complex	1	0.69	279	0.5	$15,026	$200	$2,451.00	$12,205
6	N31	BMP 25v - IESF Bench Retrofit	1	0.83	15	0.0	$18,339	$500	$2,811.96	$311,190
7	N12	BMP 6g,7f,8e - Retention Swales and BioInfiltration Mod Complex	3	1.14	455.0	0.6	$21,022	$1,125	$2,830.85	$14,185
8	N20	Priority Shoreline 108, 109	7	2.49	2,588	0.9	$47,479	$2,960	$3,094.32	$5,957
9	N24	BMP 19n - BioInfiltration Simple	1	0.32	105	0.2	$5,432	$450	$3,153.02	$18,918
10	N12	BMP 4d- BioInfiltration Simple	1	0.45	182.0	0.3	$9,049	$600	$3,322.12	$16,538
11	N22	Priority Shoreline 110, 111, 112, 113	18	8.21	10,892	1.6	$167,549	$10,624	$3,333.64	$5,027
12	N26	BMP 21r- BioInfiltration Simple	1	0.31	137.00	0.18	$7,026	$375	$3,453.85	$15,731
13	N24	BMP 16m - BioInfiltration Simple	1	0.27	109	0.2	$5,346	$450	$3,619.85	$18,066
14	N27	Priority Shoreline 119, 120,121,122,134	22	7.03	6,914	2.0	$159,016	$9,977	$3,683.33	$7,486
15	N26	BMP 20q - BioInfiltration Simple	1	0.17	77.00	0.11	$4,481	$188	$3,739.04	$16,510
16	N27	BMP 24u - Swale Inlet and Raingarden Outfall Modification	1	0.07	46	0.1	$2,620	$0	$3,743.19	$11,392
17	N10	Priority Shoreline 101	3	1.12	1,543	0.4	$29,489	$1,862	$4,295.53	$6,236
18	N5	Priority Shoreline 136-140	10	2.15	2,735	1.1	$61,600	$3,825	$4,655.01	$7,302
19	N12	Priority Shoreline 106	3	0.97	1,535	0.1	$27,704	$1,745	$4,673.93	$5,883
20	N22	BMP 11j - BioInfiltration Mod Complex	1	0.66	247	0.4	$18,113	$1,350	$4,789.84	$25,598
21	N29	Priority Shoreline 123 to 133	12	5.13	6,106	1.8	$150,705	$9,644	$4,822.42	$8,095
22	N11	BMP 3c - BioInfiltration Mod Complex	1	0.36	152	0.2	$14,305	$375	$4,950.64	$23,757
23	N7	Priority Shoreline 100 & 141	3	0.87	1,243	0.3	$27,403	$1,725	$5,138	$7,184
24	N24	Priority Shoreline 115, 116, 117	11	2.04	1,078	0.6	$70,523	$4,391	$5,612.03	$21,230
25	N25	Priority Shoreline 118	3	0.80	993	0.3	$27,704	$1,745	$5,622.69	$9,094
26	N7	BMP 1a - Parking Lot Retrofit	1	0.44	53	0.8	$22,506	$450	$6,082.48	$101,910
27	N23	Priority Shoreline 114	3	0.62	376	0.2	$26,213	$1,647	$6,883.56	$22,701
28	N18	Priority Shoreline 107	10	1.51	1,832	0.6	$84,206	$5,312	$9,076.58	$14,992
29	N2	Priority Shoreline 135	1	0.12	74	0.1	$7,375	$450	$10,063.56	$32,095
30	N27	BMP 22s - Swale with Ponding	1	0.03	31	0.1	$3,364	$150	$16,213.33	$31,381

RANKING TABLE: All Shorelines ONLY

The following ranking table is only for Priority Shoreline Catchments and Typical Shoreline Restorations. See page 222 for map of prioritized shoreline rankings based on best shoreline restoration opportunities.

RANKED BY

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	Projects Identified	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2012 Dolla	Estimated cost/ lb-TP/year (10-year)	Estimated cost/ ton-TSS/year (10-year)
1	N11	Priority Shoreline 102,103,104,105	15	8.69	15,449	1.0	$96,850	$6,037	$1,810.07	$2,035
2	N20	Priority Shoreline 108, 109	7	2.49	2,588	0.9	$47,479	$2,960	$3,094.32	$5,957
3	N22	Priority Shoreline 110, 111, 112, 113	18	8.21	10,892	1.6	$167,549	$10,624	$3,333.64	$5,027
4	N27	Priority Shoreline 119, 120,121,122,134	22	7.03	6,914	2.0	$159,016	$9,977	$3,683.33	$7,486
5	N10	Priority Shoreline 101	3	1.12	1,543	0.4	$29,489	$1,862	$4,295.53	$6,236
6	N5	Priority Shoreline 136-140	10	2.15	2,735	1.1	$61,600	$3,825	$4,655.01	$7,302
7	N12	Priority Shoreline 106	3	0.97	1,535	0.1	$27,704	$1,745	$4,673.93	$5,883
8	N29	Priority Shoreline 123 to 133	12	5.13	6,106	1.8	$150,705	$9,644	$4,822.42	$8,095
9	N27	Shoreline Restorations-Typ Participation Rates	3	0.6	240.0	0.3	$16,698	$1,361	$5,051.02	$25,255
10	N24	Priority Shoreline 115, 116, 117	11	2.04	1,078	0.6	$70,523	$4,391	$5,612.03	$21,230
11	N25	Priority Shoreline 118	3	0.80	993	0.3	$27,704	$1,745	$5,622.69	$9,094
12	N22	Shoreline Restorations-Typ Participation Rates	2	0.4	156.0	0.2	$12,967	$1,062	$6,207.05	$30,239
13	N24	Shoreline Restorations-Typ Participation Rates	4	0.7	288.0	0.2	$24,082	$1,980	$6,453.24	$30,474
14	N23	Priority Shoreline 114	3	0.62	376	0.2	$26,213	$1,647	$6,883.56	$22,701
15	N18	Priority Shoreline 107	10	1.51	1,832	0.6	$84,206	$5,312	$9,076.58	$14,992
16	N20	Shoreline Restorations-Typ Participation Rates	3	0.5	156.0	0.2	$24,270	$2,025	$9,275.00	$57,077
17	N29	Shoreline Restorations-Typ Participation Rates	1	0.2	60.0	0.1	$9,697	$804	$9,852.32	$59,114
18	N2	Shoreline Restorations-Typ Participation Rates	15	1.5	600.0	1.3	$82,035	$6,750	$9,969.00	$49,845
19	N2	Priority Shoreline 135	1	0.12	74	0.1	$7,375	$450	$10,063.56	$32,095
20	N25	Shoreline Restorations-Typ Participation Rates	15	1.8	570.0	1.6	$104,526	$8,723	$10,565.01	$67,282
21	N32	Shoreline Restorations-Typ Participation Rates	8	1.1	344.0	0.5	$64,370	$5,400	$10,568.75	$68,820
22	N10	Shoreline Restorations-Typ Participation Rates	3	0.4	162.0	0.2	$24,270	$2,025	$10,600.00	$54,963
23	N5	Shoreline Restorations-Typ Participation Rates	15	1.4	540.0	1.3	$82,035	$6,750	$11,076.67	$55,383
24	N7	Shoreline Restorations-Typ Participation Rates	15	1.4	540.0	1.3	$82,035	$6,750	$11,076.67	$55,383
25	N26	Shoreline Restorations-Typ Participation Rates	6	0.8	330.0	0.3	$48,330	$4,050	$11,388.46	$53,836
26	N7	Priority Shoreline 100 & 141	10	0.87	1,243	0.3	$61,600	$3,825	$11,490.22	$16,066
27	N13	Shoreline Restorations-Typ Participation Rates	5	0.6	220.0	0.3	$40,310	$3,375	$12,343.33	$67,327
28	N16	Shoreline Restorations-Typ Participation Rates	4	0.5	160.0	0.3	$32,290	$2,700	$12,352.08	$74,113
29	N12	Shoreline Restorations-Typ Participation Rates	2	0.2	64.0	0.1	$14,116	$1,163	$16,089.95	$80,450
30	N18	Shoreline Restorations-Typ Participation Rates	5	0.4	115.0	0.3	$32,102	$2,655	$16,757.71	$102,003
31	N11	Shoreline Restorations-Typ Participation Rates	10	0.8	320.0	1.0	$175,520	$15,093	$40,806.28	$204,031

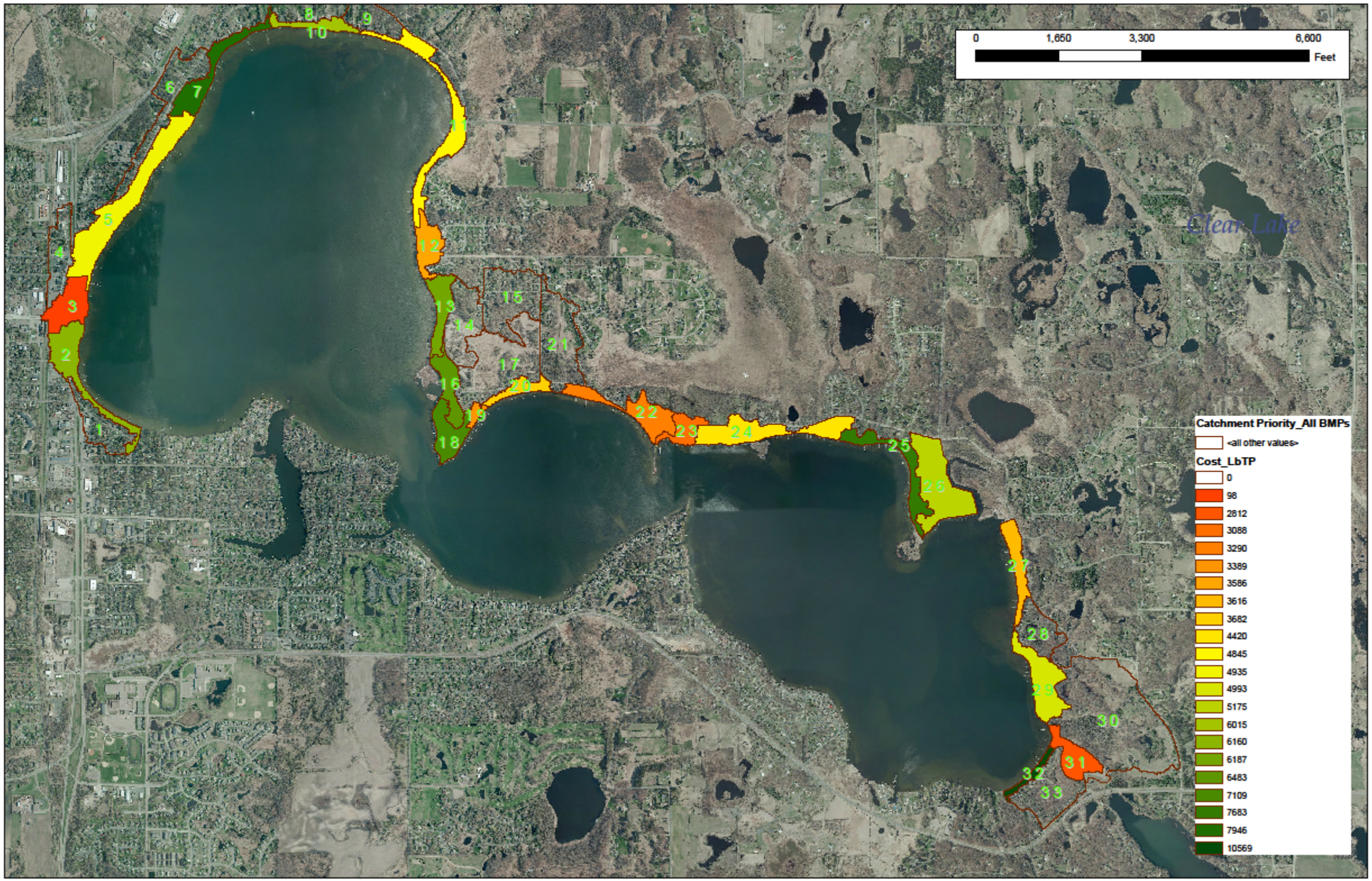
RANKING TABLE: Street Sweeping ONLY

The following ranking table is only for Street Sweeping. See page 223 for map of prioritized rank of catchments based on best Street Sweeping opportunities.

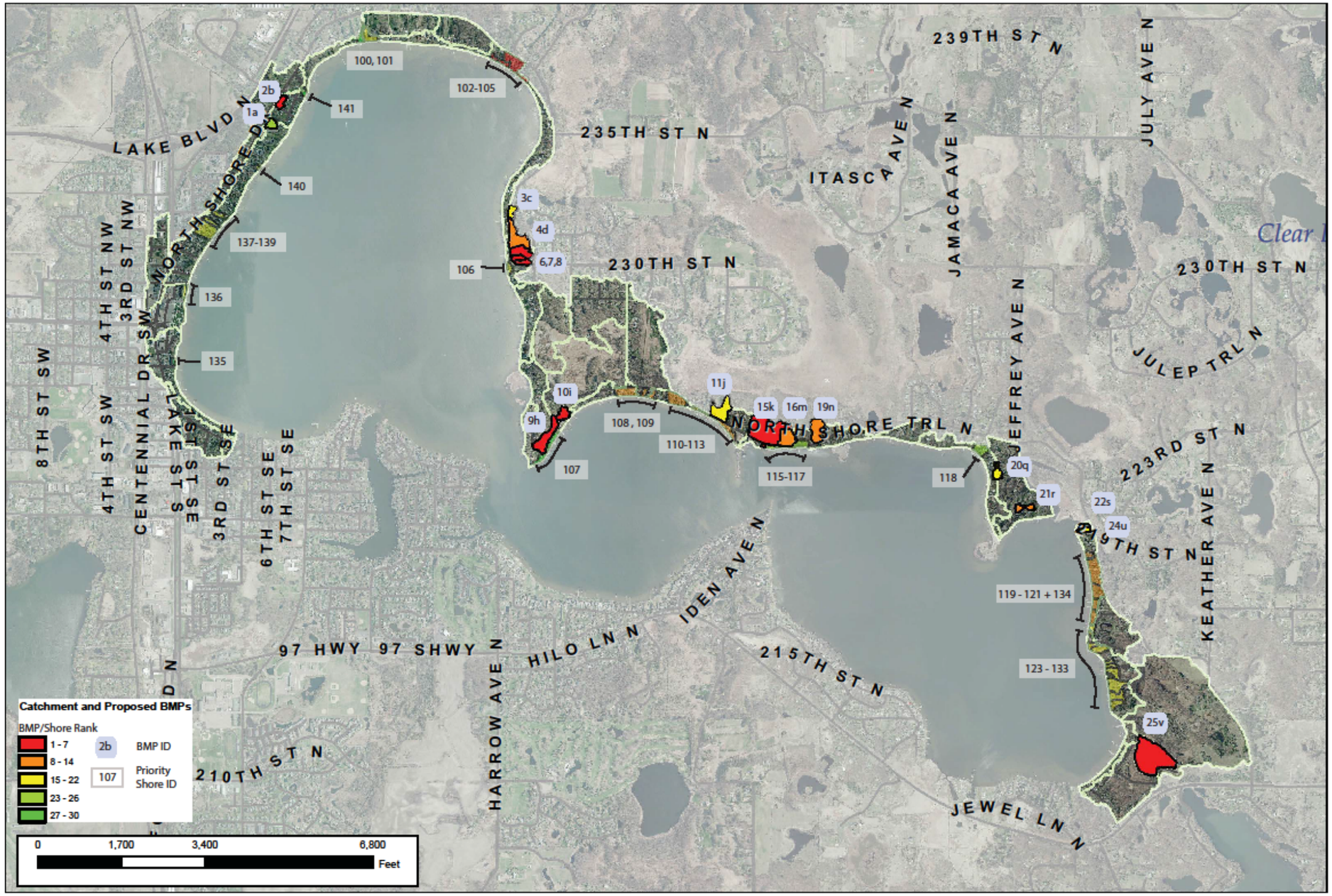
RANKED BY

Project Rank	Catchment ID FL01-Nx	Retrofit Type (refer to catchment profile pages for additional detail)	Curb Miles to sweep	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Total Project Cost	Estimated Annual Operations & Maintenance (2015 Dolla	Estimated cost/ lb-TP/year (10-yea	Estimated cost/ ton-TSS/year (10-year)
1	N2	Increased Street Sweeping to 4x per year	1.224	1.0	522.5	0.0	$469	$0	$46.47	$180
2	N5	Increased Street Sweeping to 4x per year	1.180	1.6	599.5	0.0	$812	$0	$51.54	$271
3	N26	Increased Street Sweeping to 4x per year	0.819	0.8	340.5	0.0	$750	$0	$93.76	$441
4	N7	Increased Street Sweeping to 4x per year	0.490	0.7	306.5	0.0	$694	$0	$96.36	$453
5	N22	Increased Street Sweeping to 4x per year	0.788	0.8	337.0	0.0	$745	$0	$96.72	$442
6	N3	Increased Street Sweeping to 4x per year	1.052	0.8	490.5	0.0	$790	$0	$97.52	$322
7	N24	Increased Street Sweeping to 4x per year	0.805	0.7	313.0	0.0	$748	$0	$101.03	$478
8	N13	Increased Street Sweeping to 4x per year	0.210	0.6	260.5	0.0	$646	$0	$106.32	$496
9	N18	Increased Street Sweeping to 4x per year	0.590	0.6	267.5	0.0	$711	$0	$113.92	$532
10	N12	Increased Street Sweeping to 4x per year	0.480	0.6	255.5	0.0	$692	$0	$115.93	$542
11	N11	Increased Street Sweeping to 4x per year	0.530	0.5	216.5	0.0	$701	$0	$134.74	$647
12	N27	Increased Street Sweeping to 4x per year	0.334	0.5	124.8	0.0	$667	$0	$135.14	$1,069
13	N25	Increased Street Sweeping to 4x per year	0.272	0.5	200	0.0	$657	$0	$138.50	$657
14	N16	Increased Street Sweeping to 4x per year	0.383	0.4	190.5	0.0	$675	$0	$151.80	$709
15	N23	Increased Street Sweeping to 4x per year	0.250	0.4	143.6	0.0	$653	$0	$164.40	$909
16	N20	Increased Street Sweeping to 4x per year	0.272	0.3	150	0.0	$657	$0	$187.84	$878
17	N19	Increased Street Sweeping to 4x per year	0.088	0.1	51.0	0.0	$625	$0	$516.57	$2,451

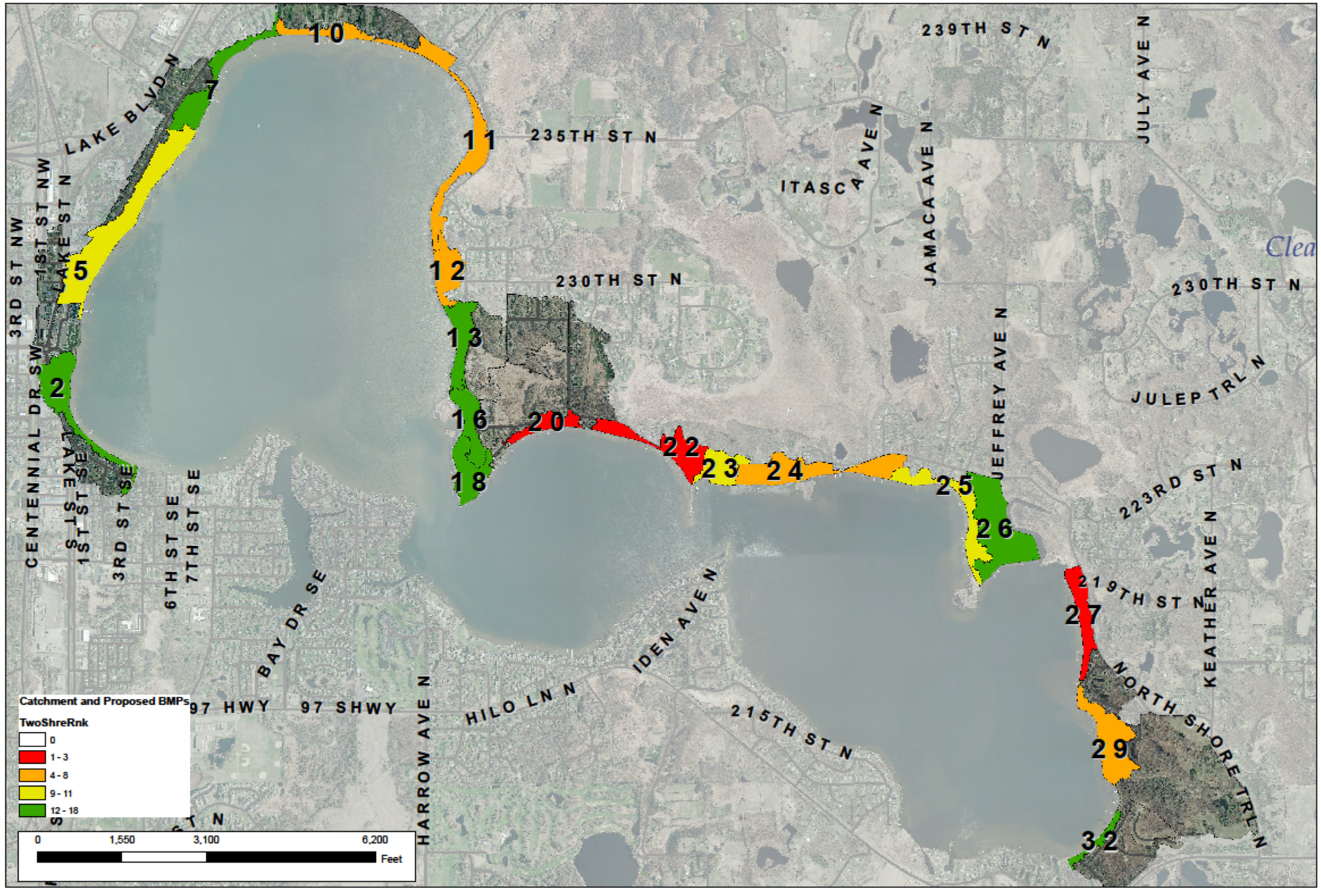
All Proposed Projects Ranking Map: The following ranking table is for all proposed practices in this report, ranked by Cost/lbTP/year over 10 years. Each catchment is ranked assuming all practices are implemented (including Street Sweeping and Typical Shoreline Restorations). See page 214 for complete ranking table



Individual BMP and Priority Shoreline Ranking Map: This map only includes BMP locations and Priority Shoreline Catchment Locations. Street Sweeping and Typical Shoreline Restorations are excluded. Cost/benefit rank for TP is determined per BMP, and not per catchment. See Appendix C for concept designs of all identified standalone projects. See page 217 for complete ranking table



All Shorelines ONLY Ranking Map: This map only includes Priority Shoreline Catchments and Typical Shoreline Restorations. Street Sweeping and other BMP locations are excluded. Cost/benefit rank for TP is determined per catchment, assuming all shoreline projects are implemented per catchment. See page 218 for complete ranking table



Street Sweeping ONLY Ranking Map: This map only includes rankings for Street Sweeping. All other shoreline and BMP locations are excluded. Cost/benefit rank for TP is determined per catchment, assuming all proposed increases in Street Sweeping are implemented per catchment. See page 219 for complete ranking table

