Street Sweeping info

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Hi Dan,

At today's Waterways meeting the Committee has a good discussion on steps to protect and potentially improve the water quality in Marco Island's canals. Would you please forward this email to the Chairman Farnsworth, who requested this, as well as the other Committee members and staff as you see fit.

Inasmuch that I happen to have a great deal of experience in storm water management from when I was practicing as a licensed civil engineer, I made a motion which the Committee adopted to forward as a recommendation to City Council. The motion is that Council pursue a street vacuuming program for the residential streets on Marco Island.

Although I understand the Public Works Department arranges for the major road intersections and Collier Boulevard to be swept on a regular basis, which is great to know, I believe the effort is mainly intended to pick up debris and litter, and is likely done using mechanical street sweepers. But as far as I know, the residential streets are never swept or cleaned, most likely because they "look" reasonably clean. That's primarily because every time we get a heavy rainfall the storm water runoff washes off whatever is on the residential streets.

But what I emphatically do know is that impervious surfaces, such as the residential streets, are a huge non-point source of pollution. I also know that constituent of this pollution source include nitrogen, phosphorus and total suspended solids (TSS), which as we've been learning are pollutants which are quite prevalent in Marco's water. These materials accumulate on the pavement from pollen, dust, vegetative matter, animal waste and a host of other natural processes. Before the roads and houses were here this material ended up on a sparsely developed island and was taken up as nutrients by the natural vegetation or percolated into the sand. Although not being the sole source of of these pollutants today, the residential streets are still a big contributor. Therefore, I firmly believe that if Marco were to embark on a long term program of "cleaning" the residential streets on a regular basis, a frequency of which is still to be determined, it will go a long way in removing much of these pollutants at the source before being washed into the canals.

During our Committee discussion I explained that there are primarily three types of street sweepers...Mechanical, which use brooms...Regenerative Air, which blow air across the pavement to aid in pickup....and Vacuum, which are just that. By and large, the Mechanical type is the least efficient when it comes to picking up small particles. Yet it is the small particles hiding in all the nooks and crannies of the pavement that are holding onto the nutrients and ready to become TSS once flushed out by rainwater. In fact I understand in some test cases,

sweeping with a mechanical broom actually increased the number of small particles by breaking up larger particles with the abrasive process of the broom action (Woodard & Curran, Campus at Fields Corner). Thus, vacuuming the residential streets should be the preferred route.

Attached below are pages from a report prepared several years ago by the DEP of Montgomery County, MD which should be insightful. Chairman Farnsworth requested that I provide to him some pertinent information on this topic. Parenthetically, the States and Counties surrounding the Capital District, including Montgomery, Prince Georges and Fairfax Co., VA have always been at the forefront of the storm water management movement.

III. Sweeper Types

Figure 1. on the right summarizes the differences of the three major sweeper types (Partland, 2001). These are mechanical broom, regenerative air, and vacuum filter sweepers.

Research during the NURP study showed the highest concentrations of pollutants were associated with the smallest particles of road grit. Mechanical broom sweepers, such as those used during the NURP study, proved very inefficient at capturing small particles. In fact, sweeping using mechanical brooms may preferentially expose these smaller particles to runoff by removing the overlying material.

Regenerative air sweepers were developed about 25 years ago by a road builder to clean debris out of the cracks and crevices of road surface. This thorough cleaning was needed to allow the permanent bonding of new pavement on top of the old.

Sweeper Types

Mechanical: Usually broom-type sweepers designed to pick up debris, these are the least expensive available. About 90% of street sweepers currently in use in the United States are of this type. Models include Elgin Pelican (three-wheel) and Eagle (four-wheel) sweepers, Athey's Mobile three- and four-wheel models, and Schwarze M-series sweepers.

Regenerative Air: This type of sweeper blows air onto the road surface, causing fine particles and sediments within pavement crevices to rise, then vacuums them up. This type of sweeper has been available for more than two decades. Elgin's Crosswind J, Mobile's RA730 series, Schwarze's A-series, and all Tymco sweepers are of this type.

Vacuum Filter: Also called vacuum-assisted or small-micron-particulate sweepers. Two general types are available: wet and dry. The dry type combines a mechanical (broom-sweeping) process with a vacuum to capture small particles it stirs up. The wet type uses water for dust suppression. Scrubber-type machines apply water to the pavement so that fine particles are suspended, then vacuum up the mixture. Elgin's GeoVac and Whirlwind models are examples of the dry type, and Schwarze's EV-Series particulate management machines are a variant.

Tandem Sweeping: Two machines are used in this process: a first pass, usually by a mechanical sweeper, is followed by a second pass with a vacuum-type machine.

Figure 1. From: J. P. Partland. 2001. A Clean Sweep to Swipe Pollutants. Stormwater. Vol. 12. No. 4.

The vacuum filter, or small-micron- particulate sweeper, was developed about 10 years ago for use in railroad yards to pick up spilled coal dust. The most advanced are "self-cleaning" systems, which periodically use compressed air to purge the filters and prevent clogging without having to stop and manually clean the filters.

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In California, the Los Angeles Regional Water Quality Control Board has drafted a total maximum daily load (TMDL) for litter in the Los Angeles River. This prompted the California Department of Transportation to assess how to effectively control litter coming from the freeway in the Los Angeles area (Lippner and Moeller, 2001). The three sweeper types were first evaluated to select the most appropriate for the detailed monitoring study. During field tests, the regenerative air sweepers showed a greater tendency than other types to get large debris stuck in the intake line or across the suction head, which then interfered with sweeping efficiency. The

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V. Pollutant Removal

Pollutant Reductions

A variety of studies have attempted to document the percent pollutant removal by sweeper type. Average percent pollutant reduction by sweeper type and road type (residential vs major road) is compared with reduction values for 5 major storm water best management practices in Figure 3A. for Total Suspended Solids (TSS) and Figure 3B. for Nitrogen (N). TSS is a measure of all particulate material (dirt, sand, grit) in a sample, while N is a plant fertilizer, too much of which can cause significant stream water quality problems.

The sweeper information is based on data compiled by the Center for Watershed Protection (CWP, 2000). The vacuum assisted sweeper shows notably higher percent reduction for both TSS and N than the other two types. The CWP averages are based on weekly sweeping with parking restrictions and operator training. The CWP literature review indicated that monthly sweeping decreased pollutant reductions to 60% of the weekly sweeping. If cars are parked on the roads being swept, then pollutant reduction capability is decreased to 75% of the rate of the base rate.

The values shown for the urban storm water best management practices (SW BMPs) are based on data compiled by the interagency technical workgroup established for the Patuxent Demonstration Project. This was a federally funded project during the 1990's to identify, construct, and monitor the effectiveness of pollution control demonstration projects throughout the Patuxent River watershed. For the urban SW BMPs, the reduction amount varies by pollutant and by structure type, with the lowest values shown for dry ponds and the highest values shown for infiltration.

For both TSS and N, the reduction factors for infiltration (70% for TSS, 60% for N) are less than those shown for vacuum assisted sweepers (78/79% for TSS, 62/53% for N). Both the TSS and N reduction factors for regenerative air sweepers on residential streets are higher than the TSS and N reduction factors for dry ponds, extended detention dry ponds, and separators/sand filters.

However, reduction factors for regenerative air sweepers on major roads (22% for TSS, 18% for N) are on the low end of pollutant reductions for stormwater management structures (dry ponds: 20% for TSS, 10% for N). This is because the regenerative air sweepers cannot pick up the great amounts of grit and finer particulate materials deposited by the greater number and types of

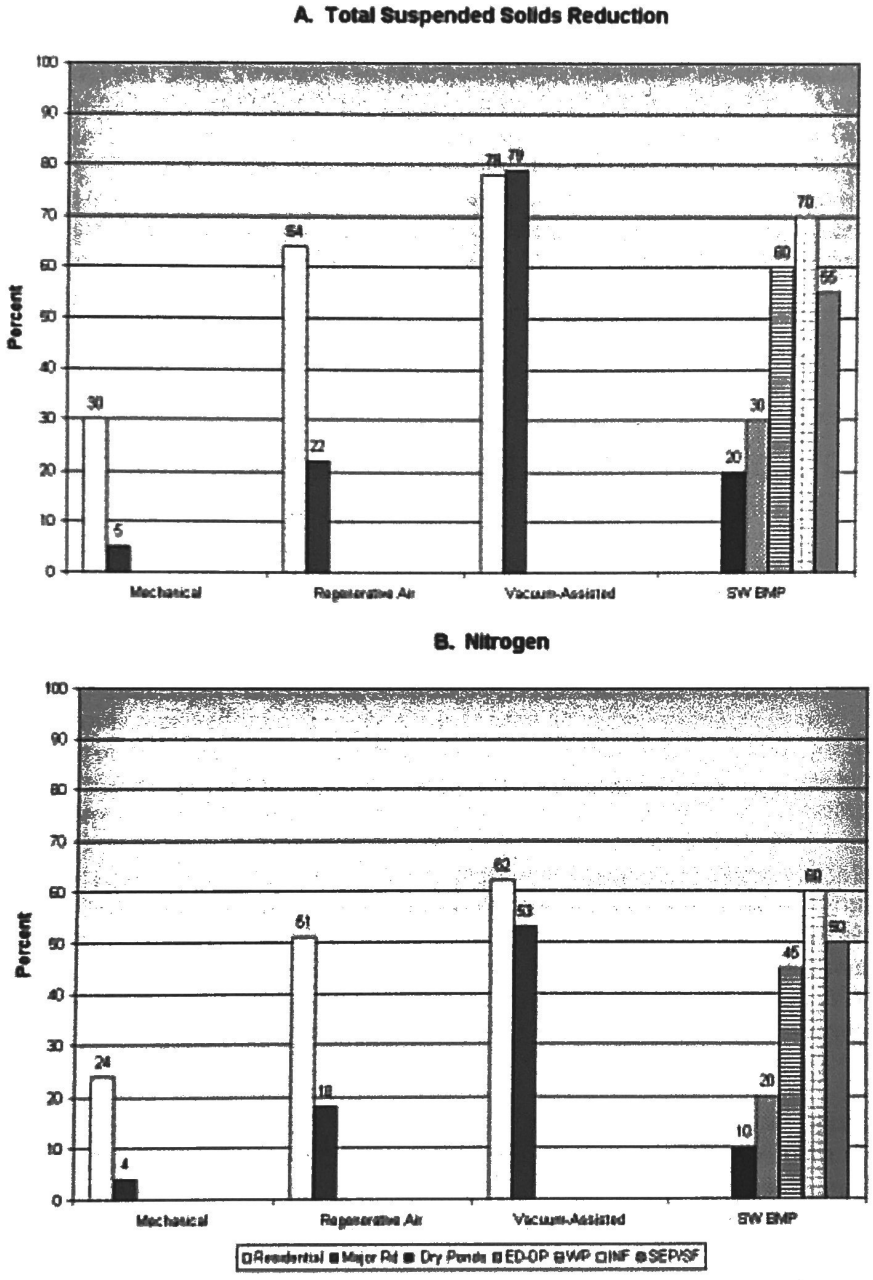

Figure 3. Percent Removal associated with Street Sweeping (for Residential vs Major Roads) and by 5 Storm Water Best Management Practices (SW BMP). *ED-DP=extended detention dry ponds; WP=wet ponds; INF=infiltration; SEP/SF=separators/sand filters. (Sweeper Type Removal from: The Watershed Treatment Model. March 2001. Center for Watershed Protection. SW-BMP removal from information compiled by Urban BMP Workgroup for Patuxent Demonstration Project, 1994)*

Amount of Pollutants Removed

During the year 2000, there were an estimated 5,561 miles swept by the DHS and 8,812 miles swept by the Bethesda Urban Partnership for a total of 14,373 curb miles. As shown in Table 4, there were 2,464 total tons of materials removed in the year 2000 through the County sweeping program. The amount collected in tons per curb mile ranged from 0.554 in the residential program to 0.011 through the Bethesda Urban Partnership program.

Table 4. Year 2000 Curb Miles Swept and Material Removed in Montgomery County.

Road Type	Curb Miles	Tons collected	Tons/curb mile
Residential	3,779.31	2093.73	0.553998
Arterial	1,644.66	263.15	0.160003
Piney Branch CBD	136.76	6.84	0.050015
Bethesda Urban Partnership (Bethesda, Silver Spring, and Wheaton CBDs)	8,812.44	100	0.011348
TOTAL:	14,373.17	2,463.72	0.171411

The tons removed per curb mile showed an inverse relationship to frequency of sweeping. The tons per mile removed from the once per year residential road sweeping is more than three times greater than that removed from arterial roads (swept about once per month), 10 times greater than in the Piney Branch CBD (swept three times per week) and 50 times greater than that in the areas swept through the Bethesda Urban Partnership (swept three times per week).

A similar pattern in amount removed vs frequency of sweeping was observed in Baltimore County. In the NPDES 2001 Annual Report, Baltimore County reported that from 1991-1995, there was an annual average of 0.597 tons per curb mile removed while from 1996-2000, this was reduced to an annual average of 0.151 tons per curb mile removed. This was correlated to a significant increase in average curb miles swept per year--from 6,869 from 1991-1995 to 19,034 curb miles per year from 1996-2000--and an increased frequency of road sweeping in certain areas of Baltimore County.

As would be expected, materials will accumulate on County roads between street sweepings, and these intervals are greatest for the residential roads. In the Bethesda Urban Partnership program, there is an additional litter control program which removes trash from sidewalks and other areas and thus keeps it from showing up in the tons collected per curb mile swept.

The CWP study mentioned earlier showed that regenerative air sweepers have lower TSS reduction factors for material collected on non-residential roads than for material collected on residential roads. There is more grit on roads in non-residental areas, and since regenerative air sweepers cannot pick grit up as efficiently as larger particles, the reduced tons per curb miles on

arterial roads may reflect this sweeper type's reduced effectiveness as well as less time for acccumulation between intervals.

The NURP study in the 1980's documented the range of pollutants, including nutrients, organic materials, bacteria, heavy metals and priority pollutants commonly found in excess amounts in urban runoff. A more recent study in California included an extensive evaluation of amount and quality of sediments from runoff that were trapped within storm drain inlets. Results for copper, lead, and zinc, heavy metals commonly found in urban storm water runoff, are shown in Table 3 (Mineart and Singh, 1994).

Table 3. Storm Inlet Sediment Quality (Mineart and Singh, 1994).

Land Use Type	Median Concentrations (mg/kg)		
	Copper	Lead	Zinc
Residential	37.9	43.8	215
Commercial	56.7	111	597.5
Industrial	46.6	117	307

The pounds of heavy metals that might have been removed through the County's street sweeping program were estimated based on these median concentrations. The residential land use type concentrations were used for the Residential Road miles swept and the commercial land use type concentrations were used for the Arterial and CBD Road miles swept. With these assumptions, there was an estimated 348 pounds of copper, 468 pounds of lead, and 2,371 pounds of zinc removed in the solid material collected from County streets during the year 2000.

For Montgomery County's NPDES Annual Report in 2000, it was estimated that conventional stormwater management structures removed 2,260 pounds of copper, 488 pounds of lead, and 12,642 pounds of zinc in urban runoff. This represented runoff from developed lands only, about 38.5% of the total county area.

The pounds of pollutants removed using the California study approach cannot be directly compared with the pounds removed using the County's NPDES annual report estimates due to potential significant differences in assumptions about pollutant concentrations in source material. However, it is apparent that routine street sweeping prevents significant amounts of pollutants from entering urban runoff.