PUTTING RESEARCH TO WORK **BRIEF**

# Reducing Storm Water Contaminants with High-Efficiency Street Sweepers

Wisconsin has over 1,300 miles of urban highways that are in close proximity to state waters. The National Pollutant Discharge Elimination System permit program (as authorized by the U.S. Clean Water Act) tasks Wisconsin DOT with controlling the quality of storm water runoff from roadways under its control. Additionally, WisDOT has an agreement with the Wisconsin Department of Natural Resources to achieve a 40 percent reduction in total suspended solids, an indication of water quality.

## What's the Problem?

The pollutants resulting from traffic and highway maintenance become attached to pavement dirt particles, which then wash into storm sewers after a rainfall. By controlling the accumulation of dirt on state highways, levels of pollutant wash-off can be reduced. Although there are several structural approaches to managing storm water runoff quality, such as settling ponds or filtration devices, a street sweeping program has been proposed as a best management practice because of its potential cost savings over these more expensive alternatives.

A prior WisDOT study (0092-45-82) was conducted to determine the benefits of sweeping, but due to a variety of quality control issues and mechanical failures with an older-style street sweeper, the data did not adequately support the benefits. WisDOT initiated this Phase II sweeping study using a high-efficiency sweeper (the Whirlwind MV), which has several structural advantages over the older-style regenerative air sweeper and the mechanical broom. These advances in sweeper technology allow the Whirlwind MV to pick up greater volumes of dirt at increased speeds.

The investigators also chose to use the WinSLAMM computer model (Source Loading and Management Model for Windows) to simulate and validate the effectiveness of street sweeping on urban highways. WinSLAMM has been calibrated for municipal streets and has been effectively used to simulate the reduction in total suspended solids on these roads as a result of sweeping programs. However, its equations have not yet been calibrated for highways. Once this has occurred and the model's accuracy has been confirmed against real-world results, WinSLAMM will be used to simulate and demonstrate the effectiveness of sweeping on highways. WinSLAMM will also be able to generate a sweeping program schedule that will deliver maximum results under a variety of conditions.

## Research Objectives

The purpose of this study was twofold: 1. To evaluate a high-efficiency sweeper under varying sweeping frequencies, and 2. To collect a sampling of data to input into WinSLAMM, both to calibrate the computer program for freeways as well as to ensure the accuracy of its equations.

Primary questions to be addressed included:

1. How much dirt accumulates on the highway (and at what rate)?
2. How much of the dirt do the street sweepers pick up?
3. After a rainfall, how much dirt runs off into the storm sewer?
4. What concentrations of contaminants are present in the storm water runoff?

## Methodology

The U.S. Geological Survey, in cooperation with WisDOT and WDNR, collected the necessary data for this study. A section of US 151 in Madison was selected as the sampling site. For comparison purposes, two sections of US 151 were studied—a swept section and an unswept section.

Changes in street dirt volume during periods of no street sweeping or rainfall were used to determine highway accumulation rates. Dirt samples were collected from both sections. For the swept section of

**Project Manager**

***"Though an exact percentage has not yet been determined, the newer high-efficiency street sweepers are certainly an improvement over the older-style models."***

**–Wendy Braun,**
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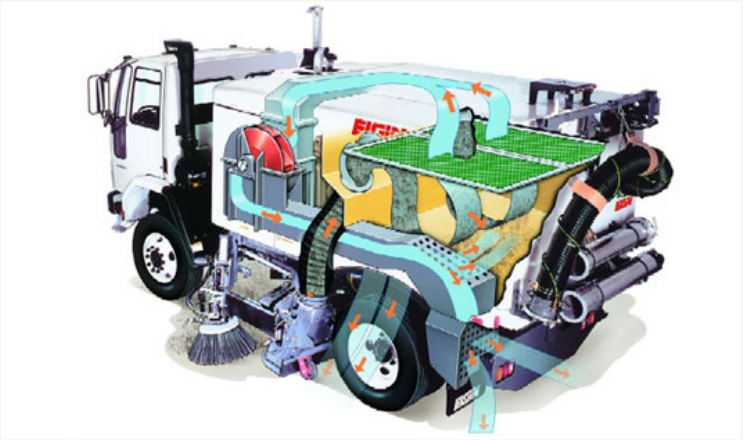

With an improved design allowing for both increased airflow and high vacuum, the Whirlwind MV removes contaminants from road surfaces more efficiently and at higher speeds.

highway, samples were taken both before and after sweeper cleanings, which generally occurred once per week with either a mechanical broom sweeper or a vacuum-assisted sweeper (the Whirlwind MV). Street-dirt samples, collected with trailer-mounted vacuums, were processed at USGS field offices prior to analysis for contaminant levels.

Storm water runoff samples were collected in the storm sewer pipe draining from the unswept section of highway. Automatic water-quality samplers were used to collect the samples, and the rainfall amount was measured with a rain gage. An electronic data logger was used to control the instruments and record the data. Samples were analyzed at the Wisconsin State Laboratory of Hygiene.

## Results

Sufficient flow and water-quality data was collected in this project to improve the way WinSLAMM estimates runoff volumes and contaminant loads from urban highways. In addition, sufficient runoff data was collected to adjust the WinSLAMM street-dirt equations for highways.

Contaminant concentrations in the runoff samples were similar to the concentrations observed in runoff samples from other urban highways. Comparing this study to recent highway runoff studies in Wisconsin, the average contaminant levels were very similar, indicating that results could be extrapolated to other highways.

Although both the mechanical broom and the vacuum-assisted sweepers have a gutter broom that dislodges fine particles from the street surface and breaks larger particles into smaller ones, only the vacuum-assisted sweeper appeared capable of picking up a significant percentage of these finer particles.

## Implementation and Benefits

Once the freeway portion of WinSLAMM has been modified to include the accumulation and wash-off equations, the program will be calibrated and verified using the runoff events monitored in this study. WisDOT will then be able to use the improved model to predict street cleaning efficiency and evaluate sweeping programs on urban highways with curbs. Information on the improved performance of high-efficiency sweepers, as compared to older models, will be useful to WisDOT in deciding whether to recommend their use.

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*This brief summarizes Project 0092-04-04, "Pollutant Loading to Stormwater Runoff from Highways: Impact of a Highway Sweeping Program, Phase II, Madison, Wisconsin," produced by the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.*

*Daniel Yeh, WisDOT Research and Communication Services*

### Investigators

*"We are optimistic that the data collected is sufficient to calibrate the WinSLAMM model for freeway and street sweeper simulations, thus allowing us to predict street sweeper efficiencies under various conditions."*

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