BMP 5.9.1: Streetsweeping

Use of one of several modes of sweeping equipment (e.g., mechanical, regenerative air, or vacuum filter sweepers) on a programmed basis to remove larger debris material and smaller particulate pollutants, preventing this material from clogging the stormwater management system and washing into receiving waterways/waterbodies.

Key Design Elements

- Use proper equipment; dry vacuum filters demonstrate optimal results, significantly better than mechanical and regenerative air sweeping, though move slowly and are most costly
- Develop a proper program; vary sweeping frequency by street pollutant load (a function of road type, traffic, adjacent land uses, other factors); sweep roads with curbs/gutters
- Develop a proper program; restrict parking when sweeping to improve removal.
- Develop a proper program; seasonal variation for winter applications as necessary.

Potential Applications

Residential: Yes
Commercial: Yes
Ultra Urban: Yes
Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction: Low/None
Recharge: Low/None
Peak Rate Control: Low/None
Water Quality: High

Water Quality Functions

TSS: 85%
TP: 85%
NO3: 50%

Description

National Urban Runoff Program (NURP) studies from the 1980's reported generally very poor results from street sweeping. In some cases, results suggested that water quality effects of conventional mechanical street sweeping programs were actually negative. This is possibly explained by the fact that the superficial sweeping accomplished by mechanical sweepers removes a "crust" of large, coarser debris on many surfaces and exposes the finer particles to upcoming storm events. These particles are then washed into receiving water bodies. However, new street sweeping technology (see discussion below) has dramatically improved street sweeping performance. While these new street sweeping technologies are considerably more costly than previous street sweeping technologies, their pollutant reduction performance compares quite favorably to other pollutant reduction BMPs. Streetsweeping can actually be quite cost effective in terms of water quality performance.


Figure 5.13-1 Vacuum Filter Street sweeper

Variations

Variations in street sweeping relate primarily to differences in equipment but also relate to important aspects of the street sweeping programs, such as frequency of street sweeping, use of regulations such as parking prohibitions, and other program factors.

Equipment -

Mechanical broom: use of mechanical brooms/brushes with conveyor belts. Designed to remove standard road debris, using various types of circulating brushes that sweep material onto conveyors and then into bins. Some machines apply water to reduce dust. Includes the Elgin Pelican (3-wheel) and Eagle (4-wheel), Athey;s Mobile (3- and 4-wheel) and Schwarze M-series. Stormwater reports that the vast bulk of sweepers in use in the US are of this type. These sweepers are least expensive and vary in cost from (approximately $60,000 in 2002, according to Stormwater magazine).

Regenerative air: compressed air is directed onto the road surface, loosening fine particles that are then vacuumed. Includes Elgin's Crosswind J, Mobile's RA730 series, Schwarze's A-series, Tymco sweepers. About twice as expensive as mechanical sweepers ($120,000 in 2002, according to Stormwater magazine).

Vacuum filter: vacuum assisted small-micron particle sweepers, either wet or dry. Dry vacuum includes mechanical broom sweeping with a vacuum (Elgion's GeoVac and Whirlwind models and Schwarze's EV-series particulate management); this technology works well even in cold weather conditions. Wet vacuum uses water dust suppression with scrubbers that apply water to pavement; particles are suspended, and then vacuumed. Four to 5 times as expensive as mechanical sweepers, according to Stormwater magazine in 2002. Equipment has been constrained by slow driving speeds (max of 25 mph).

Tandem sweeping: using two machines, surfaces are mechanically swept and then vacuumed.

Applications

Streets weeping programs vary by sweeping frequency that in turn depends on several other factors. Certainly the most obvious factor is the intensity of the roadway and its expected pollutant load – the greater the traffic intensity, the greater the pollutant load. Other factors such as frequency and intensity of rainfall also affect desired street sweeping frequency. Sutherland and Jelen (1997), measuring sediment load reduction, found very high pollutant load reduction with weekly or greater sweeping frequencies in the Portland area with relatively frequent rainfall events.

Another factor to consider in street sweeping programs is "wash-on" or material that washes onto impervious areas from upgradient/upstream pervious surfaces. Obviously if large amounts of sediment and related-pollutants wash onto the paved surfaces during storm events themselves, street sweeping is going to be relatively ineffective. The Center for Watershed Protection maintains that as site imperviousness itself increases and as the imperviousness of upgradient watershed areas increases, potential for wash-on decreases and potential effectiveness of street sweeping increases (Article 121, Center for Watershed Protection *Technical Note 103 from Watershed Protection Techniques 3(1)*, pp. 601-604).

Lastly, pollutant loads being contributed by the rainfall itself, or wetfall (such as total solids, total nitrogen, chemical oxygen demand, extractable copper) will not be reduced or removed through street sweeping by definition. For example, research performed by the Metropolitan Washington Council of Governments found that 34 percent of total nitrogen, 24 percent of total solids, and 18 percent of COD occurred as wetfall (Urban Runoff in the Washington Metropolitan Area, 1983. Final Report: Washington DC Area Urban Runoff Project. USEPA Nationwide Urban Runoff Program, MWCOG Washington DC).

In general, the greater the traffic on a roadway and the greater the number of vehicles using a parking area, the greater the pollutant loads. The greater the pollutant loads, the greater the potential effectiveness of street sweeping. Winter road applications affect street sweeping programs

Cost Issues

Costs of street sweeping include capital costs of purchasing the equipment, annual costs of maintenance, annual costs of operation, plus costs of disposal of the material that is collected. According to the US Environmental Protection Agency's *Preliminary Data Summary of Urban Storm Water Best Management Practices* (August 1999, EPA-821-R-99-012), street sweeper costs are quite variable. A mechanical sweeper with $75,000 purchase price and a 5-year life cycle was found to cost $30 per curb mile (Finley, 1996 and SWRPC, 1991), while a vacuum street sweeper purchased at $150,000 and having an 8-year life cycle cost $15 per curb mile (Satterfield, 1996 and SWRPC, 1991). Further comparisons were made by the EPA, including the effects of varying frequency of sweeping (USEPA, 1999).

The point is that although mechanical sweepers are less expensive than vacuum sweepers, their economic life is shorter than vacuum sweepers. If pollutant removal effectiveness is included in the comparison, vacuum sweepers yield substantially better cost effectiveness in most cases.

Pollutant Removal Performance

Although pollutant removal performance for street sweeping will vary with the frequency of the street sweeping program, evaluations are demonstrating remarkably high pollutant removal, especially if the program includes weekly street sweeping. The Center for Watershed Protection reports one recent study with 45-65 percent removal of total suspended solids, 30-55 percent total phosphorus, 35-60 percent total lead, 25-50 percent total zinc, and 30-55 percent total copper (Kurahashi & Associates, Inc. 1997. *Port of Seattle, Stormwater Treatment BMP Evaluation*). In *Street Sweeping for Pollutant Removal* (Montgomery County Department of Environmental Protection, Montgomery County, Maryland, February 2002), additional pollutant removal effectiveness data is reported from studies performed by the Center for Watershed Protection (*Watershed Treatment Model,* 2001). Total suspended solids reduction ranged from 5 percent (major road) and 30 percent (residential street) for mechanical sweepers to 22 and 64 percent respectively for regenerative air and 79 to 78 percent respectively for vacuum sweepers. For nitrogen, mechanical sweeper pollutant removal was 4 and 24 percent removal for major roads and residential streets, regenerative air was 18 and 51 percent, and vacuum 53 and 62 percent. In summary, although pollutant removal performance for new mechanical sweepers has improved considerably over those of the past generation, the new vacuum technology is significantly better than either mechanical or even regenerative air sweepers and achieves a level of pollutant removal that is frequently better than all other BMPs.

References

Center for Watershed Protection, 2001. *Watershed Treatment Model.*

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