Urban Myths Associated with Street Cleaning

Presented by:

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Cleaning Streets is NOT an Effective Stormwater Best Management Practice (BMP)

An Urban Myth

Nationwide Urban Runoff Program (NURP) 1982 Conclusion

“Street sweeping is generally ineffective as a technique for improving the quality of urban runoff.”

An Urban Myth

What Has Changed by 2009

- Improved Sweepers
- NPDES Permits
- TMDL Compliance
- Public Expectations are Greater
- “End-of-Pipe” Treatment is Very Expensive

Things Have Changed since 1982

- **Accurate pollutant load estimation and the ability to accurately estimate the pollutant load reductions associated with specific BMP applications is critical to the development of successful NPDES and TMDL implementation programs**

Major Take Away Points

- Pollutant washoff from streets and parking lots is the greatest single source of urban stormwater pollution
- Street dirt accumulated on streets and parking lots is the greatest contributor to pollutant washoff from streets and parking lots
- Newer sweepers are more effective at street dirt pick-up than ever before

Major Take Away Points

- Street cleaning improves stormwater quality because it reduces stormwater pollutant loadings entering waterways

- Pollutant washoff reductions by pavement cleaning are very cost effective

Major Take Away Points

- **Pacific Water Resources has the tools and experience needed to accurately estimate pollutant loads and the pollutant reduction benefits of specific pavement cleaning practices**

Major Take Away Points

Studies since the 1960's show that primary pollutants found in urban stormwater include:

- **Sediment**
- **Heavy Metals - lead, copper, zinc, etc.**
- **Nutrients – phosphorus and nitrogen**
- **Oxygen Demand**
- **Bacteria and Viruses**
- **Other Toxics - TPH, PAH's, Pesticides, etc.**
- **Litter and Trash**

Background Information

The first comprehensive study of stormwater pollutants listed the primary sources of urban stormwater pollution as:

- **Debris and contaminants from streets**
- **Contaminants from open land areas**
- **Publicly used chemicals**
- **Air-deposited substances**
- **Ice control chemicals**
- **Dirt and contaminants washed from vehicles**

APWA 1969 Chicago Study

- The study indicated that debris and contaminants from streets are the most readily controllable source of urban stormwater pollution

- The study also noted that the most significant component of street debris, in terms of producing water pollution through runoff, is the “dirt and dust” fraction of street refuse smaller than 1/8 inch (i.e. street dirt is defined)

APWA 1969 Chicago Study

1972 USEPA Study

Water Pollution Aspects of Street Surface Contaminants

Sampled street dirt from eight different cities throughout the U.S. and concluded the following:

- **Street dirt is highly contaminated with urban runoff pollutants**
- **Most street dirt was inorganic mineral similar to sand and silt**
- **Most of the pollution is associated with the fine sizes of the street dirt**

Street Dirt Characteristics

1972 USEPA Study

Water Pollution Aspects of Street Surface Contaminants

<table>
<tr><th></th><th colspan="3">Fraction of Total Constituent Associated with Each Particle Size Range (% by weight)</th></tr>
<tr><th></th><th><43 microns</th><th>43 – 246 microns</th><th>>245 microns</th></tr>
<tr><td>Total Solids</td><td>6</td><td>38</td><td>56</td></tr>
<tr><td>BOD</td><td>24</td><td>33</td><td>43</td></tr>
<tr><td>COD</td><td>23</td><td>57</td><td>20</td></tr>
<tr><td>Volatile Solids</td><td>26</td><td>34</td><td>40</td></tr>
<tr><td>Phosphates</td><td>56</td><td>36</td><td>8</td></tr>
<tr><td>Nitrates</td><td>32</td><td>45</td><td>23</td></tr>
<tr><td>Kjeldahl Nitrogen</td><td>19</td><td>40</td><td>41</td></tr>
<tr><td>Heavy Metals (all)</td><td colspan="2">51</td><td>49</td></tr>
<tr><td>Pesticides (all)</td><td colspan="2">73</td><td>27</td></tr>
<tr><td>Polychlorinated Biphenyls</td><td colspan="2">34</td><td>66</td></tr>
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Street Dirt Characteristics

1972 USEPA Study

Motor vehicles were identified as a major source of street surface contaminants

- Leakage of fuel, lubricants, hydraulic fluids, and coolants
- Fine particles worn off of tires and clutch and brake linings
- Particle exhaust emissions
- Dirt, rust, and decomposing coatings which drop off of fender linings and undercarriages
- Vehicle components broken by vibration or impact (glass, metals, etc.)

Over $30 million was spent studying the characteristics and potential control of urban stormwater runoff quality at 28 U.S. cities between 1979 - 1982

USEPA 1982 NURP Study

Street cleaning was investigated in the following U.S. cities:

City	Sites
Bellevue, WA	2
Champaign Urbana, IL	4
Milwaukee, WI	2
Winston-Salem, NC	2

USEPA 1982 NURP Study

- The studies used either a paired basin or serial basin approach with continuous sampling of end-of-pipe urban runoff quality occurring under either *swept* or *unswept* conditions

- The resulting runoff quality data was analyzed statistically, not explicitly. Computer models of that era were not considered to be reliable or accurate

USEPA 1982 NURP Study

- NURP evaluated street cleaning performance as measured by the percent change in the site median Event Mean Concentration (EMC) for each pollutant of interest

- NURP concluded that street sweeping using equipment of that era was generally ineffective in reducing the concentrations of pollutants commonly found in stormwater

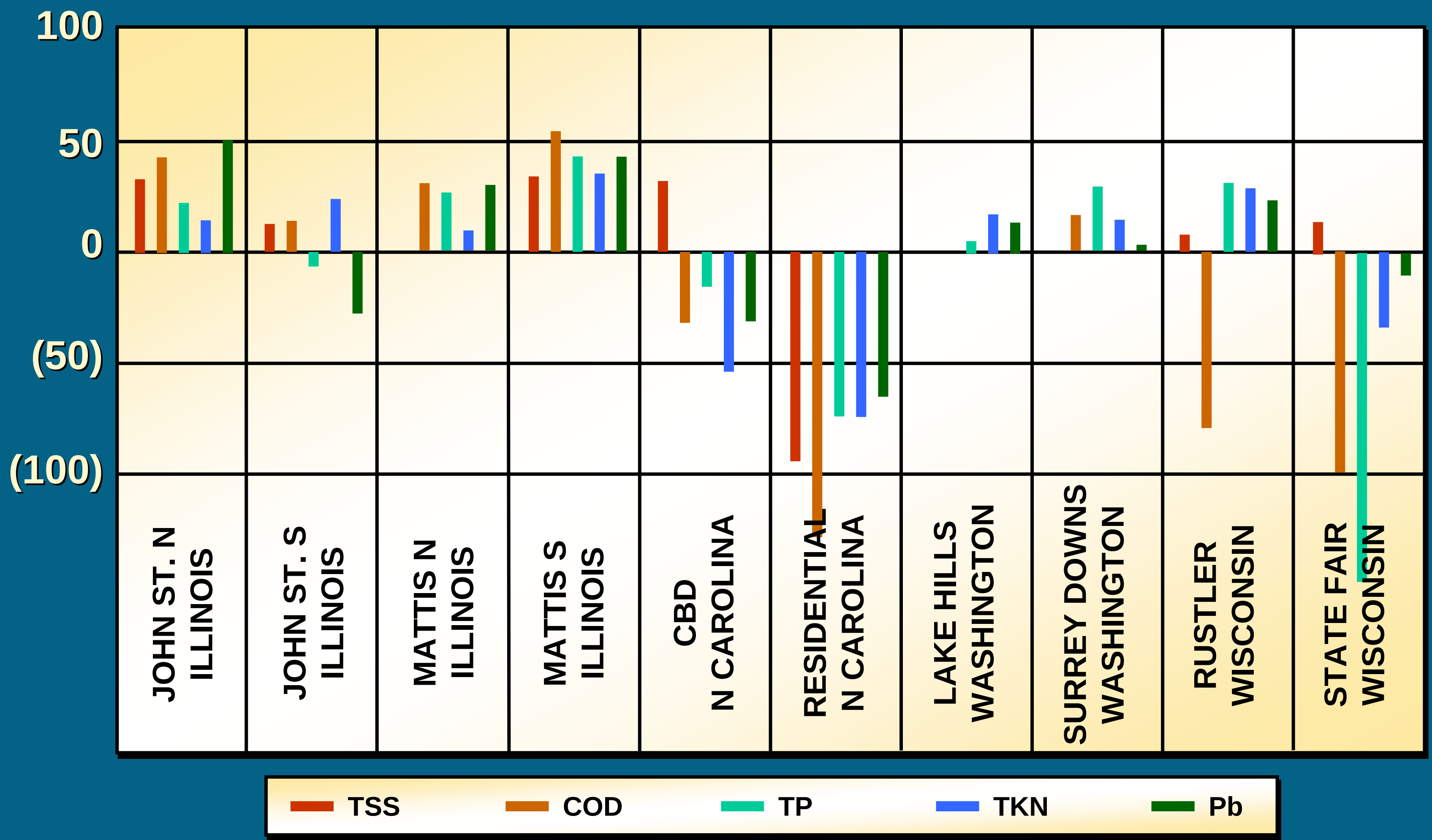
USEPA 1982 NURP Study

- However, the *actual* data analyses of the five major pollutants (TSS, COD, TP, TKN, and Lead) at each of the 10 sites where street sweeping was investigated showed that under *swept* conditions EMCs were *actually reduced* in 60% of the 50 pollutant/site investigations

- Increases in site median EMCs were reported for 16 out of the 50 pollutant/site investigations, with 9 of those from the two North Carolina sites

NURP Study – Actual Data Analyses

% EMC Reduction



NURP Study – Actual Data Analyses

- We now know that these EMC increases resulted from the NURP era street sweeper’s inability to pick up significant amounts of the “dirt and dust” fraction of the accumulated street dirt (i.e. less than 1/8 inch)
- Intense rain storms (which occur more frequently in North Carolina) were then able to efficiently transport the remaining unarmored material which led to higher pollutant concentrations for the swept condition

USEPA 1982 NURP Study

Why does this matter now?

- Technology has greatly improved the sediment pick up performance of all types of street cleaners

- Because of the NURP conclusion, most stormwater people including most consultants and NPDES coordinators believe that street cleaning is ineffective at reducing pollutant loadings in stormwater

USEPA 1982 NURP Study

Early Street Cleaning Studies (NURP Excluded)

US Naval Radiological Defense Laboratory, California (1963)

San Jose, California (1979)

Alameda County, California (1981)

Washoe County, Nevada (1982)

Ottawa, Ontario (1983)

Toronto, Ontario (1986)

City of Portland, Oregon (1988, 1990, 1993)

Washington County, Oregon (1995)

PWR's Recent Street Cleaning Studies

Port of Seattle, Washington (1998)

Livonia, Michigan (2001)

Jackson, Michigan (2001)

Gresham, Oregon (2003)

West Linn, Oregon (2004)

Yakima County, Washington (2004)

Cross Israel Highway, Israel (2004)

Other Recent/Ongoing Street Cleaning Studies

Milwaukee County, Wisconsin (2002)

Madison, Wisconsin (2007)

Baltimore, Maryland (2008)

Seattle, Washington (2009)

Controversy surrounds the question of how much of the pollution found in urban stormwater can street cleaning remove

A year long pilot study in Seattle found that regenerative air sweeping once every two weeks removed 2,200 to 3,100 lbs of dry material per acre per year

Estimated life cycle costs for a full-scale street cleaning program in Seattle were $1.37 per lb of material removed

TSS removal costs are only 15% to 50% of those estimated for regional stormwater treatment

For any assessment of street cleaning program costs accurate pick-up performance data is needed

Environmental and public health reasons

- Improves aesthetics
- Reduces pollutant loadings
- Reduces gross solids and street litter
- Could improve air quality

Why Clean?

Legal Compliance

- Phase I or II NPDES MS4 Permits
- TMDL Plan implementation

Why Clean?

Effectiveness and Cost-effectiveness

- Streets are the largest single source of stormwater pollution under the control of most jurisdictions
- Sweeping is likely the cheapest BMP based on $ per pound of pollutant removed
- Unlike most other BMPs, sweeping can have an immediate impact

Street Cleaning is a Cost Effective BMP

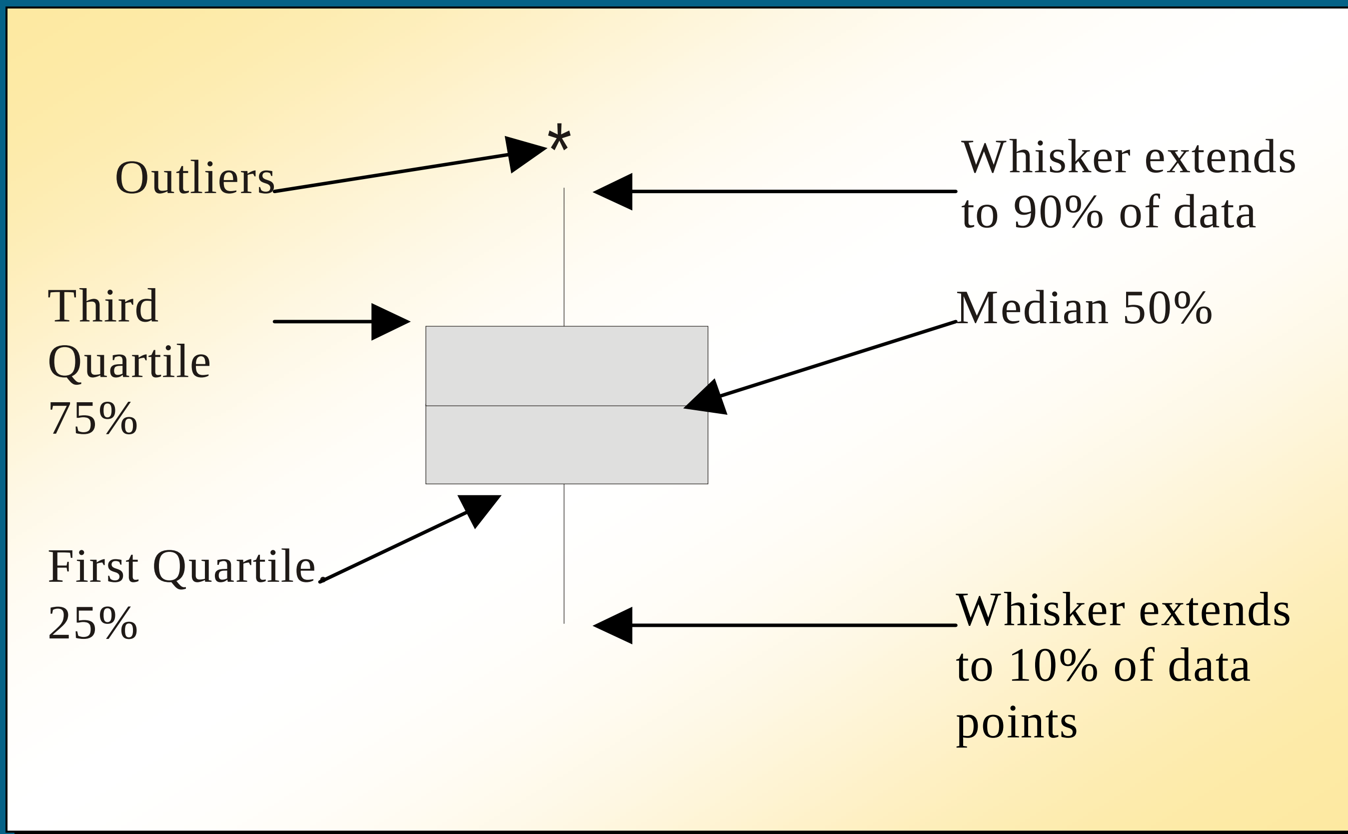
- Streets and parking lots cover ~20% of the urban landscape
- These surfaces likely contribute half, if not more, of the toxic stormwater pollutants entering urban waterways
- Structural treatment cost ~$10 to ~$50 per pound of TSS removed
- Sweeping costs $1 to $5 per pound of TSS removed

Contrary to Conventional Wisdom

The Number One Reason to Clean is:

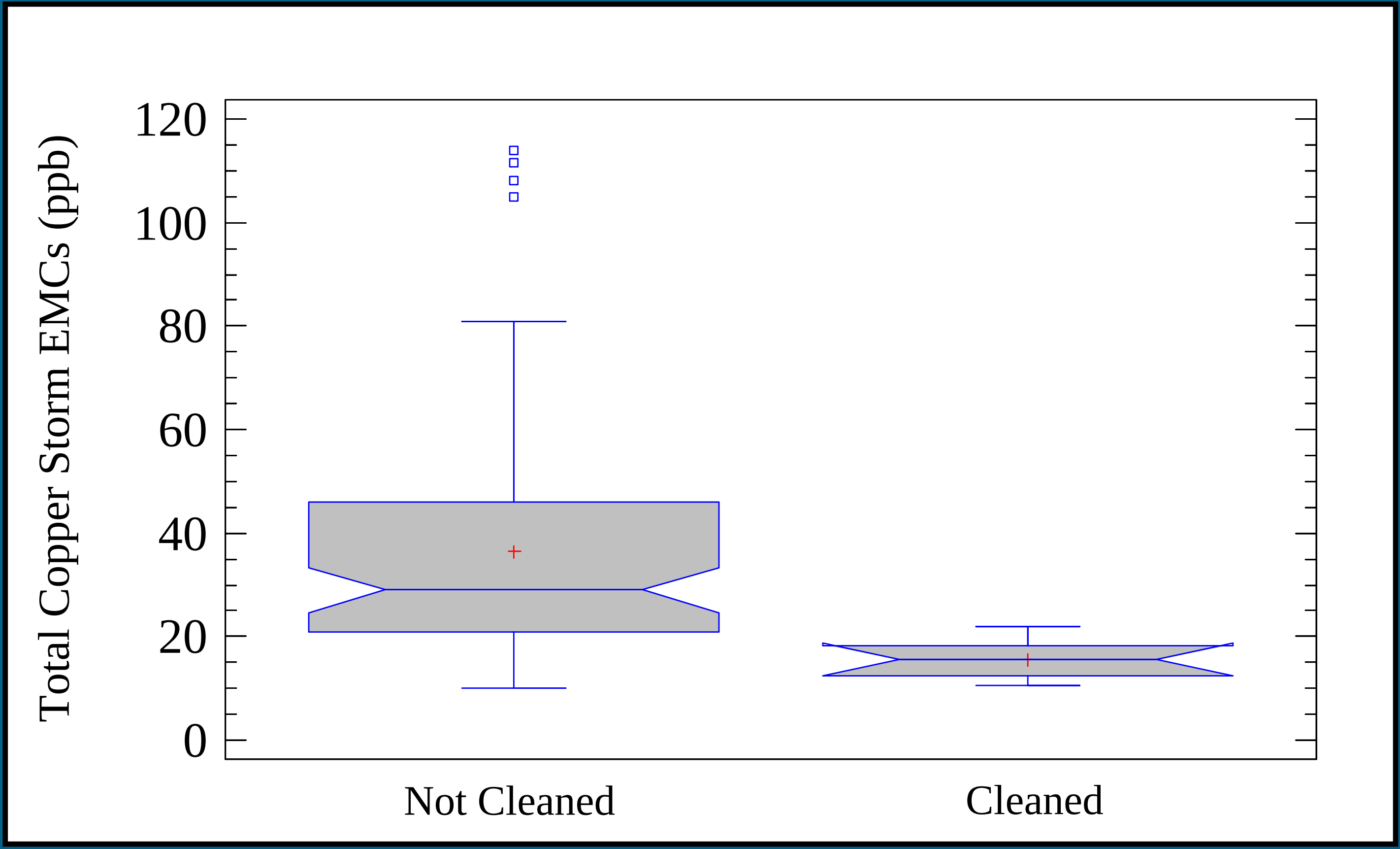
Street Cleaning Cost Effectively Reduces Stormwater Pollutant Loadings Entering Urban Waterways which Satisfies the MEP Requirement and Improves Water Quality

Box & Whisker Plots



Baltimore Street Cleaning Pilot Study

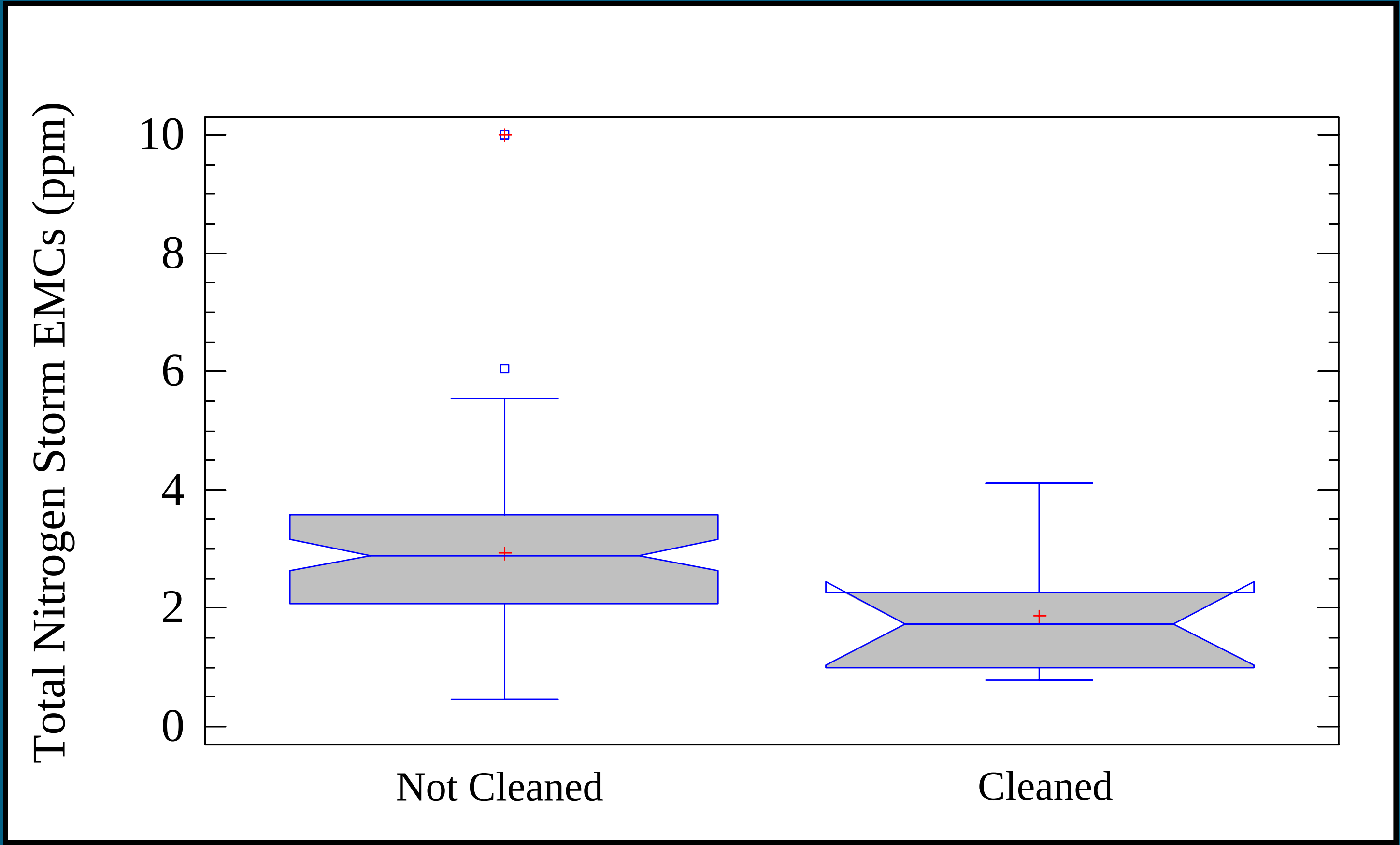
Copper concentration declined (early results)



Cleaning Reduces Pollutant Loadings

Baltimore Street Cleaning Pilot Study

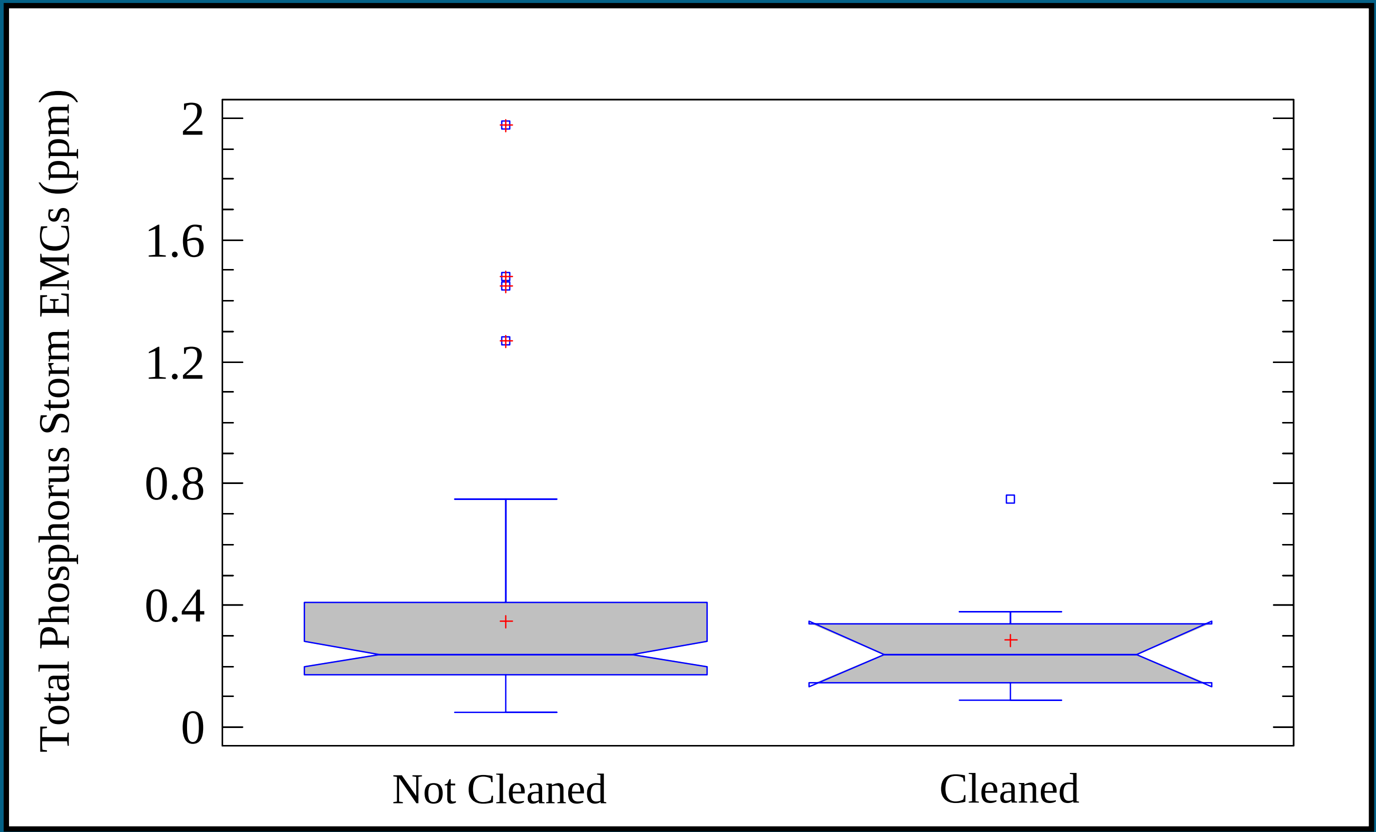
Total nitrogen concentration declined (early results)



Cleaning Reduces Pollutant Loadings

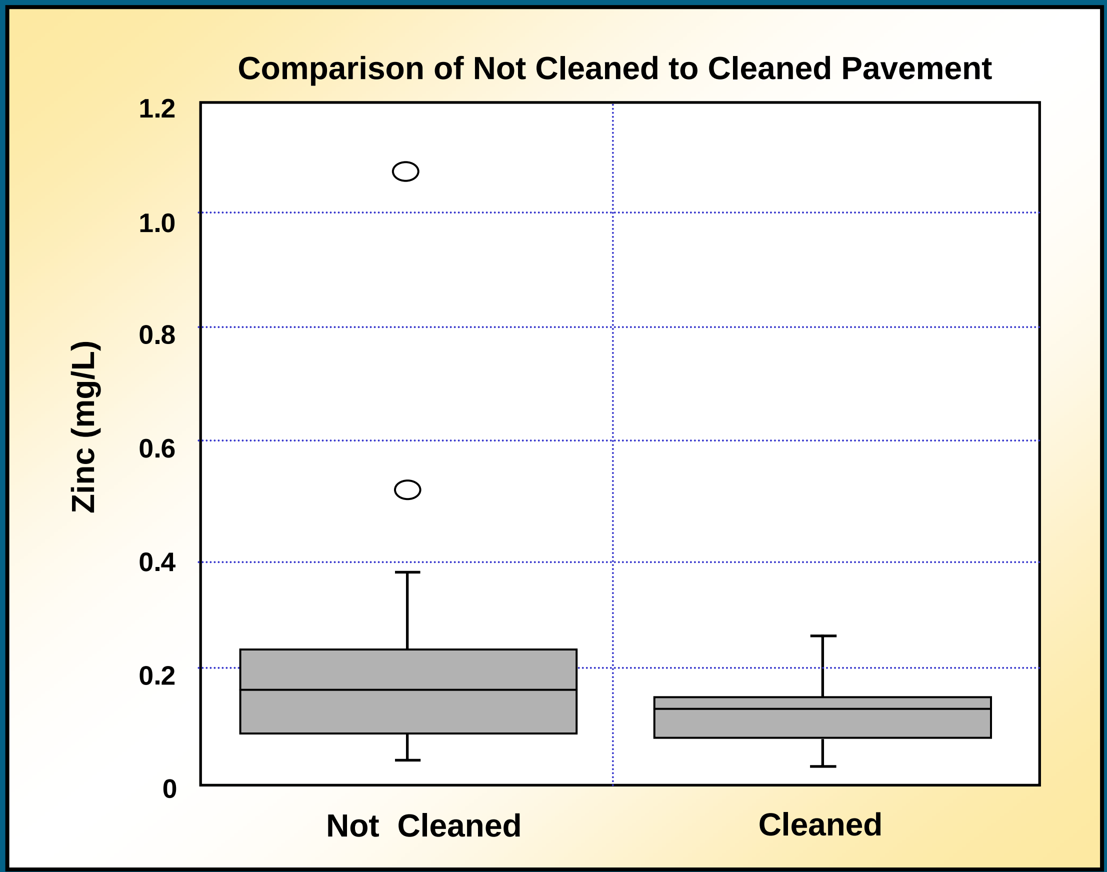
Baltimore Street Cleaning Pilot Study

Reduction of higher concentrations for total phosphorus (early results)



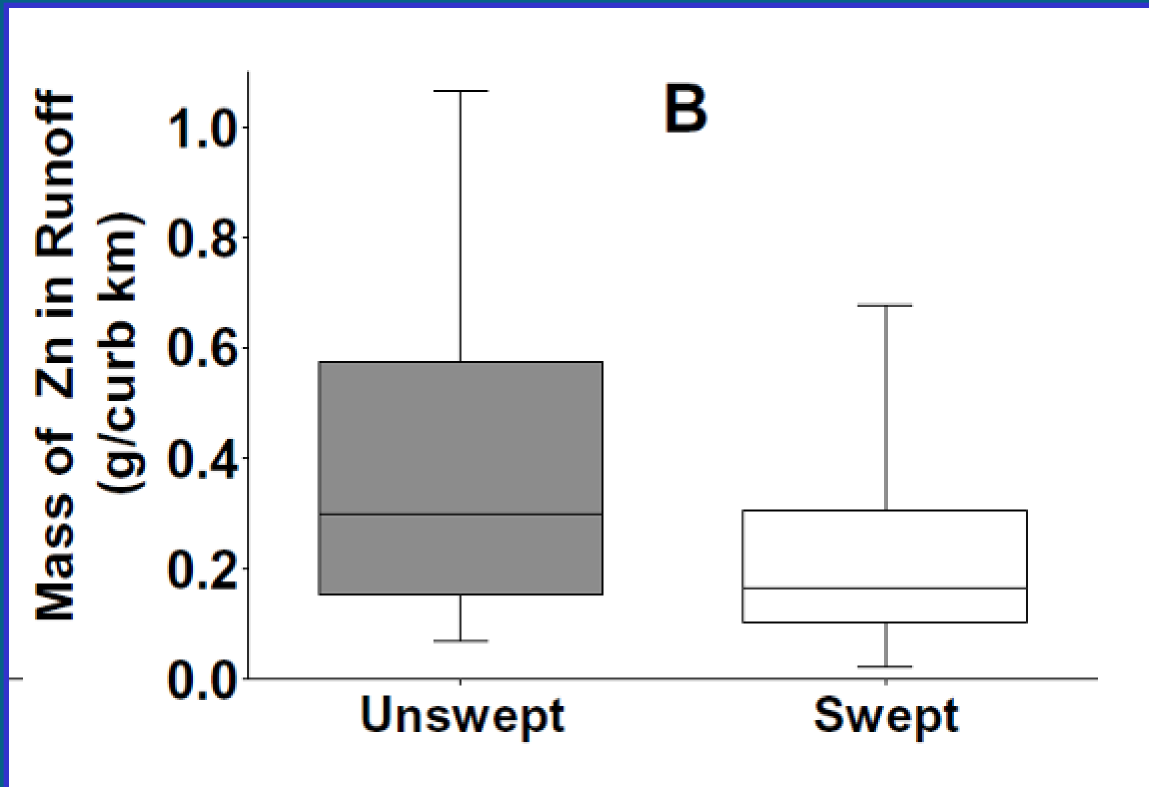
Cleaning Reduces Pollutant Loadings

Cross Israel Highway (CIH) Stormwater Quality Study



Cleaning Reduces Pollutant Loadings

Toronto Canada Roadway Street Sweeping Study



Cleaning Reduces Pollutant Loadings

When cleaning to reduce pollutant loadings:

Sediment and associated pollutant pick-up efficiency should be an important aspect of street cleaner selection

Sweeper pick-up efficiency is a function of:

- Initial accumulation
  - Magnitude
  - Particle size distribution (PSD)
- Street texture and condition
- Type of sweeper (mechanical, vacuum or regenerative air)
- Forward speed of sweeper
- Interference with parked cars
- Street surface moisture

Street Cleaner Pick-up Performance

PWR Principal Roger Sutherland has designed and implemented sweeper pick-up tests for well over 25 years

- Washoe Co Council of Governments - Reno/Sparks, Nevada (1982)
- Portland Bureau of Environmental Services (BES) – Portland, Oregon (1992)
- Port of Seattle - SeaTac International Airport (1995)
- Enviro Whirl Technologies – Centralia, Illinois (1995)
- Cross Israel Highway - Tel Aviv, Israel (2002)
- Seattle Public Utilities (SPU) – Seattle, Washington (2004)
- D.C. Dept. of Public Works - Washington D.C. (2007)

Previous Pick-up Performance Testing

- **Pacific Water Resources was asked by Elgin Sweeper Company in 2008 to independently design and conduct pick-up performance tests of four different sweeper models and document the results**
- **PWR had complete control over the test procedures, supervised the tests, directly contracted with the laboratory doing the seiving, maintained the chain of custody regarding the transport of the remaining material collected from the sweeper tests and documented the test results**
- **The sweeper models and types tested were:**
    - **Crosswind (NX) (Regenerative Air with air controls)**
    - **Crosswind (Regenerative Air)**
    - **Whirlwind (MV) (Vacuum)**
    - **Eagle (Mechanical tested with & without water spray)**

Elgin Sweepers Tested

Pick-up Performance Testing Mandate from Elgin:

Design a test such that the important test variables are truly representative of average real world sweeping conditions

Important Test Variables:

- Pavement moisture
- Pavement condition
- Initial accumulation and particle size distribution
- Curbed street with realistic distribution of accumulated material across the street
- Forward sweeping speed
- Safe testing conditions

Important Test Variables

Most Street Cleaning Programs Request Pick-up Performance Demonstrations of Candidates’ Cleaners

However, the test conditions imposed rarely involve realistic day-to-day sweeping conditions.

Unrealistic Performance Demonstrations

Typical Unrealistic Test Conditions

Unrealistic Performance Demonstrations

Test Location & Dry Pavement Conditions are Important

- Testing scheduled to occur over a three day period during the month of July 2008 in St. Charles, Illinois
- Testing procedure requires initially dry pavement conditions
- Initial conditions including pavement moisture must be identical for each individual test

Problem:

It rains in Illinois during the summer

Solution:

Test under a huge tent erected in a large parking lot owned by Elgin's parent company so dry and safe conditions will be maintained throughout the test period

Test Location & Dry Pavement Ensured

Test Location & Dry Pavement Ensured

Realistic Test Track Conditions

- 50 ft long and 2 ft wide
- Asphalt pavement
- Fair pavement condition
- Uneven surface
- Numerous cracks
- Cracks are sealed
- Safe testing environment

Realistic Test Track With Curb

- Create a batch of representative “street dirt” simulant.
- Sieve a representative sample of the simulant into eight preselected particle size (PS) groups so its particle size distribution (PSD) is known.
- Spread a known and realistic quantity of street dirt simulant evenly on the test track using a calibrated fertilizer spreader.
- Execute a single pass of a sweeper maintaining a specified forward speed while two observers record the actual time spent cleaning the tesk track with stopwatches.
- Using an industrial vacuum with a smooth stainless steel canister, hand vacuum the remaining simulant.
- Carefully transfer the material to a plastic zip-lock bag, weigh it, label it and establish the chain of custody.

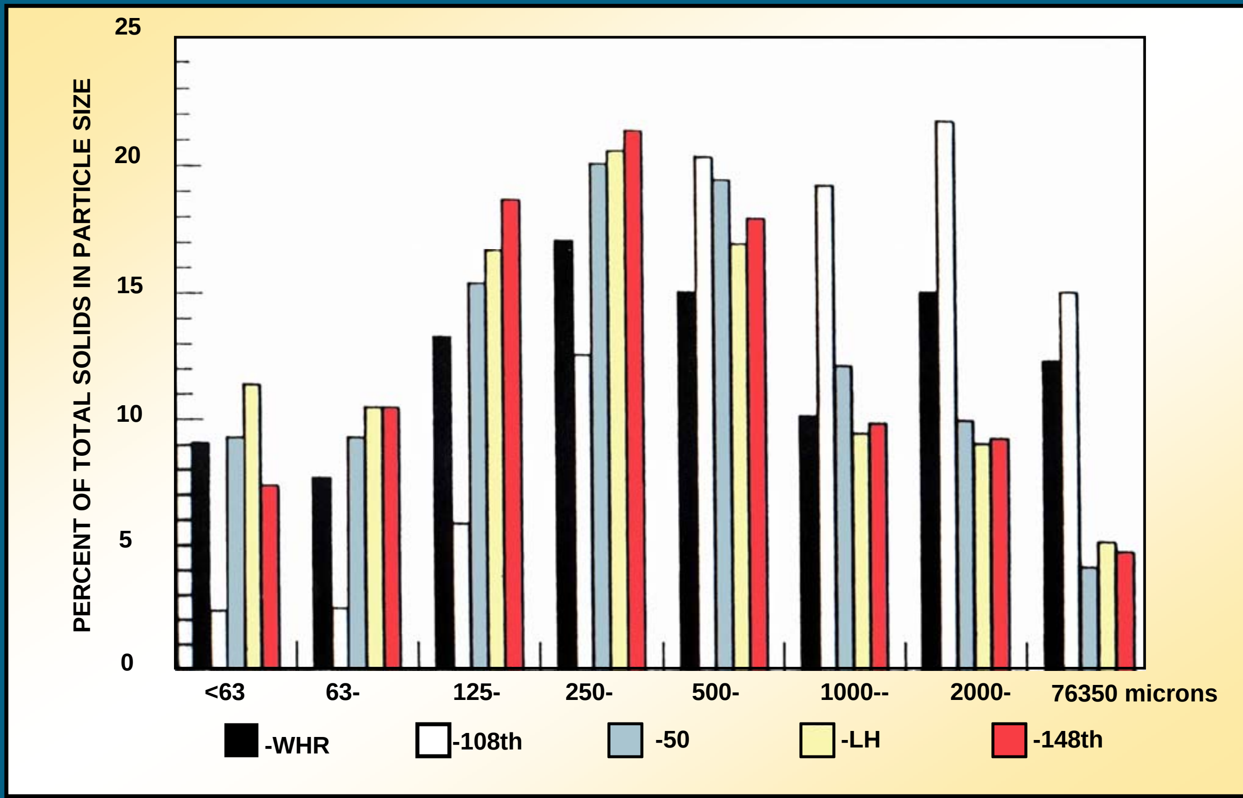
Pick-up Performance Test Procedure

Street Dirt Material is a Important Test Variable

- Ingredients should have the same specific gravity of street dirt which is about 2.60
- Must be combined in a recipe that results in a particle size distribution (PSD) of actual street dirt.
- Simulant used was a mixture of six different manufactured silica products designed to mimic the average PS distributions found in the City of Bellevue (suburb of Seattle) in the early 1980's as part of the Nationwide Urban Runoff Program (NURP).

Street Dirt Simulant is Important

Dry Season Particle Size Distributions (PSD) in Bellevue, Washington



Observed PSDs for Street Dirt

Particle Size Distribution (PSD) of Street Dirt Simulant

Table 1 – Particle Size Distribution (PSD) of Street Dirt Simulant

PS No.	Sieve No.	Size Range (microns)	Bellevue NURP Average Incremental Mass (%)	Incremental Mass (%)	Percent Retained	Percent Passing
8	1/4	>6370	8.2	0.0	0.0	100.0
7	10	2000-6370	13.0	16.9	16.9	83.1
6	18	1000-2000	11.8	10.8	27.7	72.3
5	30	600-1000	17.8	7.1	34.8	65.2
4	60	250-600	19.1	19.4	54.2	45.8
3	120	125-250	14.2	30.1	84.3	15.7
2	230	63-125	8.0	7.1	91.4	8.6
1	Pan	<63	7.9	8.6	100	0.0

PSD of Street Dirt Simulant

Initial Accumulation & Distribution is Important

- Bellevue NURP data showed average dry season accumulations ranged from 160 to 920 lbs per curb mile (45 to 259 grams per curb meter) which is typical for most street dirt studies
- 7.5 lbs (3405 grams) of simultant applied evenly alone the 50 ft track which resulted in 792 lbs per curb mile (222 grams per curb meter)
- Material was evenly spread within 2 ft of the curb face which is typically where 90+% of street dirt is actually found

Initial Accumulation & Distribution

Forward Sweeping Speed is Important

- Recommended forward sweeping speed is typically 4 to 6 mph
- Test called for maintaining a forward speed of 5 mph
- Sweeper will travel the test track length of 50 feet in 6.8 seconds
- Stopwatches were used during multiple practice runs to time the sweeper on the test track by two observers to ensure that the desired speed can be maintained

Testing the Elgin Crosswind NX

Pick-up Performance Testing for Elgin Sweeper

Vacuuming the Remaining Material

Pick-up Performance Testing for Elgin Sweeper

Transferring Material to Zip Lock Bag

Overall Pick-up Performance Results

Sweeper Model	Type	Remaining Mass (gms)	Initial Mass (gms)	Pick-up Mass (gms)	Pick-Up %	Forward Sweeping Speed (mph)
Crosswind (NX)	Regenerative	85.6	3405	3319.4	97.5	4.7
Crosswind	Regenerative	121.1	3405	3283.9	96.4	4.9
Eagle (FW)	Mechanical	288.3	3405	3116.7	91.5	4.9
Eagle (FW) with water	Mechanical	646.0	3405	2759.0	81.0	4.7
Whirlwind (MV)	Vacuum	221.1	3405	3183.9	93.5	5.1

Pick-up Efficiencies by Particle Size Range

(Percent of Initial Mass)

PS No.	Size Range (microns)	Crosswind NX	Crosswind Std.	Eagle FW waterless	Eagle FW with water	Whirlwind MV
7	2000-6370	99.4	99.4	95.9	95.8	99.3
6	1000-2000	98.5	98.7	93.3	91.2	98.2
5	600-1000	97.8	98.1	93.1	88.3	96.3
4	250-600	97.9	97.6	93.4	84.2	93.5
3	125-250	97.7	95.7	91.1	72.0	89.6
2	63-125	97.0	93.0	89.9	68.7	86.5
1	<63	90.8	89.4	78.1	68.2	93.5

- **Test results were excellent and real world test conditions were simulated**
- **Machine performance conformed to expectations:**
  - **Regenerative air machines performed best with the Crosswind (NX) with dust control at 97.5% and the standard Crosswind at 96.4%**
  - **Vaccum based Whirlwind (MV) was third at 93.5%**
  - **Mechanical Eagle (FW) without water was at 91.5% and the Eagle (FW) with water was 81.0%**
- **Pick-up performance is reduced when water is used for dust suppression but fugitive dust losses were not measured**

Pick-up Performance Test Results

- Fine particle (less than 63 microns) pick-up performance is a major concern
- Air machines outperformed mechanical ones with 89.4% to 93.5% pick-up of finest range although the mechanical Eagle (FW)without water was impressive at 78.1%
- Vacuum based Whirlwind (MV) was the highest in fine particle pick-up at 93.5%
- Fugitive dust losses were not measured Crosswind (NX) and Eagle (FW) without water had essentially no visible dust losses

Pick-up Performance Test Results

- Approximately 50 different sweeper models are available for purchase nationwide from four major sweeper manufacturers
- Only 4 models from one major manufacturer have been tested using controlled real world sweeping conditions.
- Real world testing of the models available from the other three major manufacturers should be conducted
- With the increased regulation of stormwater runoff through the NPDES and TMDL programs, the need for real world pick-up performance testing is greater today than ever before

Other Manufacturer Testing is Needed

- **Type of sweeper used**
  (pick-up performance is most important)
- **Forward speed of the sweeper**
  (4 to 6 miles per hour is recommended)
- **Parked car interference**
  (requires a political will, ordinances and enforcement whose fines can be used to support the cleaning program)
- **Frequency of street cleaning**
  (usually varies by land use or street categories)

Street Cleaning Programs Can Control

- But how does a street cleaning program determine the most cost-effective or best program for reducing stormwater pollutant washoff?
- For accurate estimates, computer modeling must be used
- PWR uses a model they developed called SIMPTM

- Estimates pollutant loadings for both NPDES reporting and TMDL planning

- Can establish the relationship between frequency of cleaning by land use or street category and the amount of pollutant that would have been removed from the urban runoff washoff over an historic rainfall record of unlimited length

Benefits of SIMPTM Modeling

SIMplified Particulate Transport Model (SIMPTM)

- Simulates accumulation of street dirt during dry weather
- Simulates wet weather washoff of pollutants on a storm-by-storm basis through an historic rainfall record of unlimited length
- Simulates the pollutant reduction benefits of specific cleaning operations described by cleaner type, pick-up performance by particle size (PS) and cleaning frequency, which are inputs

SIMPTM Description

Most models simplistically simulate pollutant loading by multiplying the estimate runoff of each event times an assumed average pollutant concentration, invariable from storm-to-storm.

This approach called the Simple Method:

- **Cannot estimate storm-by-storm concentrations**
- **Usually overestimates total annual pollutant washoff**
- **Cannot evaluate changes in street cleaning operations or other BMPs**

In Contrast – SIMPTM explicitly simulates:

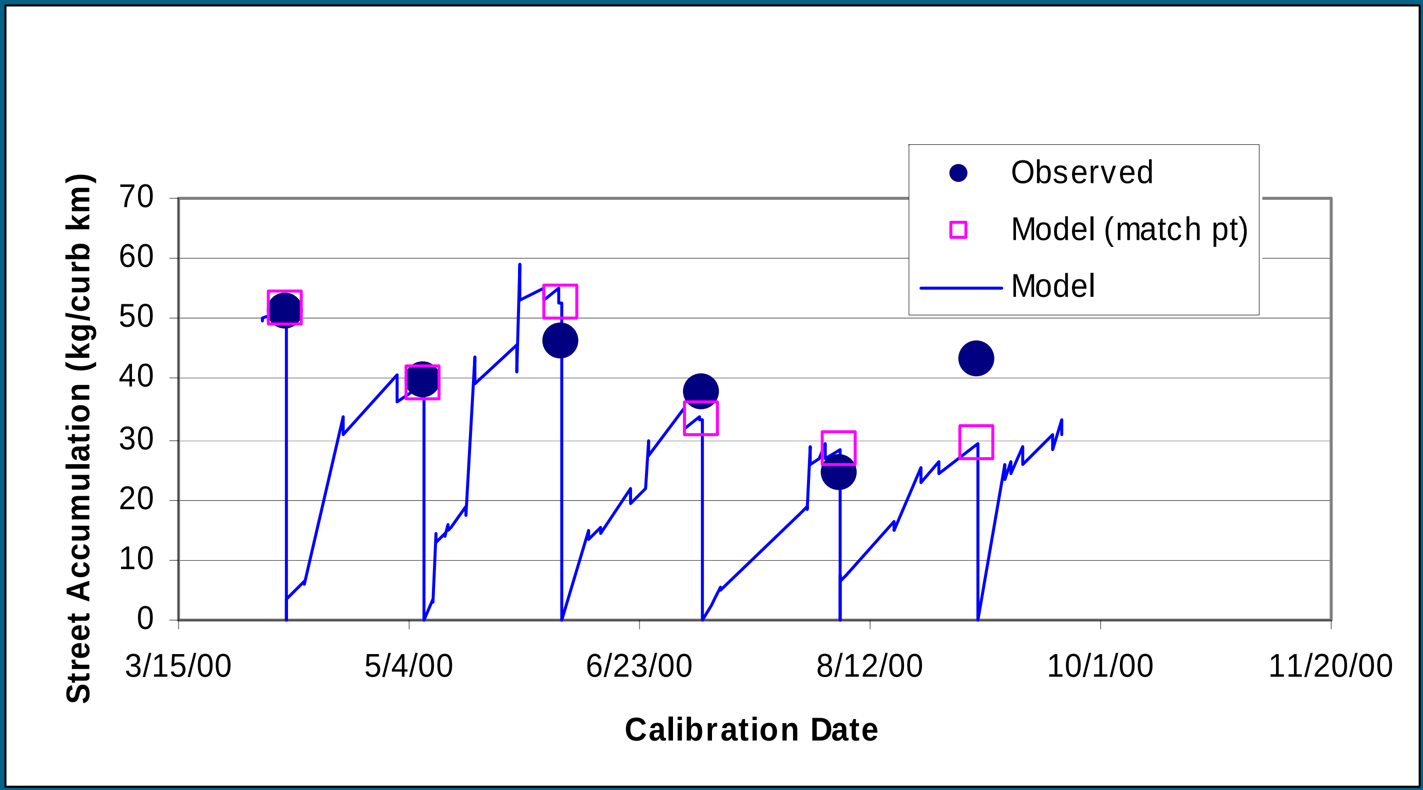
- The physical processes of stormwater runoff to transport accumulated pollutants for each storm resulting in realistic and variable concentrations from storm-to-storm

- The ability of the street cleaning operation to periodically remove variable sediment size fractions of accumulated street dirt, which reduces the pollutant accumulation and washoff

This results in accurate estimates of:

- Pollutant loadings and concentrations from specific sites or land use categories over an historic rainfall record of unlimited length
- Accumulated street dirt and associated pollutants
- Pollutant pick-ups from street sweeping and catchbasin cleaning
- The most cost effective or optimal street and/or catchbasin cleaning frequency

SIMPTM Calibration of Street Dirt Accumulation
Durand Single-Family Residential Site



Observed vs Simulated Catchbasin Accumulations

Site Name	Monitoring Date	No. of Catchbasins	Observed Accum Avg. Depth of Sediment (m)	Simulated Accum Avg. Depth of Sediment (m)
Newburgh	5/11/00	7	.018	.006
Fox Creek	3/24/00	8	.012	.015
Munger	5/11/00	8	.015	.006
Riverside	3/24/00	14	.009	.003

Observed versus Simulated Street Cleaner Pick-up

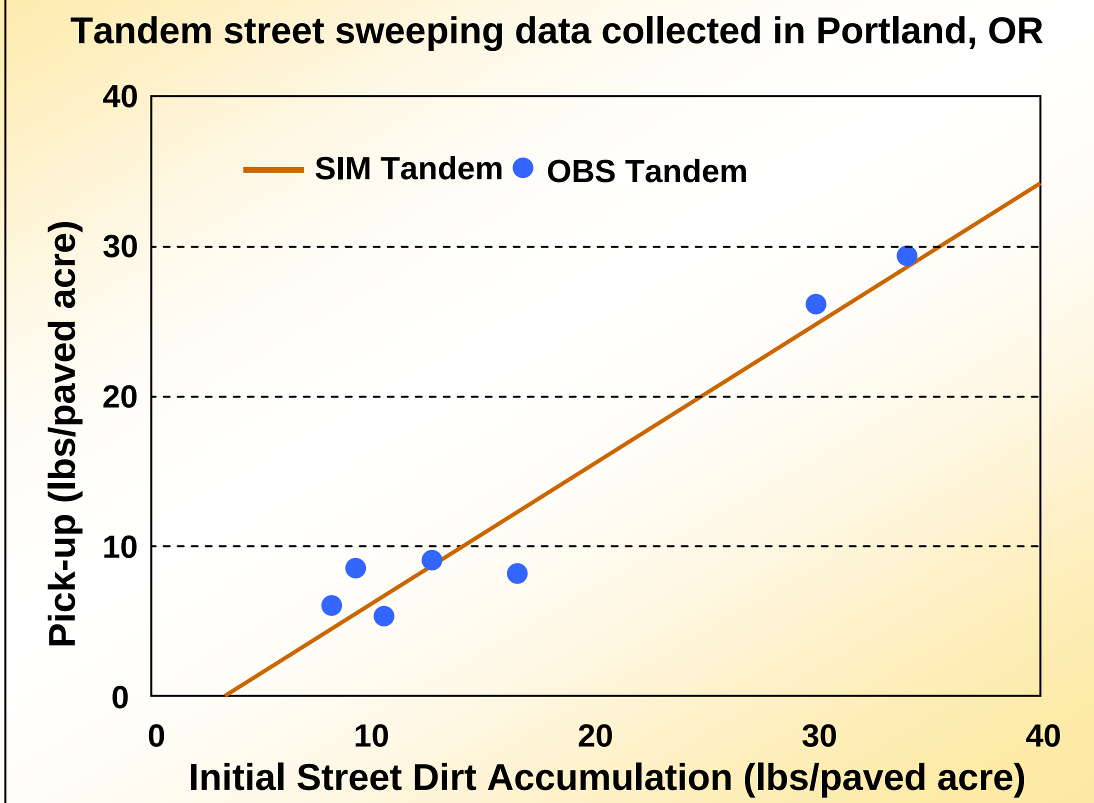
Size Group #1

<63 microns

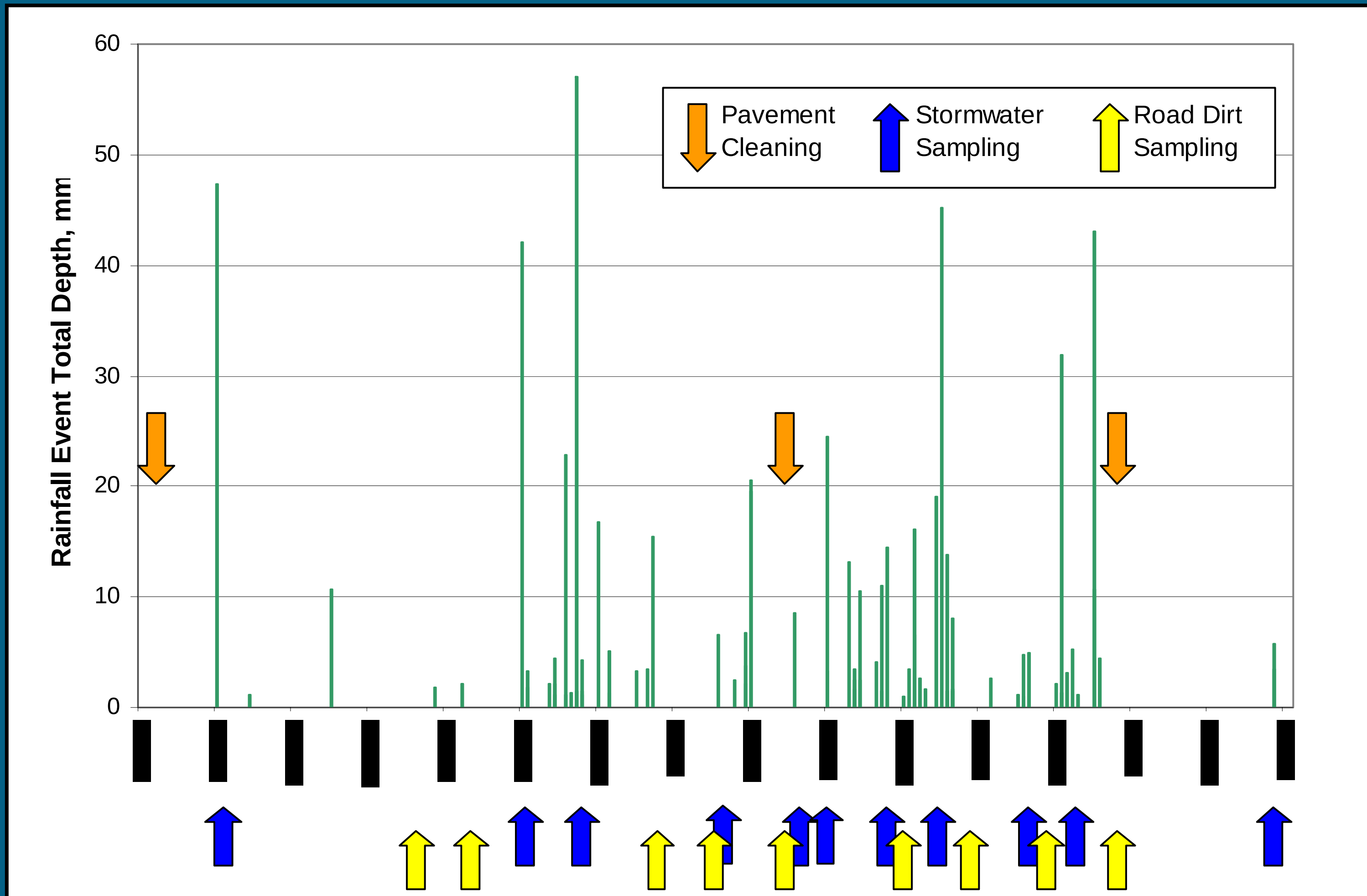
SSeff = 93%

SSmin = 2.0

Lbs/Paved acre



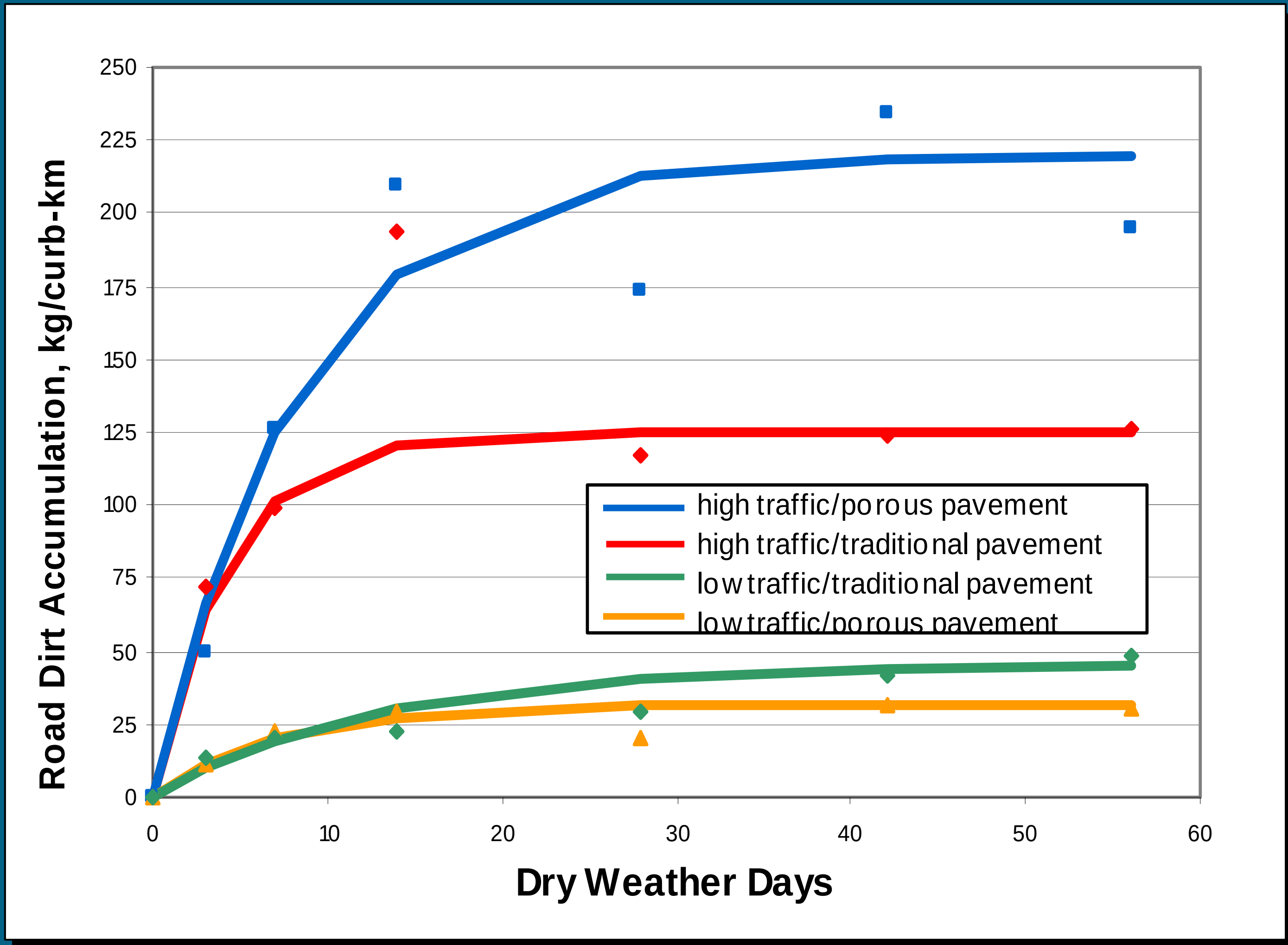
Timing of Rainfall Events, Samplings and Cleanings



CIH Case Study

SIMPTM Calibration

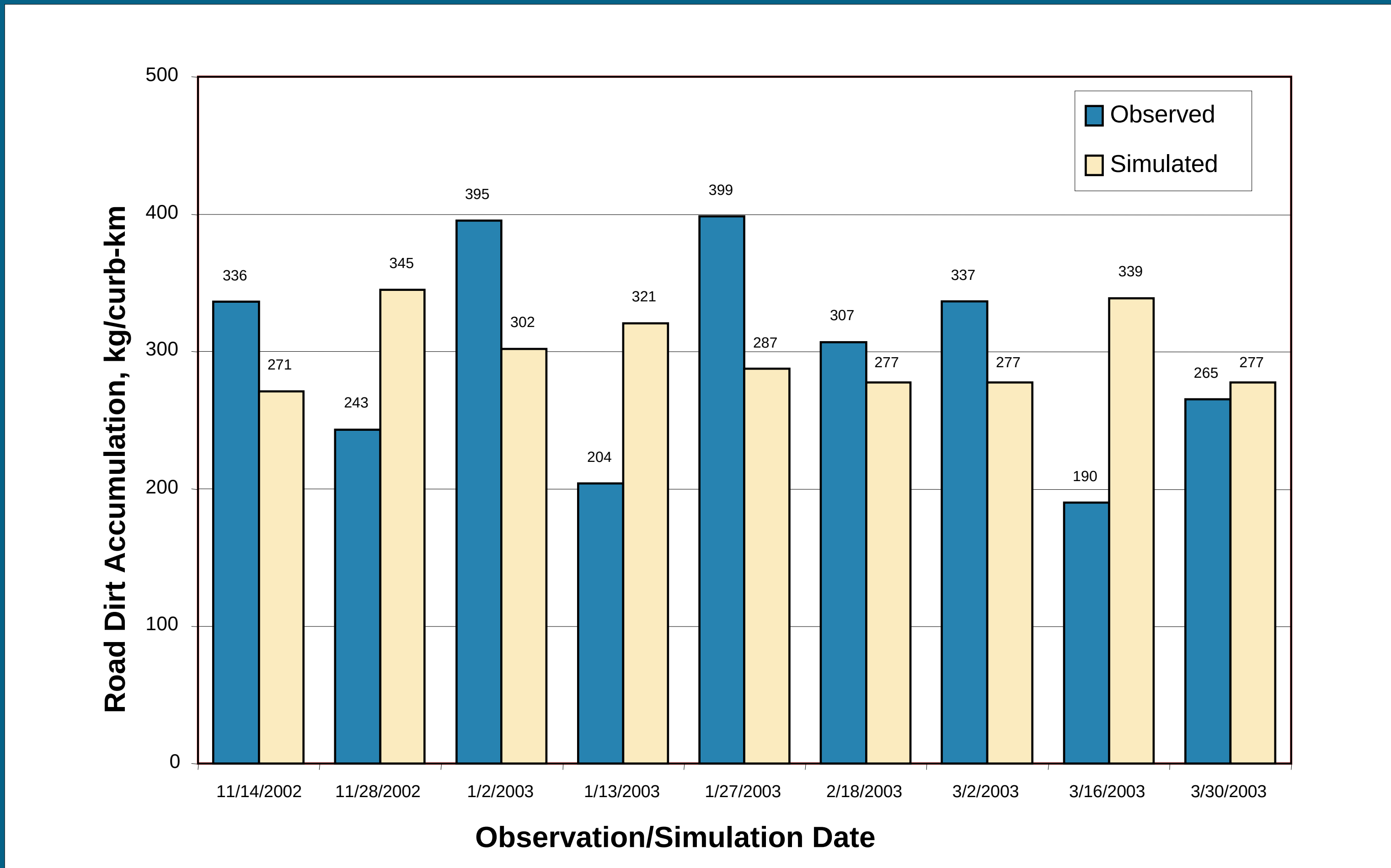
Dry Weather Road Dirt Accumulation



CIH Case Study

SIMPTM Calibration

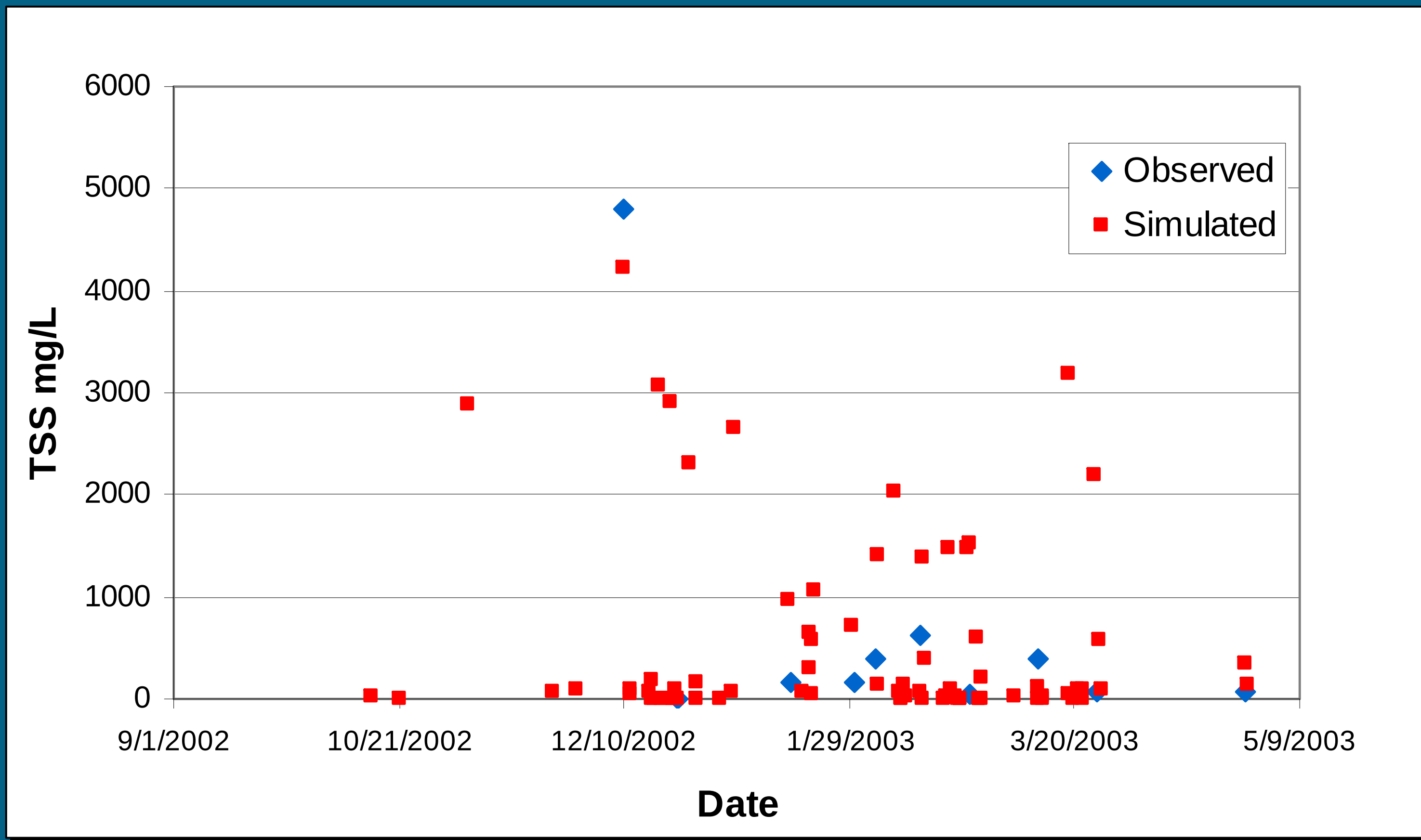
Simulated versus Observed Road Dirt Accumulations on Porous Pavements



CIH Case Study

SIMPTM Calibration

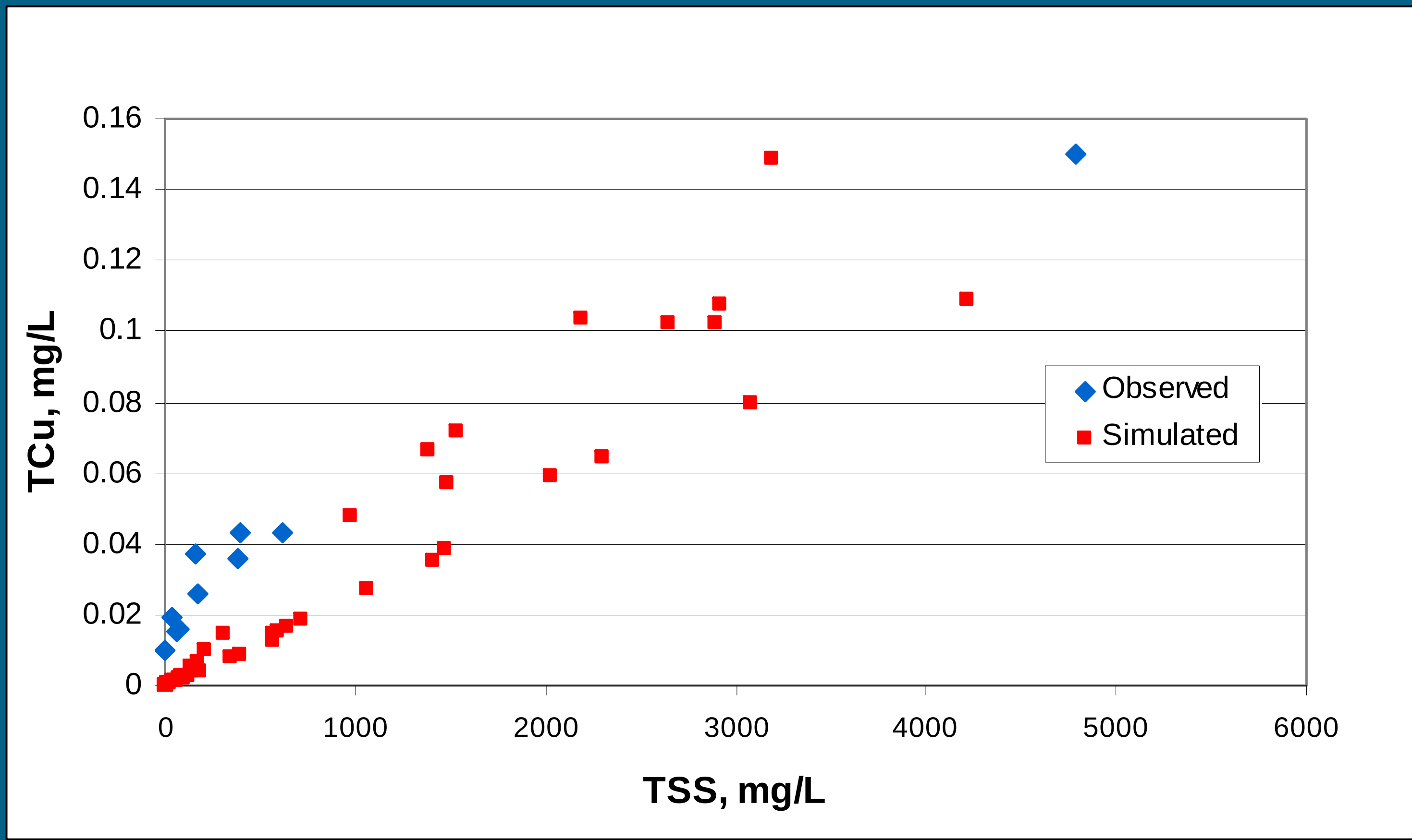
Simulated versus Observed TSS Concentrations from Traditional CIH Pavements



CIH Case Study

SIMPTM Calibration

Simulated versus Observed Paired TCU and TSS Concentrations from Traditional CIH Pavements



CIH Case Study

SIMPTM Calibration

Pacific Water Resources, Inc. has developed and successfully implemented a study process that provides accurate estimates of:

- **Urban pollutant loadings over specific time periods**
- **Reductions in these loadings associated with specific cleaning practices**
- **Optimum effort levels for the most cost-effective street and catchbasin cleaning practices**

PWR Study Process

- Most stormwater studies can not afford the considerable time or cost needed to continuously monitor the quantity and quality of stormwater events from small homogenous sites

- Instead, sites representative of watershed land uses can be monitored for the accumulation of sediments and associated pollutants at a fraction of both the time and cost

- Then, SIMPTM can be calibrated to the accumulation data and simulate site specific pollutant loadings and pollutant reduction effectiveness of BMPs like street cleaning

PWR Study Process

- **Delineate watershed land use characteristics**
  - **use best available mapping**
  - **conduct “windshield surveys”**
- **Select land use monitoring sites**
- **Periodically monitor sediment accumulations on street and parking lot surfaces**
- **Periodically conduct physical and chemical analyses**
  - **sieve into eight particle size fractions**
  - **composite back to three fractions for chemical analysis of oxygen demand, nutrients, metals (particulate and dissolved) and other toxics**

PWR Study Process

Sediment sampling at accumulation monitoring sites

Street Dirt Accumulation Monitoring

Representative Single-Family Residential

Livonia, Michigan

Street Dirt Accumulation Monitoring

Representative Commercial Parking Site

Livonia, Michigan

Street Dirt Accumulation Monitoring

Representative Recreational Parking Site

Livonia, Michigan

Street Dirt Accumulation Monitoring

Representative Single-Family Residential

Jackson, Michigan

Street Dirt Accumulation Monitoring

Representative Downtown Commercial

Jackson, Michigan

Street Dirt Accumulation Monitoring

Representative Highway

Jackson, Michigan

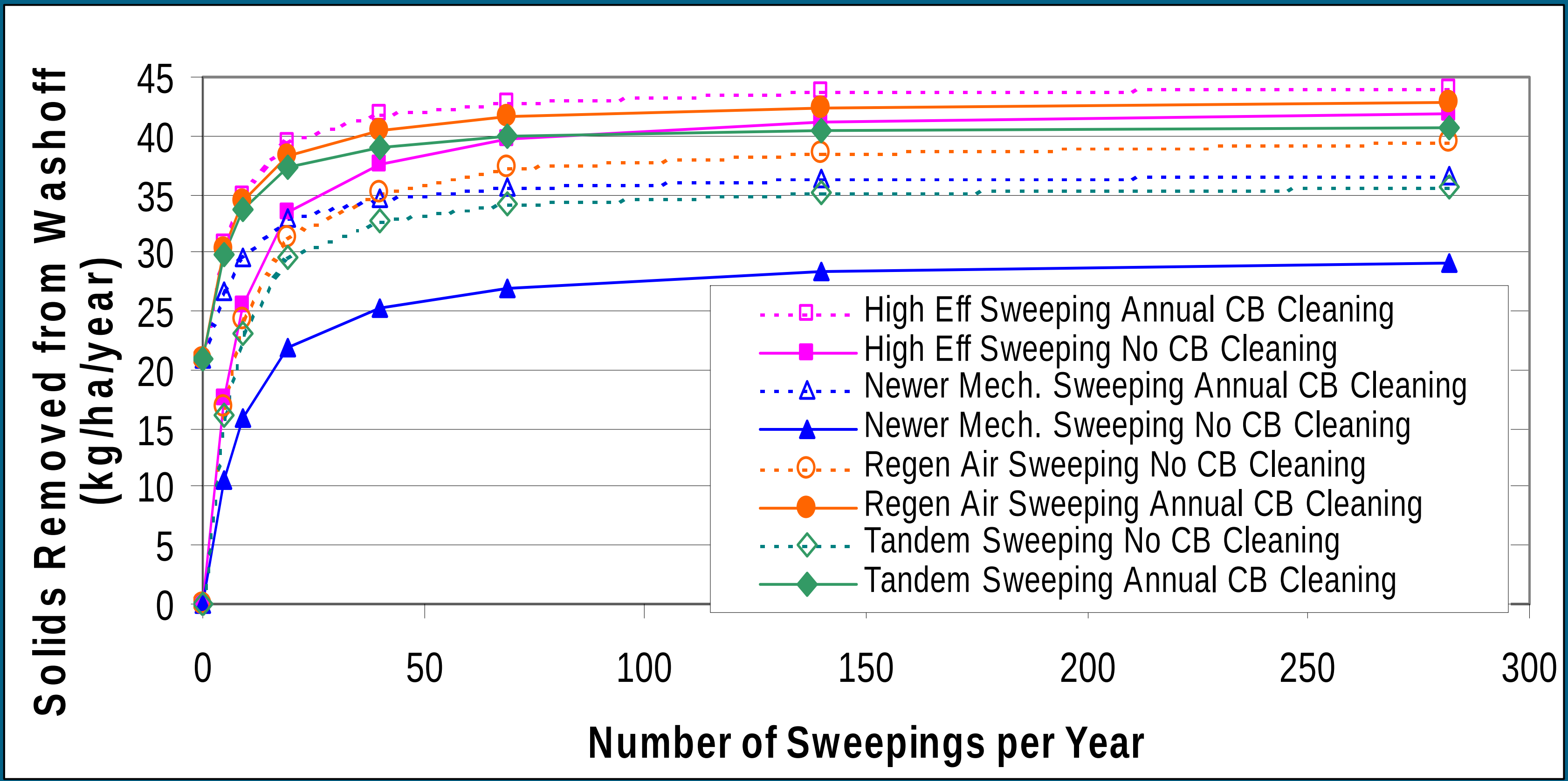
Street Dirt Accumulation Monitoring

- Calibrate SIMPTM
  - Match simulated versus observed sediment accumulations on paved surfaces
- Estimate unit costs of cleaning activities
- Conduct alternative BMP evaluation
  - Use chemical results to simulate pollutant loadings
  - Use cost data to help determine the optimum level of cleaning or the Maximum Extent Practicable (MEP)

PWR Study Process

BMP Production Functions

Single-Family Residential

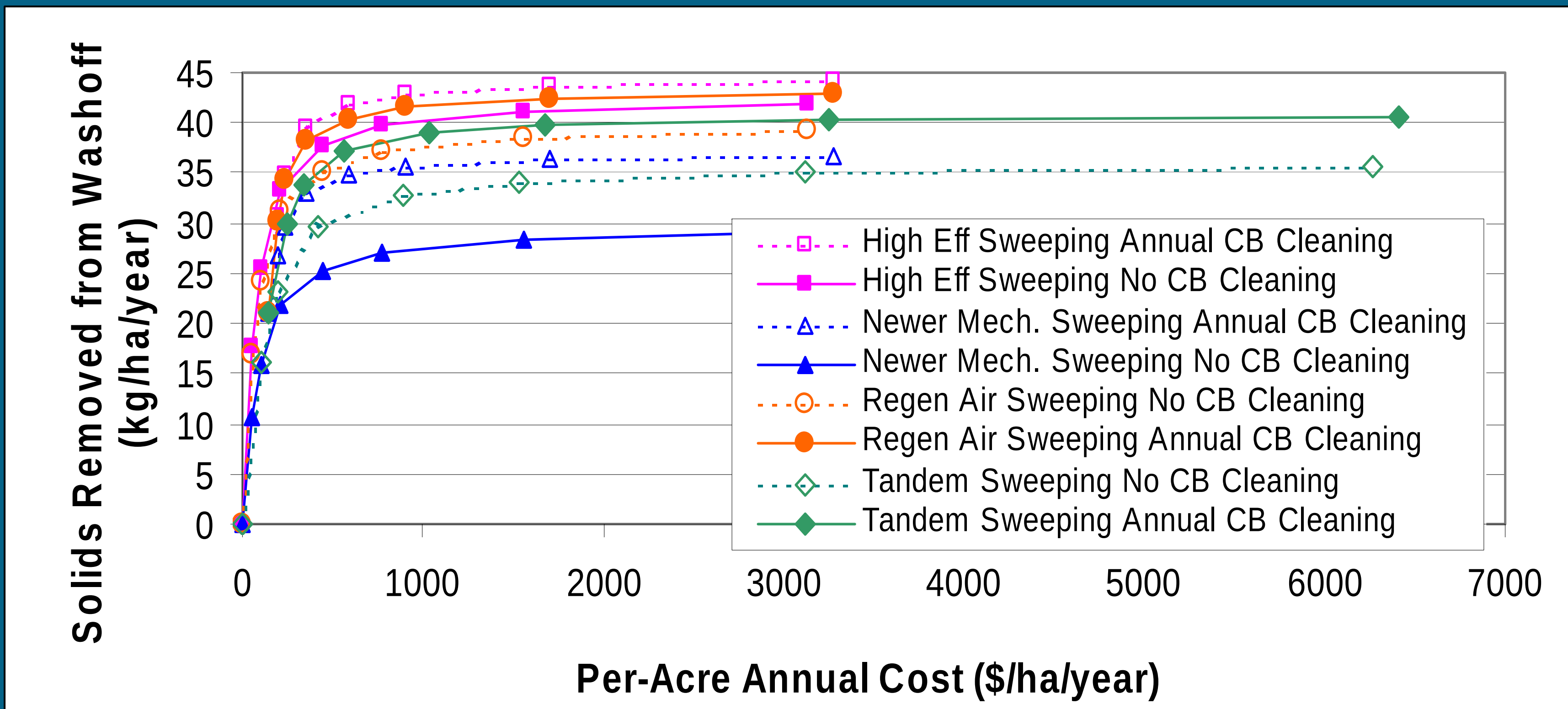


Livonia, MI Case Study

SIMPTM Modeling Results

BMP Total Cost Curves

Single-Family Residential

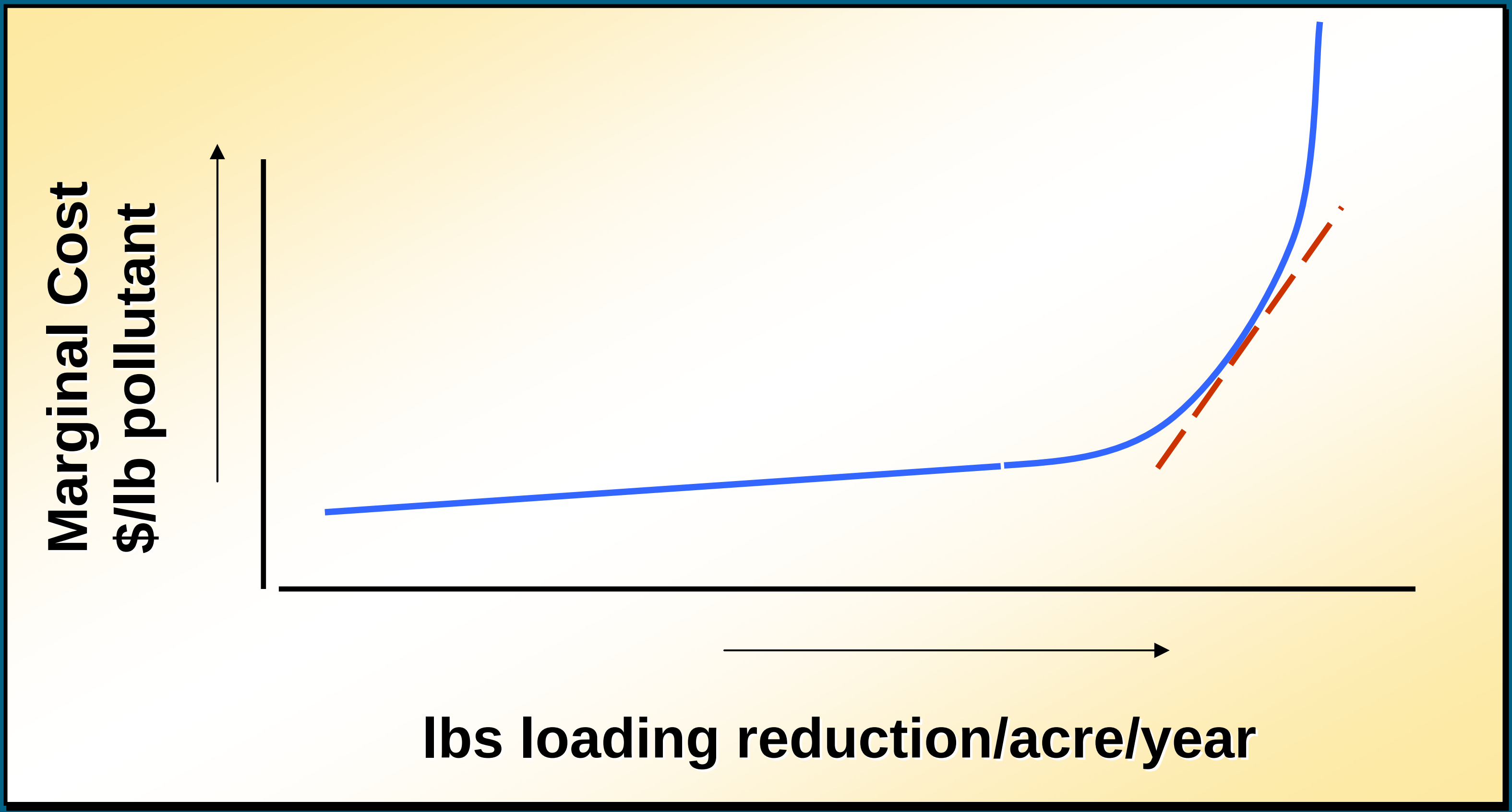


Livonia, MI Case Study

SIMPTM Modeling Results

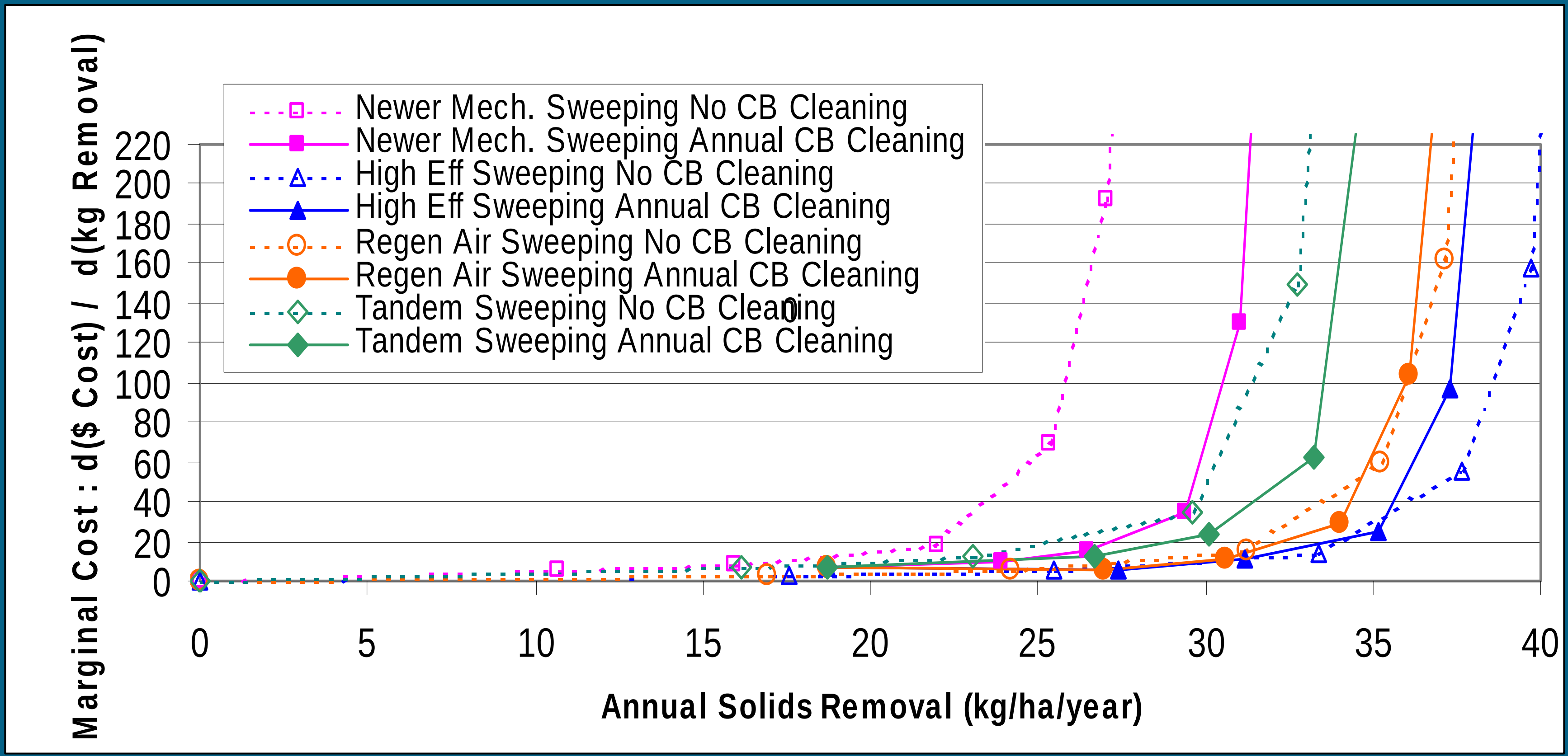
As related to …

$ and *M*aximum *E*xtent *P*racticable



BMP Marginal Cost Curves

Single-Family Residential

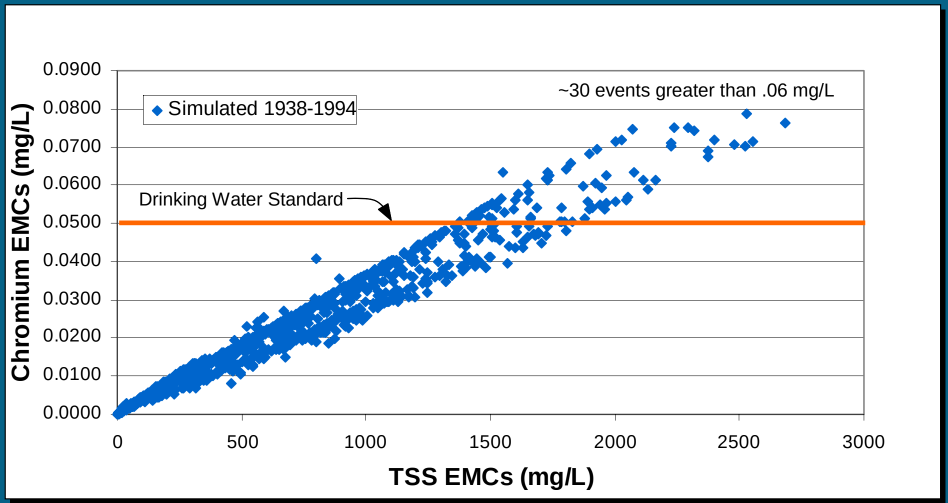


Livonia, MI Case Study

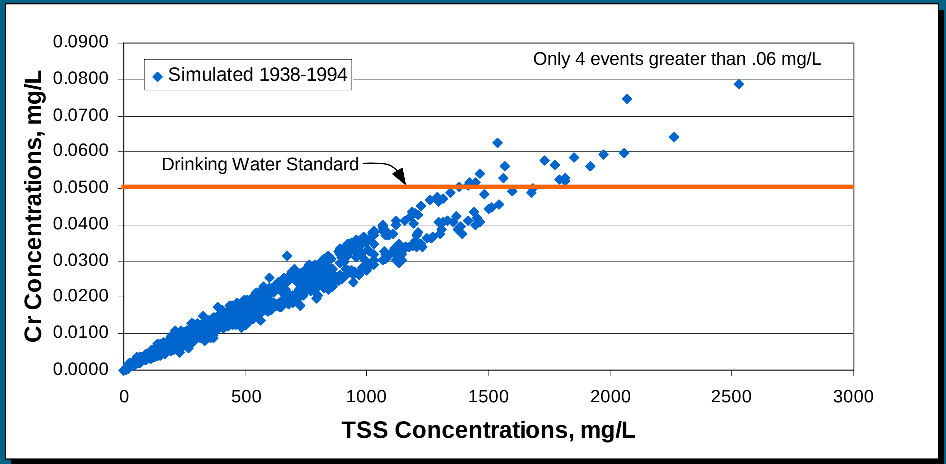
SIMPTM Modeling Results

Simulated TSS and Chromium EMCs

Not Cleaned



Cleaned

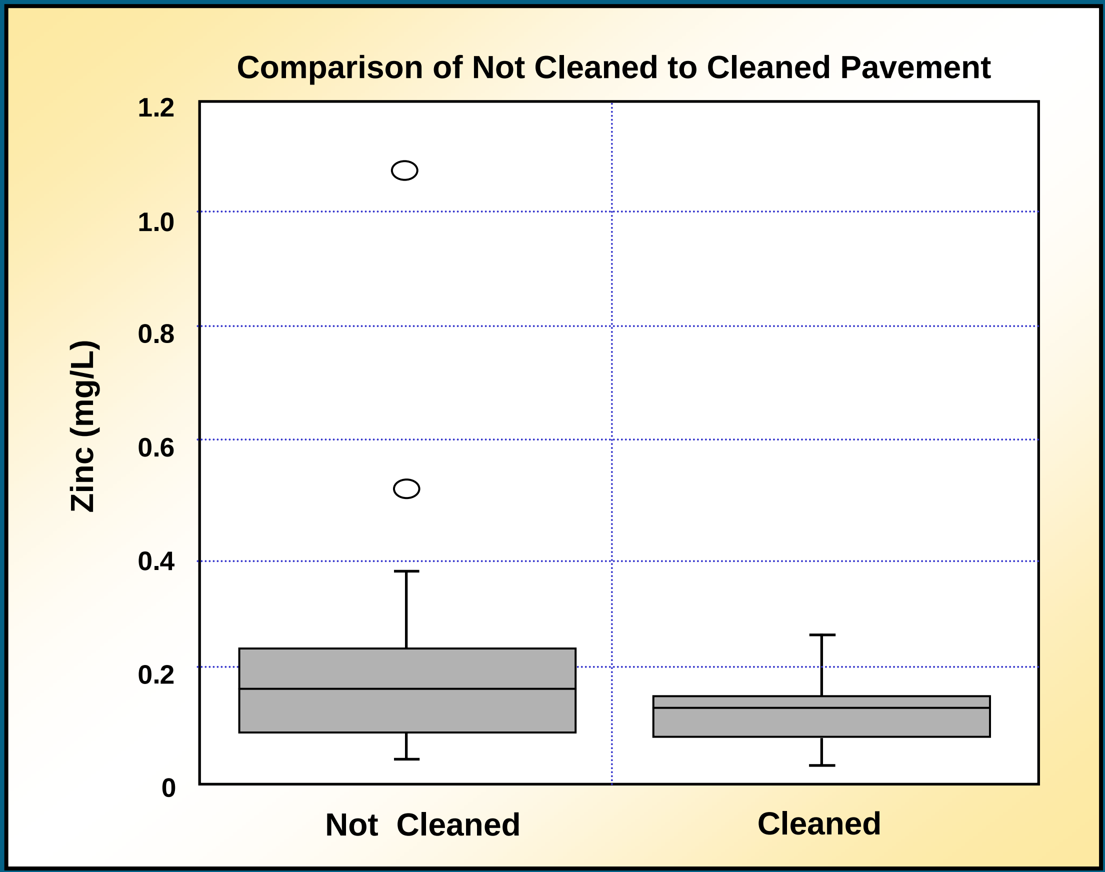


Cleaning has greater effect on reducing higher concentrations of pollutants

(exactly what was observed in the collected data)

Statistic	Simulated Chromium Concentrations (mg/L) from Traditional Pavement with High Traffic Volume		
	Not Cleaned	Six Cleanings/Year with Regenerative Air	Percent Reduction
Median	.026	.023	12
Mean ($\bar{x}$)	.031	.027	13
80 Percentile	.042	.034	19
90 Percentile	.054	.043	20
95 Percentile	.064	.050	22

Cross Israel Highway Stormwater Quality Study



Cleaning Improves Water Quality

A Simplified Procedure for a First-Order Estimate of Pollutant Washoff Reduction from Pavement Cleaning

Step 1

- Identify the total amount of material that is currently removed annually by the sweeping of your streets

__________ Cubic yards

Step 2

- Calculate the amount of sediment in weight by assuming one ton per cubic yard (or use actual weight if known)

____________ Tons

Step 3

- Calculate the amount of sediment that would have reached the storm drain system, if it had not been removed by sweeping.
- Assume that 10% to 25% would have reached the storm drains, giving you a range of sediment. Multiply the result for Step 2 by 0.10 to 0.25.

___________ Tons to ___________ Tons

Step 4

- Calculate the amount of toxic pollutants kept from the storm drains.
- Multiply Step 3 times 40 to 60 pounds per ton.

______ Pounds to ______ Pounds

- Analyze your sediment (i.e. less than 2000 microns) for the amount (mg/Kg) of key pollutants such as TPH, metals (e.g. zinc, copper lead), phosphorus and nitrogen

- Redo Step 4 for each pollutant separately

Refinements

- What are the total curb miles of streets swept each year (curb miles swept times annual frequency of sweeping)

- Calculate the average amount of material and pollutants removed per curb mile swept

Refinements

- Quantify the amount of sediment collected from the different basic types of streets that are swept – arterial, commercial, residential, industrial

- Redo Steps 1 through 4, but for each street type

Refinements

- What is the total annual budget spent for sweeping?

- Calculate the cost of sweeping per curb mile swept, using information from #2 above

Programmatic Evaluation

- What is the population of your community?
- What is the cost of sweeping per capita?
- How does this compare to other nearby communities?

Programmatic Evaluation

- Do you have mechanical sweepers?

- Talk to the street department about purchasing more efficient vacuum or regenerative air sweepers as each of the currently owned sweepers is retired.

- **If you are moving from mechanical to more efficient sweepers, you can conservatively assume that you will increase the total amount of toxic pollutants that are removed by sweeping by 30% to 50% (Step 4 times 1.3 to 1.5)**

- What is the frequency of the sweeping of arterial streets with high traffic volumes?

  If less than weekly, consider weekly sweeping.

- **What is the frequency of the sweeping of arterial streets with moderate traffic volumes?**

  If less than monthly, consider bi-weekly to monthly sweeping.

Programmatic Evaluation

- What is the frequency of the sweeping of residential streets with low traffic volumes?

  If less than quarterly, consider monthly to quarterly sweeping.

Programmatic Evaluation

Special consultation

- Identify pollutants of interest
- Development of program goals, objectives and constraints
- Selection of new sweepers
- Selection of sites to conduct street dirt monitoring
- Training on procedures to collect and analyze street dirt
- General advice on sweeping frequency/route development
- Assistance in presentations to elected officials
- Preparation of technical memoranda and reports

Sweeper testing and selection

- Pick-up efficiency testing of current sweepers
- Pick-up efficiency testing of new candidate sweepers
- Preliminary estimate of pollutant load reduction from current and new candidate sweepers
- Recommendations regarding new sweepers

Full-scale study and program development

- Includes the items listed previously
- Major addition is the use of SIMPTM to provide
  - Better estimation of the current and potential load reductions
  - Better understanding of how these reductions benefit water quality
  - Develop relationship between sweeping frequency and the performance of structural treatment controls
- If you have a consultant currently assisting you with your stormwater pollution control program, we recommend a collaborative effort

Check Out This Fantastic Web Site!

www.WorldSweeper.com

Everything you ever wanted to know about any aspect of the power sweeping industry at one easy to use location

Will Premier an interview with me regarding this APWA National Congress presentation and other related street sweeping issues on September 24th

Other Sweeping Resources Information

Thanks for Viewing

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