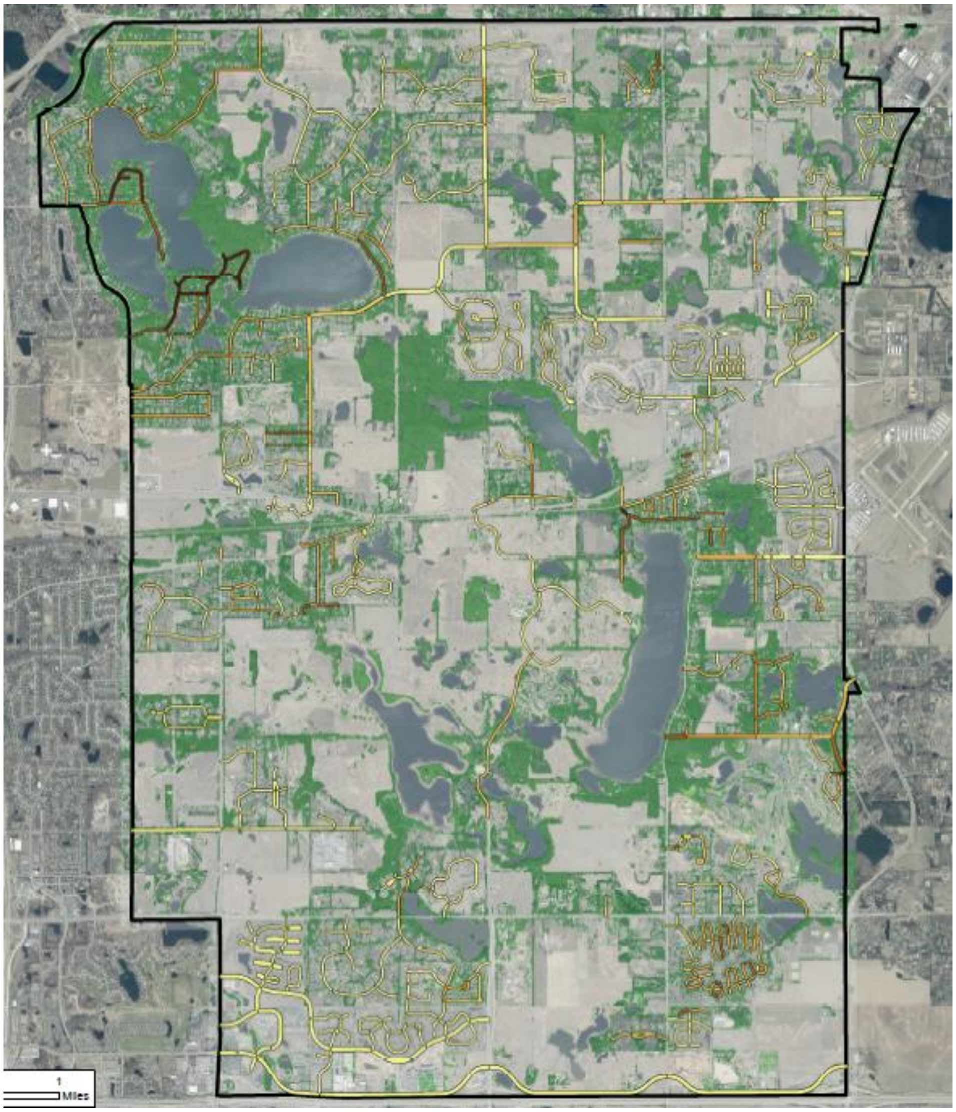
Enhanced Street Sweeping Analysis

City of Lake Elmo



Report Prepared for the City by Washington Conservation District

Funded by Lower St. Croix Watershed Partnership

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Background

Street sweeping is a cost-effective way to reduce nutrient and sediment loads entering lakes, streams and wetlands from storm sewers. Sweeping is typically completed in the spring to remove accumulated sediment from winter road treatment, and again in the fall to reduce leaf litter. However, trees adjacent to roadways can be a significant contributor of nutrient loading throughout the year as they drop seeds, pollen, leaves, and other organic debris. Similarly, large gaps in traditional fall and spring sweeping schedules give these materials time to re-accumulate and flush into storm drains before they can be removed.

Figure 1. Leaves, seeds, and other tree debris accumulating in road gutters will eventually wash into storm drains and downstream waterbodies unless they are removed.

Enhanced street sweeping is the incorporation of additional sweeping protocols, the timing and location of which are targeted to maximize water quality protection. One way to prioritize locations for enhanced sweeping is to quantify tree canopy cover overhanging and immediately adjacent to roadways; this is because tree canopy cover is highly correlated with the amount of recoverable organic materials on roadways (Kalinosky, 2015) and average total phosphorus concentrations in stormwater runoff (Janke et al. 2017). Tree canopy data can then be combined with stormwater infrastructure information to identify roadways likely contributing most to nutrient inputs derived from fallen tree materials.

The Washington Conservation District received funding from the Lower St. Croix Partnership to map and rank city streets for enhanced sweeping practices in multiple communities. The maps developed as part of this analysis include: road canopy cover percentages, roads vs subwatersheds, and prioritized sweeping zones (See Appendix).

The enhanced street sweeping analysis for the **City of Lake Elmo** includes roads draining directly to priority lakes as well as land that ultimately drains to the St. Croix River. This report presumes the majority of paved streets in these drainage areas are currently swept once or twice per year in the late spring and/or fall. However, these well-established neighborhoods contain high quantities of mature trees and some stormwater infrastructure, resulting in several roadways that are excellent candidates for enhanced street sweeping protocols. This report describes enhanced street sweeping scenarios that would maximize the cost efficiency of pollutant removal from these roadways.

Methods

Study Areas

All areas within or immediately adjacent to the direct drainage subwatersheds of Lake Jane/Olson/Demontreville, as well as areas that ultimately drain to the St. Croix River were included in enhanced street sweeping considerations. Streets that drain to landlocked areas or have low canopy cover were not considered because they are not suitable or recommended for enhanced street sweeping. Subwatershed boundaries were obtained from subwatershed data maintained by Valley Branch Watershed District.

Tree Canopy Assessment

Tree canopy cover within the study areas was analyzed following methodology in the *Tree Canopy Assessment Protocol for Enhanced Street Sweeping Prioritization*, produced by Emmons and Oliver Resources Inc. (EOR) for the Lower St. Croix Watershed Partnership (LSCWP).

Figure 2 Roadway buffers, derived from MNDOT right-of-way widths, within which tree canopy coverage was calculated

First, centerline data was compiled for all paved roadways within or immediately adjacent to the targeted subwatershed boundaries. Longer roads were split into smaller sections to increase the resolution of canopy cover estimates along them. Next, each roadway was assigned a right-of-way width corresponding with its MNDOT functional classification. Right-of-way values were then referenced to generate a buffer around each roadway, and deciduous tree canopy abundance within these buffers (total percentage areal coverage) was quantified by intersecting them with the *Twin Cities Metro Area (TCMA) Urban Tree Canopy Classification* dataset (*Figure 2*). Altogether, these processes allowed for canopy cover comparisons within the study areas, and correspondingly the prioritization of roadways most likely to contribute nutrient-rich stormwater derived from tree materials.

Stormwater Infrastructure Considerations

The subwatersheds selected for enhanced sweeping considerations contain stormwater infrastructure such as catch basins, subsurface storm sewers, stormwater ponds, and biofiltration/ bioinfiltration areas. Where the data were available, local stormwater infrastructure was also considered for priority sweeping zones.

Street Sweeping Priority Ratings

Once subwatersheds were delineated and stormwater infrastructure was assessed, all candidate roadways were classified into one of three categories based on connectivity to priority lakes:

- **High Priority:** Paved roadways/segments of roadways located within priority subwatershed boundaries, high canopy coverage, and draining directly to a BMP and/or stormwater outfall at the lake's edge.
- **Medium Priority:** Paved roadways/segments of roadways lying within priority subwatershed boundaries and moderate canopy coverage, but not directly connected to a stormwater BMP and/or storm sewer outfall or are separated by a large distance from the priority drainage areas.
- **Low Priority:** Paved roadways/segments of roadways confirmed to fall outside of the subwatershed boundaries with negligible or no connection to priority lakes through storm sewer networks. These areas are not recommended for enhanced or additional street sweeping.

Sweeping Zones and Frequency

This enhanced sweeping plan was developed for maximum load reduction and recommended sweeping frequencies are shown in Table 1. High priority zones will be swept a total of 6 or 7 times per year, medium priority 4 or 5 times, and low priority once or twice per year. Current sweeping frequency is referred to as "Baseline." In optimal conditions, the Baseline would be 2 times per year. Accordingly, for low priority areas essentially receive no prioritization for extra sweeping. Under optimal conditions (where Baseline is 2 sweepings per year), high priority zones are recommended to be swept three times in the spring (Biweekly after snow has melted, once during the summer, and three times in autumn (Biweekly once leaves have started falling). Under optimal conditions (where Baseline is 2 sweepings per year), medium priority zones should be swept twice in the spring after snowmelt and twice in the autumn after leaves have started falling.

Table 1: Street sweeping zones and recommended frequencies.

Sweeping Zones	Recommended Sweeping Frequency for Optimal Load Reduction
Baseline (Current) Sweeping	Typically 1 or 2X Annually
Medium Priority	3 Additional Sweepings Annually
High Priority	6 Additional Sweepings Annually

Given the street sweeping schedules and priorities described above, three enhanced sweeping scenarios were generated and compared: one for existing sweeping practices and three for enhanced street sweeping options (Optimal, Option 1, and Option 2) – See Appendix B.

Cost and Pollutant Recovery Estimates

Pollutant load recovery, cost, and cost effectiveness estimates for the aforementioned sweeping scenarios, routes, and schedules were compared using the planning calculator tool produced by Kalinosky and others (2014), available in the Minnesota Stormwater Manual. This calculator uses statistical models informed by tree canopy cover and MN-based street sweeping studies to predict the amount of solids and nutrients that can be recovered through street sweeping. A cost of $172 per curb mile, based on current estimated rates experienced by the City of Afton to contract street sweeping services, was applied to each candidate sweeping plan to compare costs and cost effectiveness.

NOTE: Pollutant load reductions achieved through street sweeping are dependent on several factors, such as when and how often streets are swept and the type of machinery that is used. For example, sweeping immediately prior to a major storm event and using a regenerative-air sweeper rather than a mechanical sweeper are both actions that will yield higher nutrient recovery rates. All load recovery, cost, and cost effectiveness values described herein are only estimates used for relative comparisons between candidate sweeping scenarios. The load recovery planning calculator was not calibrated with data from water quality sampling or laboratory analyses of recovered street materials from the study areas.

Findings and Recommendations

Streets Assessed and Classified

A total of 55.81 curb miles (street miles x 2) of candidate streets were evaluated. Of this, 13.9 curb miles are in High, 20.17 curb miles in Medium, and 21.74 in Low Priority Zones. See Table below and *Appendix B* for a breakdown of curb miles within each subwatershed.

Canopy Cover

Average tree canopy cover for candidate streets/street segments ranged from 0% - 81%. Canopy cover was ranked into five categories: 0-20%, 20-40%, 40-60%, 60-80%, and 80-100%. Table 2 shows the percent canopy within each of the 14 subwatersheds/zones.

Table 2: Canopy coverage by Zone #.

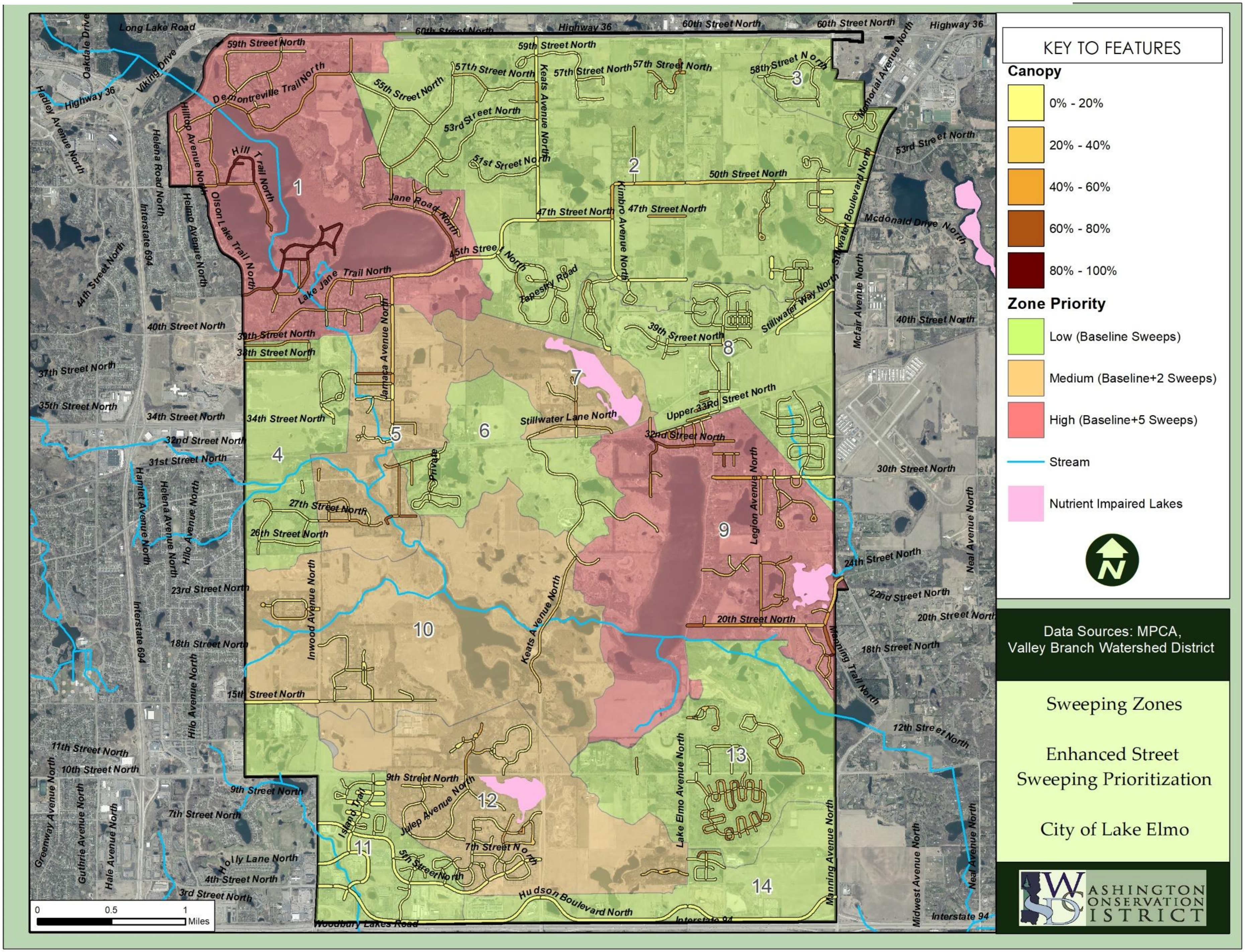
Sweeping Zones Summary						
Zone #:	**Major Watershed**	**Canopy % of Zone**	**Zone Curb-Miles**	**Priority**	**Target Waterbody Drainage**	**Canopy Coverage Range**
1	Tri-Lake Area	40.9%	8.16	High	Direct	Med-High
2	Stormwater Pond	23.0%	12.28	Low	Landlocked	Low-Med
3	NorthEast	5.6%	1.35	Low	Upstream	Low-Med
4	Beutal Pond	15.9%	2.07	Low	Landlocked	Low-Med
5	Raleigh Creek	28.6%	2.71	Medium	Upstream	Low-High
6	Friedrich's Pond	12.5%	1.80	Low	Landlocked	Low
7	Sunfish Lake	19.1%	0.77	Medium	Landlocked (Impaired)	Low-Med
8	Downs Lake	5.1%	6.46	Medium	Upstream	Low
9	Lake Elmo	37.5%	5.74	High	Direct	Med-High
10	Eagle Point Lake	14.6%	3.04	Medium	Upstream	Low-Med
12	Goose Lake	9.8%	4.98	Medium	Landlocked (Impaired)	Low
13	Horseshoe Lake	33.6%	4.24	Low	Landlocked	Low-High
14	Rest Area Pond	10.7%	2.22	Medium	Upstream	Low
Total			**55.81**			

See *Appendix* for more details on canopy coverage and additional maps.

Load Recovery and Cost Estimates

March (or immediately following snow melt) and October are the most cost-effective times to complete street sweeping, followed by other months in the spring and fall (*Appendix A*). Current Baseline street sweeping practices yield an estimated phosphorus (P) recovery rate of 1-2 lbs/year at an average cost around $230/lb P recovered. In comparison, all enhanced street sweeping scenarios explored in this analysis yielded higher phosphorus recovery rates and improved the cost effectiveness of phosphorus removal. Targeting only high priority streets further improved load recovery and cost effectiveness. See *Table 3* for a summary of candidate street sweeping scenarios, and *Appendix B* for all planning calculator outputs.

Figure 3: Street Sweeping Zones



Recommendations

To maximize cost effectiveness for phosphorus removal and water quality benefits to the City, two Options are recommended. Option 1 would reduce annual TP loads by 113 lbs/yr with a total cost of approximately $25,000/year. Option 2 would reduce annual TP loads by 68 lbs/yr with a total cost of approximately $14,000/year. Many factors may change these costs, such as necessity to hire multiple contractors. Further, if additional funds are identified higher sweeping frequencies may become the preferred alternative.

Table 3: Load reductions and cost estimates for existing and candidate sweeping practices in the priority watersheds

Load Reductions and Cost Estimates

Month Swept	Existing (Current baseline)	Optimal Load Reduction Plan			Option #1			Option #2		
Street Priority:	(All Streets)	High	Medium	Low	High	Medium	Low	High	Medium	Low
	Frequency	Frequency			Frequency			Frequency		
March	-	1	1	-	1	-	-	-	-	-
April	-	1	1	1	1	1	-	1	-	-
May	-	1	-	-	1	-	-	-	-	-
June	-	1	-	-	-	-	-	-	-	-
October	1	2	1	1	2	1	1	1	1	1
November	-	1	1	-	1	1	-	1	-	-
Total Curb-miles/Year	55.81			204.10			148.30			83.61
Est. Sweeping Cost/Year	$ 9,598.73	$		35,105.66	$		25,506.93	$		14,380.53
Est. Phosphorus Recovery (Total lbs/year)	41.23			128.92			112.84			68.47
Average Cost lb/P	$ 232.80	$		272.30	$		226.04	$		210.03

In summary, the recommended street sweeping schedule(s) would benefit water quality in the City and for downstream water bodies. Sweeping immediately following snowmelt removes accumulated winter pollutants before they can be flushed into sewers by heavy spring rains. Sweeping in the fall removes leaf litter and other organic debris identified as major contributors to nutrient loads in stormwater. An additional sweeping on priority roads during these seasons will further reduce accumulated pollutants in street gutters, such as pollen and seeds in the late spring and leaves that continue blowing/ falling onto roads following the initial autumnal leaf-drop and sweeping.

Lower St. Croix Partnership Funding Available!

The Lower St. Croix Watershed Partnership (LSCWP) has allocated funds to enhance street sweeping operations for interested communities, including increased sweeping in late spring, early summer, and fall in areas with medium to high tree canopy that direct connect and flow to priority water bodies. In this analysis, Option 2 is designed to provide the highest water quality benefit and cost efficiency if the only additional funding used for sweeping, in addition to baseline practices, is the reimbursement funds provided by the LSCWP.

Reimbursement rates will be as follows:

- Tier 1: $100/curb-mile/year (complete the MPCA credit calculator based on curb miles swept and provide the report)

- Tier 2: $125/curb-mile/year (complete the MPCA credit calculator based on the tracking of weights, dates, and provide the report)

To apply for a grant, interested communities can work with their local LSCWP contact. Participating communities will be responsible for implementing their customized enhanced sweeping plan over three years that will include annual incentive payments adding up to (but not to exceeding) $5,000 per year.

References

Anoka Conservation District (ACD). Enhanced Street Sweeping Analysis: Martin and Linwood Lakes. 2023.

Lower St. Croix Watershed Partnership (LSCWP) and Emmons and Oliver Resources Inc. (EOR). Tree Canopy Assessment Protocol for Enhanced Street Sweeping Prioritization. 2022.

Janke, Benjamin D., Jacques C. Finlay, and Sarah E. Hobbie. 2017. Trees and Streets as Drivers of Urban Stormwater Nutrient Pollution. Sci. Technol. DOI: 10.1021/acs.est.7b02225 Environ.

Kalinosky, P., L.A. Baker, S.E. Hobbie, R. Binter, and C. Buyarski. 2014. User Support Manual: Estimating Nutrient Removal by Enhanced Street Sweeping. Minneapolis, MN.

Kalinosky, P.M. 2015. Quantifying Solids and Nutrient Recovered Through Street Sweeping in a Suburban Watershed. A Thesis Submitted to the Faculty of University of Minnesota. Minneapolis, MN.

Appendices

Appendix A: Planning Calculator Monthly Estimates – Example

Monthly Phosphorus Recovery and Cost Estimates for Martin Lake				
Month	Sweeping Events	Phosphorus, lb	Cost, $	$ Cost, lb/P
January	0	0	$ -	$ -
February	0	0	$ -	$ -
March	1	6	$1,011.00	$163.18
April	1	4	$1,011.00	$239.72
May	1	3	$1,011.00	$298.26
June	1	3	$1,011.00	$349.66
July	1	2	$1,011.00	$517.95
August	1	2	$1,011.00	$421.71
September	1	2	$1,011.00	$410.46
October	1	6	$1,011.00	$158.31
November	1	4	$1,011.00	$273.93
December	0	0	$ -	$ -

Appendix B: Planning Calculator Outputs for all Street Sweeping Scenarios

Optimal Load Reduction Plan

Zone #	Major Watershed	Zone Curb-Miles	Priority	Baseline Frequency	Cost per curb-mile	Baseline sweeping, Curb-Miles	Enhanced Sweeping (Over Baseline)	Enhanced Curb-Miles (Over Baseline)	Total Curb-Miles (Baseline +Enhanced)	Baseline Predicted Solids Removed (lb)	Baseline Predicted Phosporus Removal (lb)	Enhanced Predicted Solids Removed (lb)	Enhanced Predicted Phosporus Removal (lb)	Total Predicted Solids Removed (Baseline + Enhanced, lbs)	Total Predicted Phosporus Removal (Baseline + Enhanced, lbs)	Baseline Cost (2x per year)	Enhanced Cost (Over Baseline)	Total Cost for Enahnced Sweeping + Baseline	Average Cost($)/lb P removed
1	Tri-Lake Area	8.16	High	2	$ 172.00	16.32	5	40.81	57.13	29,666.66	19.69	59,014.24	34.97	88,680.90	54.67	$ 2,807.45	$ 7,018.63	$ 9,826.08	$ 179.75
2	Stormwater Pond	12.28	Low	2	$ 172.00	24.57	-	-	24.57	21,260.71	13.38	-	-	15,858.62	9.77	$ 4,225.42	$ -	$ 4,225.42	$ 432.39
3	NorthEast	1.35	Low	2	$ 172.00	2.69	-	-	2.69	1,146.32	0.68	-	-	1,137.83	0.68	$ 463.27	$ -	$ 463.27	$ 681.51
4	Beutal Pond	2.07	Low	2	$ 172.00	4.14	-	-	4.14	3,508.30	2.16	-	-	3,583.85	2.25	$ 711.93	$ -	$ 711.93	$ 315.73
5	Raleigh Creek	2.71	Medium	2	$ 172.00	5.43	2	5.43	10.85	5,998.47	3.84	4,076.00	2.57	10,074.47	6.41	$ 933.44	$ 933.44	$ 1,866.87	$ 291.35
6	Friedrich's Pond	1.80	Low	2	$ 172.00	3.60	-	-	3.60	2,069.34	1.26	-	-	2,069.34	1.26	$ 619.09	$ -	$ 619.09	$ 489.86
7	Sunfish Lake	0.77	Medium	2	$ 172.00	1.54	2	1.54	3.07	1,131.73	0.70	769.02	0.47	1,900.75	1.17	$ 264.04	$ 264.04	$ 528.08	$ 450.01
8	Downs Lake	6.46	Medium	2	$ 172.00	12.91	-	-	12.91	5,352.25	3.19	-	-	5,352.25	3.19	$ 2,221.11	$ -	$ 2,221.11	$ 695.86
9	Lake Elmo	5.74	High	2	$ 172.00	11.48	5	28.70	40.18	18,025.44	11.84	38,320.83	22.52	56,346.26	34.37	$ 1,974.35	$ 4,935.87	$ 6,910.21	$ 201.08
10	Eagle Point Lake	3.04	Medium	2	$ 172.00	6.07	2	6.07	12.14	3,805.60	2.34	2,544.02	1.54	6,349.62	3.87	$ 1,044.15	$ 1,044.15	$ 2,088.30	$ 539.09
12	Goose Lake	4.98	Medium	2	$ 172.00	9.95	2	9.95	19.91	5,083.74	3.08	3,454.44	2.05	8,538.18	5.13	$ 1,712.07	$ 1,712.07	$ 3,424.15	$ 667.22
13	Horseshoe Lake	4.24	Low	2	$ 172.00	8.47	-	-	8.47	11,330.11	7.36	-	-	8,320.44	4.73	$ 1,457.53	$ -	$ 1,457.53	$ 308.24
14	Rest Area Pond	2.22	Medium	2	$ 172.00	4.44	-	-	4.44	2,330.34	1.41	-	-	2,330.34	1.41	$ 763.60	$ -	$ 763.60	$ 539.74
Total		55.81				111.61		92.49	204.10	110,709.00	70.95	108,178.55	64.12	210,542.85	128.92	$ 19,197.46	$ 15,908.20	$ 35,105.66	$ 272.30

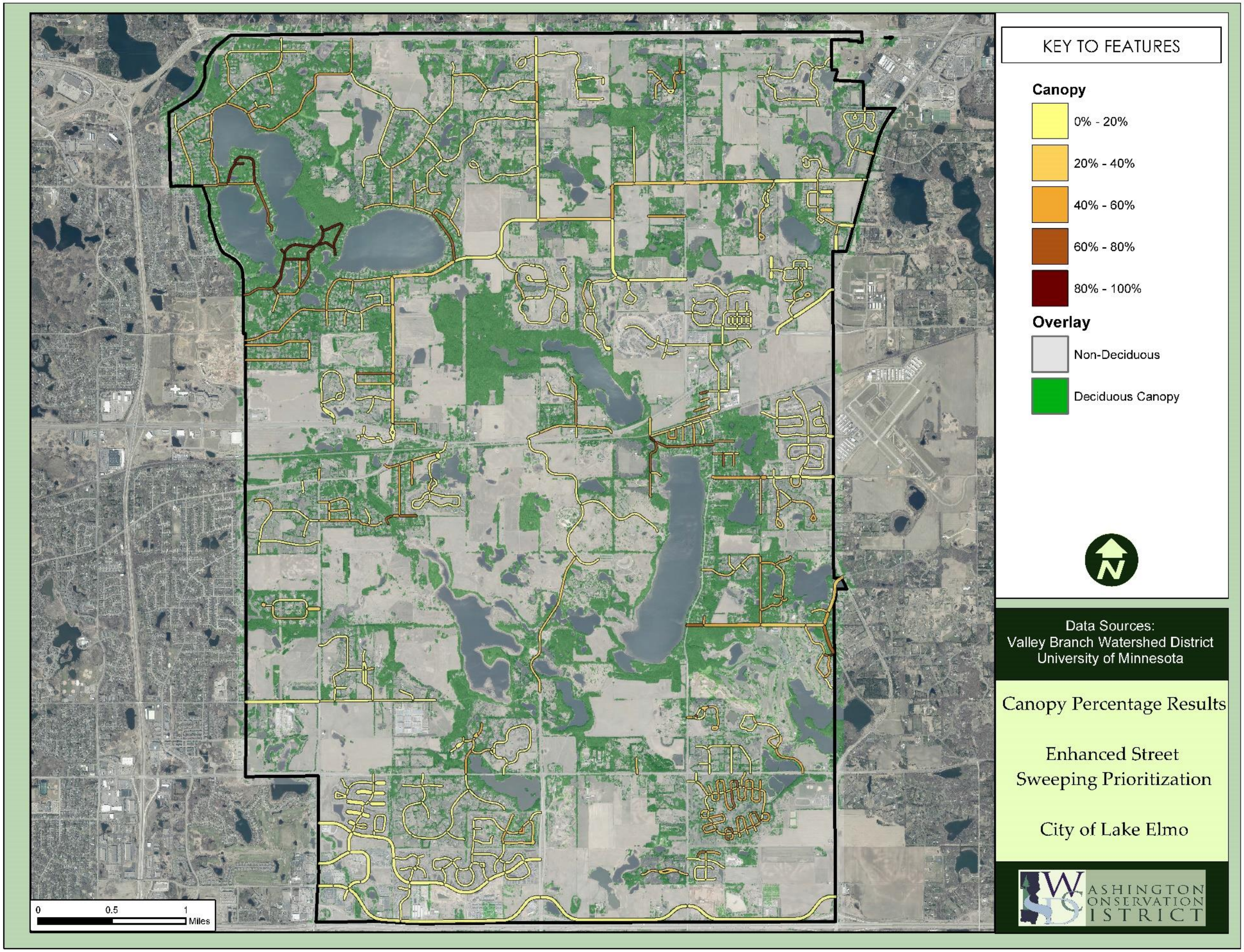
Option #1

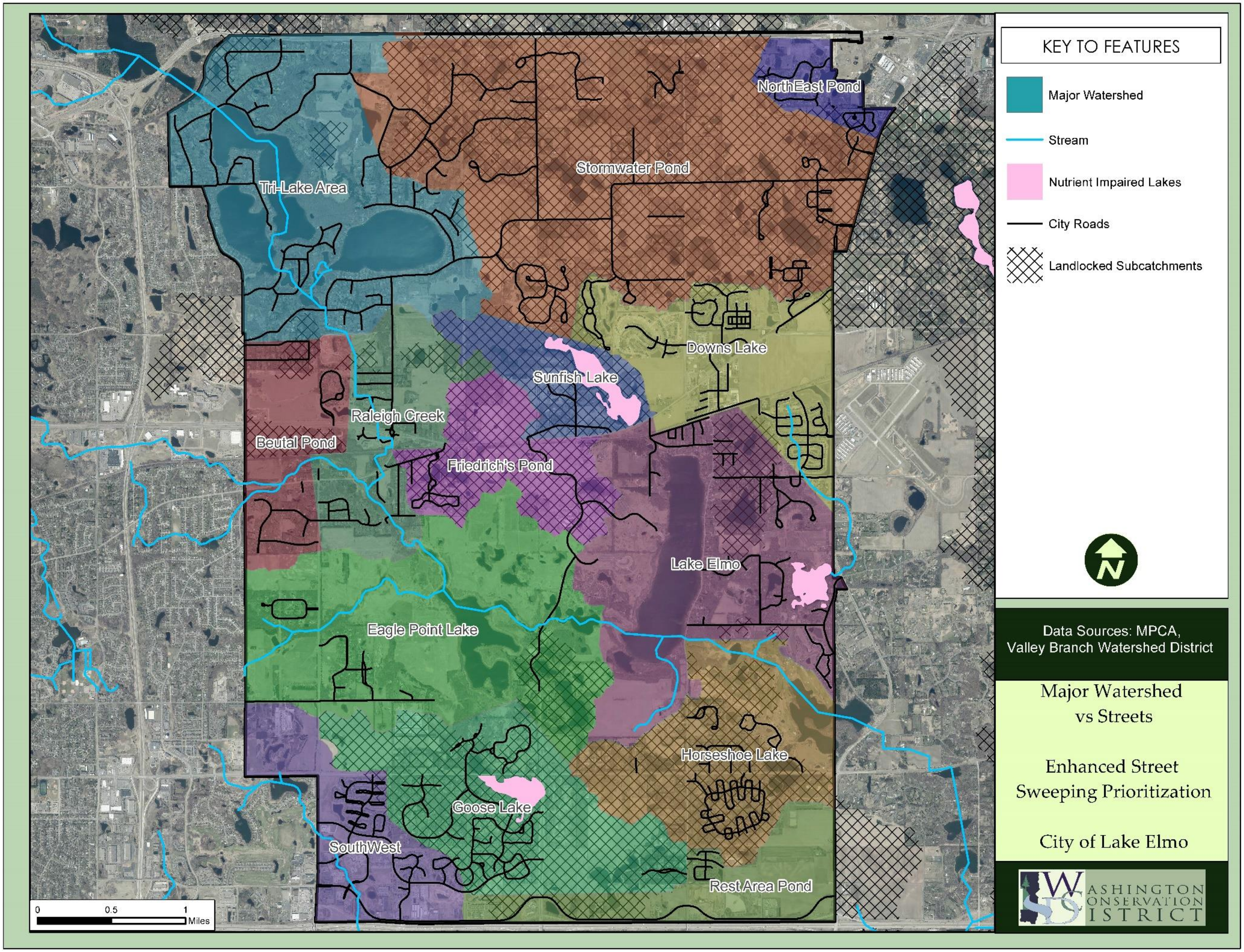
Zone #:	Major Watershed	Zone Curb-Miles	Priority	Baseline Frequency	Cost per curb-mile	Baseline sweeping, Curb-Miles	Enhanced Sweeping (Over Baseline)	Enhanced Curb-Miles (Over Baseline)	Total Curb-Miles (Baseline +Enhanced)	Baseline Predicted Solids Removed (lb)	Baseline Predicted Phosporus Removal (lb)	Enhanced Predicted Solids Removed (lb)	Enhanced Predicted Phosporus Removal (lb)	Total Predicted Solids Removed (Baseline + Enhanced, lbs)	Total Predicted Phosporus Removal (Baseline + Enhanced, lbs)	Baseline Cost (2x per year)	Enhanced Cost (Over Baseline)	Total Cost for Enahnced Sweeping + Baseline	Average Cost($)/lb P removed
1	Tri-Lake Area	8.16	High	1	$ 172.00	8.16	5	40.81	48.97	14,423.07	11.75	66,275.03	37.60	80,698.10	49.35	$ 1,403.73	$ 7,018.63	$ 8,422.36	**$ 170.68**
2	Stormwater Pond	12.28	Low	1	$ 172.00	12.28	-	-	12.28	10,429.62	8.06	-	-	10,429.62	8.06	$ 2,112.71	$ -	$ 2,112.71	**$ 262.24**
3	NorthEast	1.35	Low	1	$ 172.00	1.35	-	-	1.35	562.34	0.41	-	-	562.34	0.41	$ 231.64	$ -	$ 231.64	**$ 561.60**
4	Beutal Pond	2.07	Low	1	$ 172.00	2.07	-	-	2.07	1,314.58	0.99	-	-	1,314.58	0.99	$ 355.96	$ -	$ 355.96	**$ 358.04**
5	Raleigh Creek	2.71	Medium	1	$ 172.00	2.71	2	5.43	8.14	1,721.03	1.30	3,041.25	1.61	4,762.28	2.91	$ 466.72	$ 933.44	$ 1,400.16	**$ 480.59**
6	Friedrich's Pond	1.80	Low	1	$ 172.00	1.80	-	-	1.80	994.56	0.74	-	-	994.56	0.74	$ 309.54	$ -	$ 309.54	**$ 415.72**
7	Sunfish Lake	0.77	Medium	1	$ 172.00	0.77	2	1.54	2.30	557.46	0.43	985.09	0.53	1,542.55	0.95	$ 132.02	$ 264.04	$ 396.06	**$ 415.72**
8	Downs Lake	6.46	Low	1	$ 172.00	6.46	-	-	6.46	2,636.36	1.93	-	-	2,636.36	1.93	$ 1,110.56	$ -	$ 1,110.56	**$ 575.18**
9	Lake Elmo	5.74	High	1	$ 172.00	5.74	5	28.70	34.44	8,827.15	7.12	42,633.50	24.02	51,460.66	31.14	$ 987.17	$ 4,935.87	$ 5,923.04	**$ 190.19**
10	Eagle Point Lake	3.04	Medium	1	$ 172.00	3.04	2	6.07	9.11	1,830.52	1.38	3,234.74	1.71	5,065.27	3.09	$ 522.08	$ 1,044.15	$ 1,566.23	**$ 507.39**
12	Goose Lake	4.98	Medium	1	$ 172.00	4.98	2	9.95	14.93	2,473.54	1.84	4,371.02	2.27	6,844.56	4.11	$ 856.04	$ 1,712.07	$ 2,568.11	**$ 624.54**
13	Horseshoe Lake	4.24	Low	1	$ 172.00	4.24	-	-	4.24	5,558.08	4.43	-	-	5,558.08	4.43	$ 728.76	$ -	$ 728.76	**$ 164.47**
14	Rest Area Pond	2.22	Low	1	$ 172.00	2.22	-	-	2.22	1,139.48	0.85	-	-	1,140.32	4.72	$ 381.80	$ -	$ 381.80	**$ 80.91**
Total		55.81				55.81		92.49	148.30	52,467.80	41.23	120,540.65	67.74	173,009.29	112.84	$ 9,598.73	$ 15,908.20	$ 25,506.93	$ 226.04

Option #2

Zone #:	Major Watershed	Zone Curb-Miles	Priority	Baseline Frequency	Cost per curb-mile	Baseline sweeping, Curb-Miles	Enhanced Sweeping (Over Baseline)	Enhanced Curb-Miles (Over Baseline)	Total Curb-Miles (Baseline +Enhanced)	Baseline Predicted Solids Removed (lb)	Baseline Predicted Phosporus Removal (lb)	Enhanced Predicted Solids Removed (lb)	Enhanced Predicted Phosporus Removal (lb)	Total Predicted Solids Removed (Baseline + Enhanced, lbs)	Total Predicted Phosporus Removal (Baseline + Enhanced, lbs)	Baseline Cost (2x per year)	Enhanced Cost (Over Baseline)	Total Cost for Enahnced Sweeping + Baseline	Average Cost($)/lb P removed
1	Tri-Lake Area	8.16	High	1	$ 172.00	8.16	2	16.32	24.48	14,423.07	11.75	25,487.21	14.55	39,910.28	26.30	$ 1,403.73	$ 2,807.45	$ 4,211.18	$ 160.11
2	Stormwater Pond	12.28	Low	1	$ 172.00	12.28	-	-	12.28	10,429.62	8.06	-	-	10,429.62	8.06	$ 2,112.71	$ -	$ 2,112.71	$ 262.24
3	NorthEast	1.35	Low	1	$ 172.00	1.35	-	-	1.35	562.34	0.41	-	-	562.34	0.41	$ 231.64	$ -	$ 231.64	$ 561.60
4	Beutal Pond	2.07	Low	1	$ 172.00	2.07	-	-	2.07	1,314.58	0.99	-	-	1,314.58	0.99	$ 355.96	$ -	$ 355.96	$ 358.04
5	Raleigh Creek	2.71	Medium	1	$ 172.00	2.71	-	-	2.71	1,721.03	1.30	-	-	1,721.03	1.30	$ 466.72	$ -	$ 466.72	$ 358.57
6	Friedrich's Pond	1.80	Low	1	$ 172.00	1.80	-	-	1.80	994.56	0.74	-	-	994.56	0.74	$ 309.54	$ -	$ 309.54	$ 415.72
7	Sunfish Lake	0.77	Medium	1	$ 172.00	0.77	-	-	0.77	557.46	0.43	-	-	557.46	0.43	$ 132.02	$ -	$ 132.02	$ 310.17
8	Downs Lake	6.46	Low	1	$ 172.00	6.46	-	-	6.46	2,636.36	1.93	-	-	2,636.36	1.93	$ 1,110.56	$ -	$ 1,110.56	$ 575.18
9	Lake Elmo	5.74	High	1	$ 172.00	5.74	2	11.48	17.22	8,827.15	7.12	15,598.59	8.82	24,425.75	15.94	$ 987.17	$ 1,974.35	$ 2,961.52	$ 185.85
10	Eagle Point Lake	3.04	Medium	1	$ 172.00	3.04	-	-	3.04	1,830.52	1.38	-	-	1,830.52	1.38	$ 522.08	$ -	$ 522.08	$ 378.57
12	Goose Lake	4.98	Medium	1	$ 172.00	4.98	-	-	4.98	2,473.54	1.84	-	-	2,473.54	1.84	$ 856.04	$ -	$ 856.04	$ 465.98
13	Horseshoe Lake	4.24	Low	1	$ 172.00	4.24	-	-	4.24	5,558.08	4.43	-	-	5,558.08	4.43	$ 728.76	$ -	$ 728.76	$ 164.47
14	Rest Area Pond	2.22	Low	1	$ 172.00	2.22	-	-	2.22	1,139.48	0.85	-	-	1,139.48	4.72	$ 381.80	$ -	$ 381.80	$ 80.91

Appendix C: Additional Maps




KEY TO FEATURES
Major Watershed
Stream
Nutrient Impaired Lakes
City Roads
Landlocked Subcatchments
Data Sources: MPCA, Valley Branch Watershed District
Major Watershed vs Streets
Enhanced Street Sweeping Prioritization
City of Lake Elmo
WASHINGTON CONSERVATION DISTRICT
Tri-Lake Area
Stormwater Pond
NorthEast Pond
Downs Lake
Sunfish Lake
Raleigh Creek
Beutal Pond
Friedrich's Pond
Lake Elmo
Eagle Point Lake
Horseshoe Lake
Goose Lake
SouthWest
Rest Area Pond
0
0.5
1
Miles