STORMWATER MANAGEMENT PRIORITIZATION FOR THE WATERSHED OF LAKE WINDSOR – MINNETONKA, MN

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The project on which this presentation is based was completed in collaboration with the City of Minnetonka as part of the 2012–2013 Resilient Communities Project (RCP) partnership. RCP is a program at the University of Minnesota's Center for Urban and Regional Affairs (CURA) that connects University faculty and students with Minnesota communities to address strategic projects that advance local resilience and sustainability.

This publication may be available in alternate formats upon request.

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Resilient Communities Project

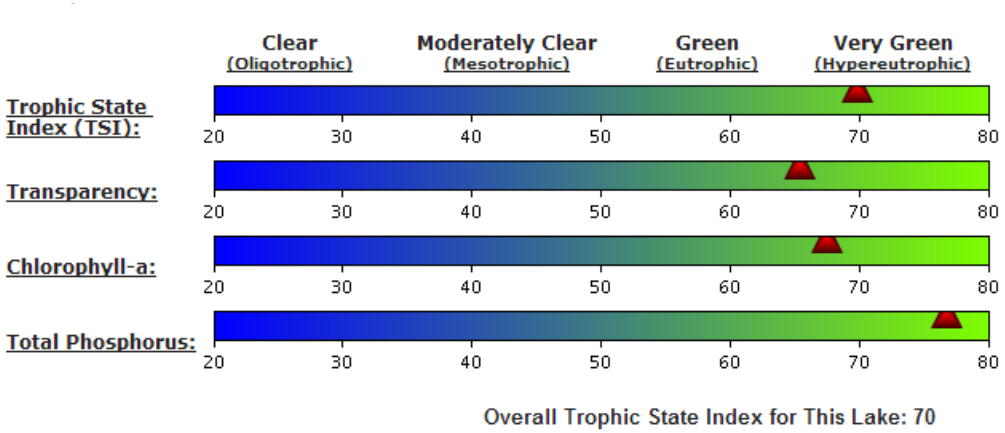
Introduction – Lake Windsor

- Classified as Level III lake- Support wildlife and waterfowl
- 7 Acres in total
  - 196 Acres Drainage
- Highly Residential Area

Credit: Google Maps

Impairments

- Lake is given grade of F (lowest 10% in area)
  - Phosphorus is main culprit
- Not suitable for swimming and wading
- No TMDL until 2017



Credit: MPCA

Goals

- Increase Water Quality
  - Reduce Effluent Concentrations + Reduce total runoff to lake
    - Street Sweeping
    - Retention
    - Infiltration
    - Retrofit

Traditional BMPs

- Dry Detention Basins
  - TSS Removal
  - Large Area
- Wet Retention Basins
  - TSS and P removal
  - Large Area

www.stormwaterpartners.com

www.mwcog.org

Traditional BMPs

- Constructed Wetlands
  - TSS removal
  - P removal/addition
  - Large Area
- Sand Filters
  - TSS and P removal
  - Large Area

www.lakecountyil.gov

www.ci.sandy.or.us

Traditional BMPs

- Infiltration Basins
  - TSS and P removal
  - Smaller Area
- Infiltration Trenches
  - TSS and P removal

Credit: www.cuyahogaswcd.org

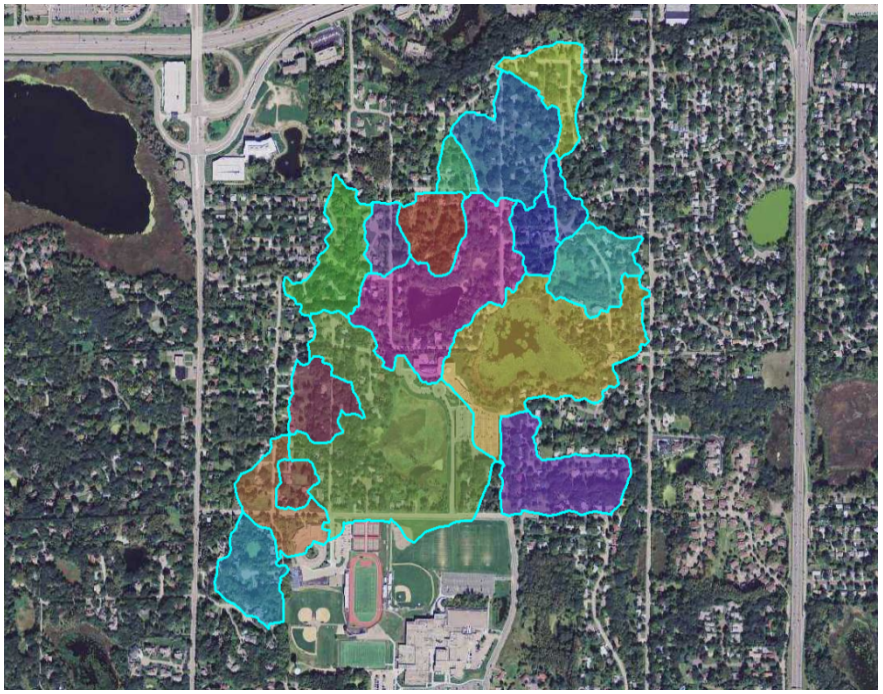
Credit: sustainablestormwater.org

Methods of Analysis

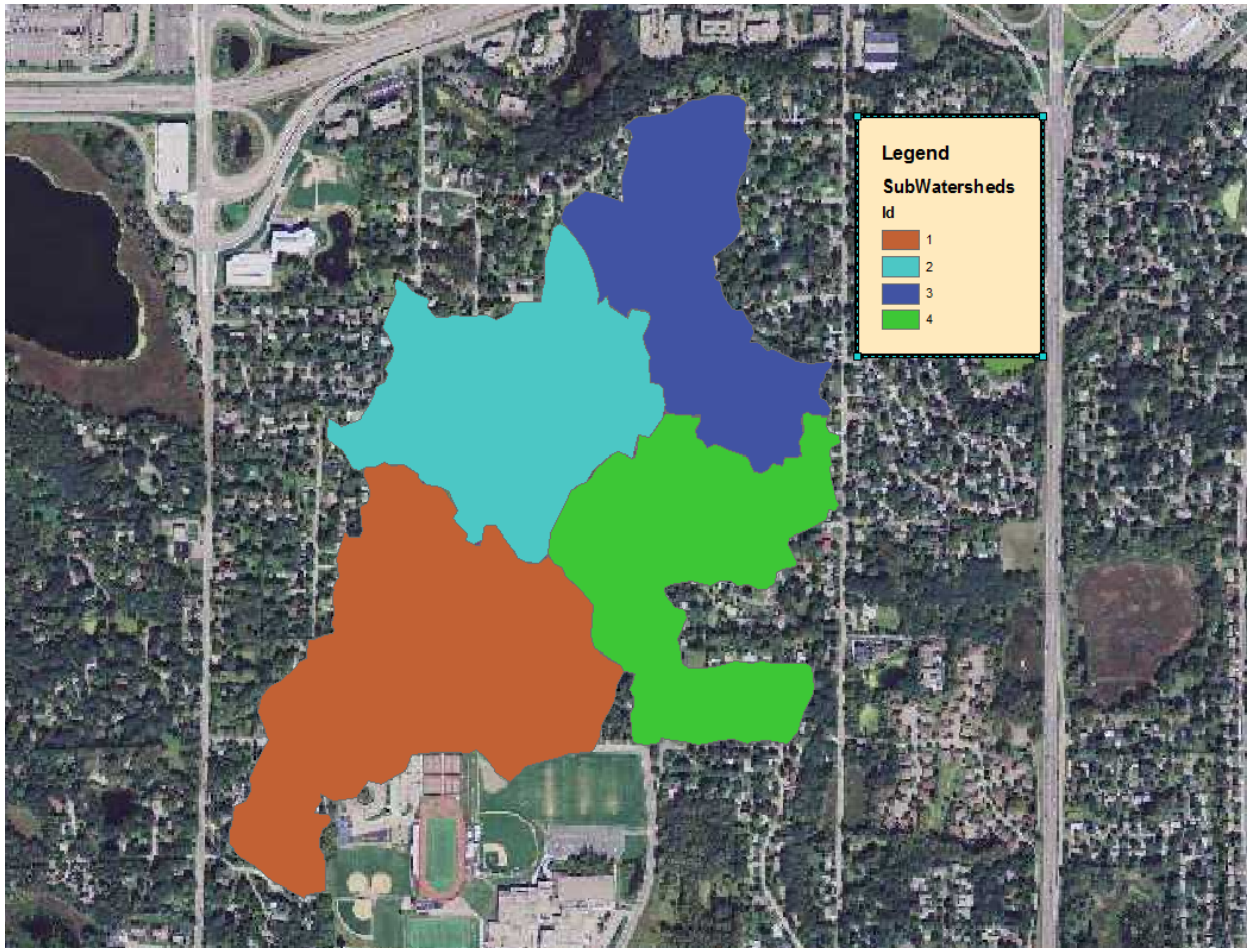
- Process borrowed from Weiss, Gulliver, and Erickson (2007)
- Using WQV Determined by 1.15 in. storm
  - Estimate
    - Sizes
    - 20 year pollutant removal
    - Initial cost plus 20 year operation and maintenance cost

Infiltration Analysis – Feasibility

- Land Use
  - Highly developed- not much space for large practice
- Rain gardens and small infiltration basins look best
- P8 Used to estimate effectiveness – NURP particle distribution



Infiltration Analysis – Feasibility



Infiltration Analysis – Feasibility

- Assumed that a total of 0.37 acres of infiltration area
  - Achieved total reduction of
    - 7.3% Runoff Volume
    - 10% Phosphorus
    - 12% TSS
- This assumed 7.5 acres of runoff area
  - Infiltration basin area ~5% of that

Street Sweeping

- Current Practice
  - Once per year (spring)
  - Mainly mechanical
  - 10 curb miles

- Three Studies Examined
  - San Diego, CA
    - Sweeper Performance
  - Prior Lake, MN
    - Phosphorus Removal
  - Ramsey-Washington Metro Watershed District
    - Cost Analysis

Street Sweeping Cont.

- San Diego, CA Study
  - Frequency
  - Technology
  - Speed

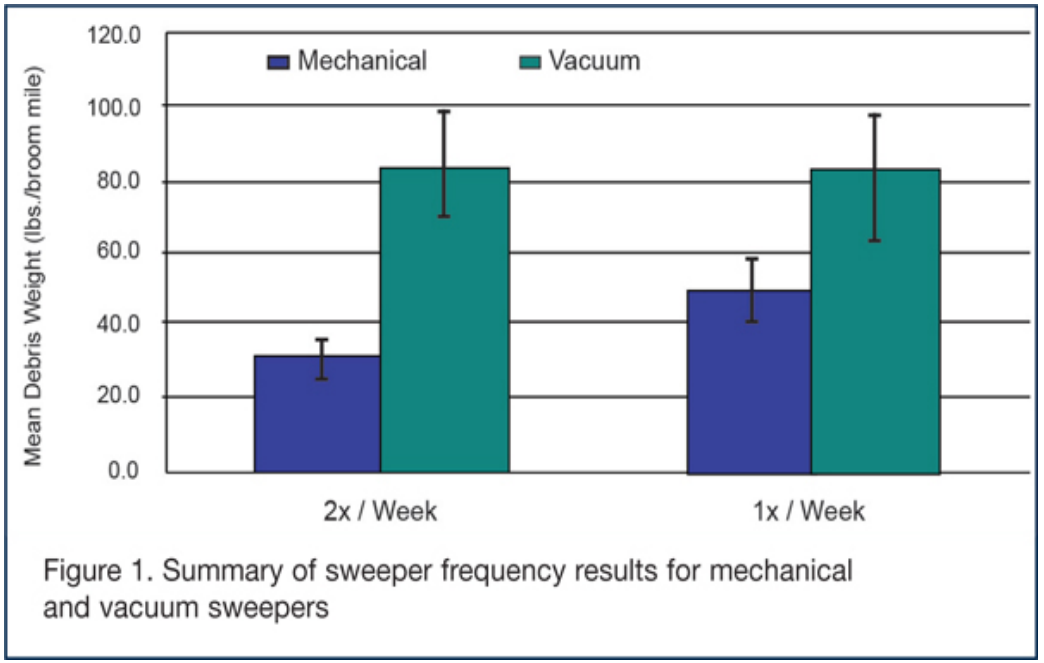
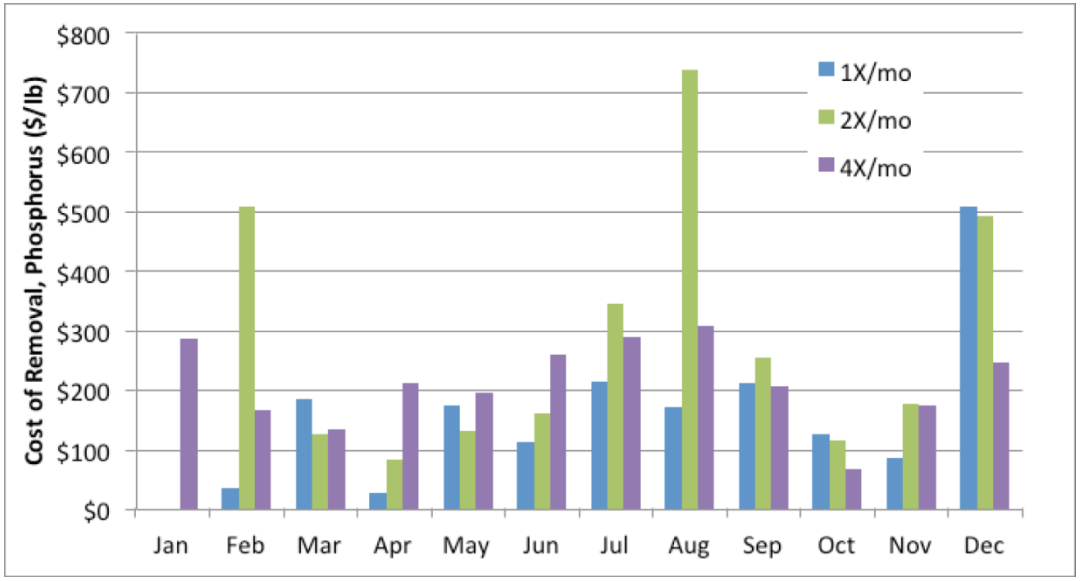


Figure 1. Summary of sweeper frequency results for mechanical and vacuum sweepers

(Stormwater, Fall 2012)

Street Sweeping Cont.

- Prior Lake, MN Study
  - Canopy Cover
  - Seasonal Loading
  - $$/lb. P Removed



Frequency	Low Canopy	Med Canopy	High Canopy
Annual Dry Material Load (lb/curb-mile)			
Once per month	1825	2179	4122
Twice per month	2894	4227	5815
4 per month	5141	7292	7205
Annual Phosphorus Load (lb/curb-mile)			
Once per month	1.4	1.5	2.6
Twice per month	1.9	3.5	5.0
4 per month	3.0	5.6	6.3

(SWUPDATES, March 2013)

Street Sweeping Cont.

- **Ramsey-Washington Metro Watershed District Study**
  - Cost Analysis
  - Machine lifespan

Frequency ($/curb-mile/year)

Sweeper Type	Sweeping Frequency					
	Weekly	*Bi-Weekly*	*Monthly*	*Four times per year*	*Twice per year*	*Annual*
Mechanical	$2,235	$1,120	$520	$170	$90	$45
Vacuum	$1,260	$630	$290	$100	$50	$25

(RWMWD, 2005)

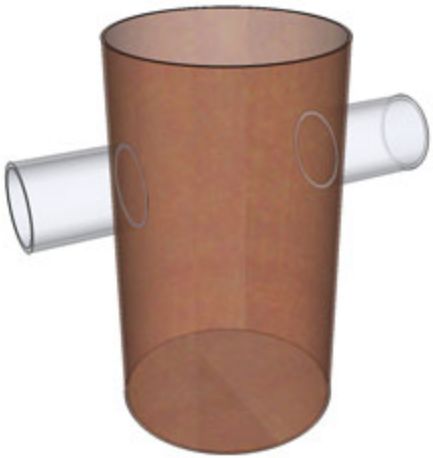
Sweeper Type	Life	Purchase Price	Operation and Maintenance Costs ($/curb-mile)
Mechanical	5 years	$100,000	$40
Vacuum	8 years	$200,000	$20

(RWMWD, 2005)

Underground Stormwater Treatment Devices

- **Standard Sump (Manhole)**
  - ✓ a location for pipe junctions and maintenance access
  - ✓ remove sand and silt particles from stormwater
  - ✓ high propensity for washout of the collected sediment.

- ✓ With appropriate maintenance these sumps may qualify as a stormwater BMP device for the removal of suspended sediment

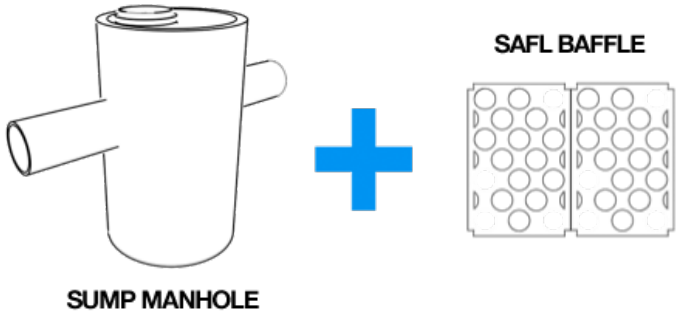


Underground Stormwater Treatment Devices

- **SAFL Baffle** (Saint Anthony Falls Laboratory, University of Minnesota)

a retrofit to the sump

- To decrease the maintenance frequency of standard sumps
- To prevent standard sumps from becoming a source of suspended sediment under high flow conditions



Images Credit – Upstream Technologies

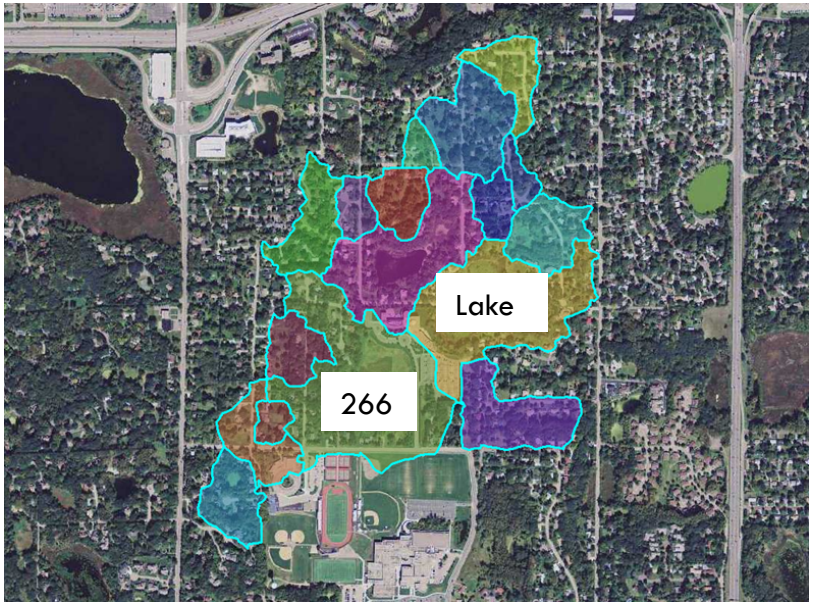
SAFL Baffle Performance modeling

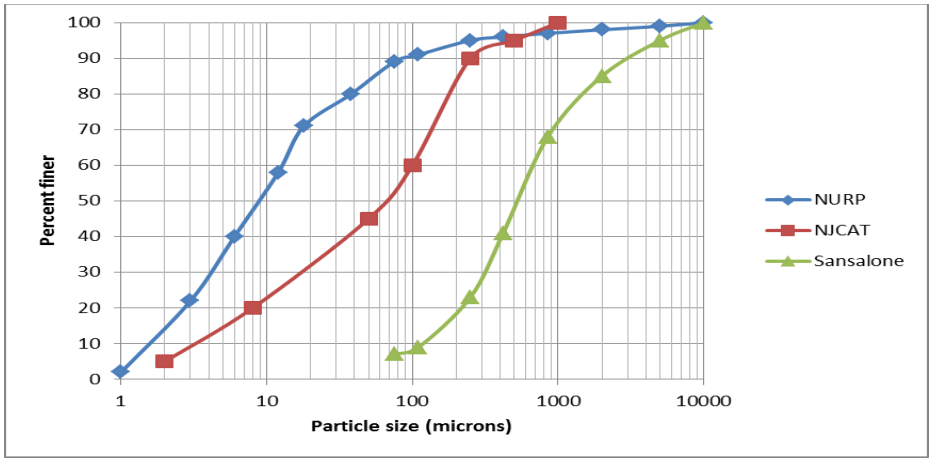
- Subwatershed 266 (41.7 ac)
- Particle size distributions :

  (1) National Urban Runoff Program- NURP (U.S. EPA 1986)

  (2) The New Jersey Corporation for Advanced Technology- NJCAT

  (3) Sansalone et al. (1998)





SHSAM 6.6
(Sizing Hydrodynamic Separators And Manholes)
By Barr Engineering Co.

SAFL Baffle Performance Results

Modeling case	Description	TSS Removal Efficiency (%)	
		Min	Max
a	Sump , NURP , fr=1	0	2.8
b	Sump , NURP	0	2.8
c	Sump , Sansalone , fr=1	4.7	60.3
d	Sump , Sansalone	4.7	60.4
e	Sump+SAFL Baffle, NURP, fr=1	0.2	7
f	Sump+SAFL Baffle, NURP	0.2	7
g	Sump+SAFL Baffle, Sansalone, fr=1	10.6	73.4
h	Sump+SAFL Baffle, Sansalone	12.1	73.6
i	Sump+SAFL Baffle, NJCAT, fr=1	1.6	32.2

Results show that sump cleaning frequency of once a year is a reasonable recommendation for the study area.

Cost To Treat

BMP	Cost/Year for Lifespan	Lifespan
Dry Basin	$37,000*	20 Years**
Wet Basin	$51,000*	20 Years**
Sand Filters	$132,000*	20 Years**
Bioretention	$130,000*	20 Years**
Wetland	$26,000*	20 Years**
Infiltration Trench	$257,000*	20 Years**
Street Sweeping	$35,000 – 42,000*	5 – 8 Years
Sump + SAFL Baffle	$700	20 Years

*Cost observed over this time period.
**Costs observed over this time period

Cost Effectiveness

BMP	Average ($/lb) TSS Removed	Average ($/lb) P Removed	Average TSS Removed (lb/yr)***	Average P Removed (lb/yr)***
Dry Basin	$2.33	$2,218	22376	42
Wet Basin	$2.10	$1,081	27406	85
Sand Filters	$4.02	$4,088	34512	74
Bioretention	$3.93	$1,567	35969	146
Wetland	$1.29	$959	28709	65
Infiltration Trenches	$6.57	$4,465	40202	106
Street Sweeping*	$0.52 - $1.28	$671 - $1860	21,790 – 72,920	15 - 56
Sump + SAFL Baffle	$0.40	NA	1670**	NA

*Includes the cost of purchasing a street sweeper

** Per Device

***Assumes Treatment of 100% Impervious Surface

Synthesis and Recommendations

- Street Sweeping
- Placement of bio-infiltration practices
- SAFL Baffle retrofits

Thank you!