

**Technical Memorandum 2 -
Summary of Municipal Practices Survey**

Research in Support of an Interim Pollutant Removal
Rate for Street Sweeping and Storm Drain Cleanout Activities

A project supported by the U.S. Chesapeake Bay Program
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Prepared by the
Center for Watershed Protection
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Final Draft



Summary Findings of the Municipal Practices on Street Sweeping and Storm Drain Cleanout Practices Survey

1. The Center for Watershed Protection surveyed twenty MS4s in the Chesapeake Bay watershed about their street sweeping and storm drain cleanout practices. Collectively, these communities represent nearly half of the urban population in the Chesapeake Bay watershed. Only one community did not have a street sweeping program. All communities surveyed had a storm drain cleanout program.
2. Chesapeake Bay MS4 street sweeping and storm drain cleanout programs are exceedingly diverse in their size and scope. Cumulatively, Chesapeake Bay MS4 programs are spending as much as \$13 million/year on these programs.
3. Chesapeake Bay communities sweep at least 70% of the public streets in their community on an annual basis. 85% of communities sweep more frequently than once per year. However, only a small subset of communities are sweeping frequently enough (e.g. biweekly or more) to realize a potential water quality benefit as outlined in Technical Memo 1.
4. Most Chesapeake Bay communities maintain several thousand miles of streets. Street sweeping frequency is often related to street land use or street type. For example, streets located in commercial or central business districts tend to be swept more frequently than local residential streets. Additional street sweeping is commonly scheduled for Spring cleanup of streets from the previous winter de-icing practices.
5. Pollutant reduction is not a primary factor driving Chesapeake Bay MS4s to sweep streets or cleanout storm drains, inlets or catchbasins. The purpose of street sweeping and storm drain cleanouts is based on maintaining aesthetics and responding to public demand. Only one community reported that nutrients were a target pollutant for street sweeping. This may reflect that fact that minimal monitoring has been completed within the Bay to determine the effectiveness of these practices with respect to improving stormwater quality.
6. Respondents noted several factors that reduce the effectiveness of street sweeping programs, including parked cars and inadequate budgets. Ineffective technology was not stated as a problem, although only 27% of the communities use the more efficient street sweeping technology (i.e., regenerative air, vacuum). Conversely, more modern equipment such as vacuum-based technology is used in the majority of the communities to cleanout storm drains.
7. Communities that use a stormwater utility fee or other stormwater tax typically have larger street sweeping budgets.
8. Storm drains, inlets and catchbasins within the Bay are infrequently cleaned out. 75% percent of Phase I and Phase II communities cleanout their storm drains

every two years or less, either as part of a regular cleanout program or based on complaints or clogging

9. Assuming this research study is able to confirm the value of street sweeping as a nutrient reduction BMP, most Chesapeake Bay MS4s would need to greatly increase the frequency of sweeping or target specific areas of street dirt accumulation in order to see potential water quality improvements.
10. At this time, with a few local exceptions, storm drain cleanouts cannot be considered a nutrient reduction BMP given the small percentage of storm drains, inlets or catch basins that are cleaned out, the infrequency of cleaning, and the absence of a database to track and maintain cleanout records.

1.0 Introduction and Overview

The Technical Memorandum summarizes data generated from a survey of municipal street sweeping and storm drain cleanout practices in Phase I NPDES and select Phase II MS4 permit holders within the Chesapeake Bay watershed. The purpose of the survey was to determine the extent of these practices within the watershed, and to provide supporting material to further define the interim pollutant removal efficiencies for street sweeping and storm drain cleanout practices in the Chesapeake Bay presented in Technical Memorandum 1. For the purposes of this Memo, the term *storm drain cleanout* refers to removal of material from storm drain inlets, catch basin, or storm drains pipes.

An extension of the conceptual model defined in Technical Memo 1 is used to improve upon the potential nutrient and sediment reductions achieved through municipal street sweeping and storm drain cleanouts. Data provided by the survey enables the interim pollutant removal rates to be updated to reflect local conditions and practices.

The technical memorandum is organized by eight major sections, which are summarized below.

- 1. Introduction and Overview**
- 2. Survey Methods** – An overview of the survey methods and analyses is presented.
- 3. Street Sweeping Practices in the Chesapeake Bay Watershed** – This section summarizes survey data to: characterize street sweeping programs in the Chesapeake Bay Watershed, identify factors that affect street sweeping performance, and provide cost estimates for street sweeping.
- 4. Storm Drain Cleanout Practices in the Chesapeake Bay Watershed** – This section summarizes survey data to: characterize storm drain cleanout programs in the Chesapeake Bay Watershed and provide cost estimates for these programs.
- 5. Pollutant Characterization of Street and Catch Basin Sediment** – This section provides estimates of the amount of material and pollutants removed from catchments by street sweeping and storm drain/catch basin cleanouts based on data provided by survey respondents.
- 6. Survey and its Application to the Conceptual Model** – This section discusses how the data generated from the survey, together with the monitoring program, will further aid in the definition of pollutant removal rates for nutrients and sediment. The conceptual model is used to estimate the treatable miles of streets swept in the Chesapeake Bay watershed and the amount of material removed from catch basins and storm drain inlets that would otherwise be washed away into the storm drain system.

7. **Program Recommendations** – A set of initial program recommendations for Chesapeake Bay communities are provided to suggest steps that may be taken to adopt street sweeping and storm drain cleanouts as a nutrient reduction BMP.

8. **References**

Appendix A – Letter of introduction to survey communities and copy of survey.

Appendix B – A summary of survey responses is provided by question.

2.0 Survey Methods

A total of 36 surveys were mailed out to stormwater coordinators in the Chesapeake Bay basin and other selected communities throughout the United States. Of the 36 surveys, eight communities were located outside of the Chesapeake Bay basin in an effort to acquire additional data. The overall survey response rate was 73%. The results presented in this memo reflect only the responses from the Chesapeake Bay communities, unless otherwise stated. The total number of Chesapeake Bay basin surveys completed was 20.

The purpose of the survey was to get data on current street sweeping and storm drain cleanout practices, and to determine whether communities currently compute nutrient removal efficiencies for these practices. For the purposes of this Memo, the term *storm drain cleanout* refers to removal of material from storm drain inlets, catch basin, or storm drain pipes. The survey also asked communities to provide supplemental data on solids removed and their chemical composition from street sweeping and storm drain cleanout activities where available. The survey included forty-three questions that addressed: contact information and community description, street sweeping program characteristics, storm drain and catch basin cleanout program characteristics, and monitoring data and collection. A copy of the survey instrument is included in Appendix A.

Surveys were mailed to about 65% of Phase I communities in the Chesapeake Bay basin. The proportion of Chesapeake Bay Phase II communities that were solicited was less than 5%. It was presumed that very few Phase II programs would have established a street sweeping or storm drain cleanout program for water quality purposes. Table 1 lists the distribution of surveys by permit type and notes which communities did or did not complete surveys.

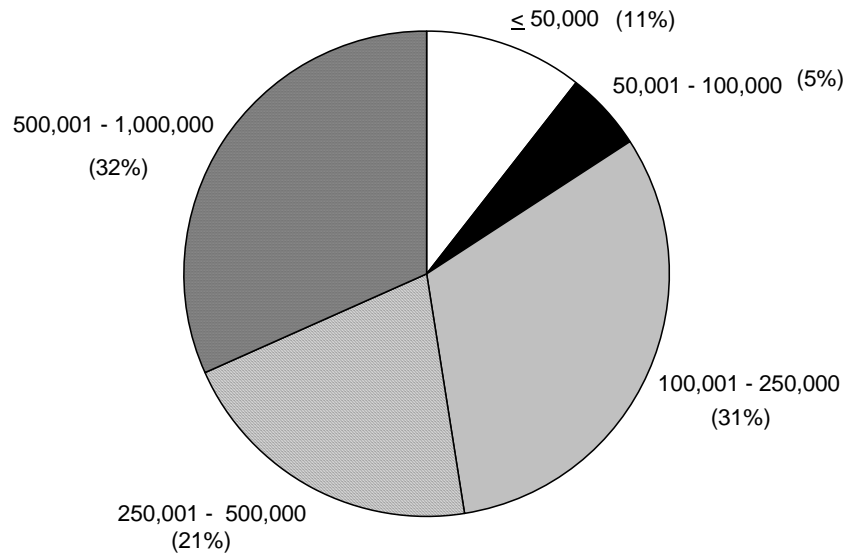
The communities surveyed within the Chesapeake Bay basin varied widely in their physical area and population. The average area was 302 square miles, with a range of 6 to 689 square miles. With the exclusion of the Maryland State Highway Authority, 85% of the survey respondents had a population greater than 100,000. A distribution of the population of the surveyed communities is illustrated in Figure 1. Communities surveyed in a comparable study (Schilling, 2005) were smaller, with the majority (77%) of communities having populations ranging from 10,000-100,000.

Surveys were mailed in February 2006 and returned by April 24, 2006. Telephone calls were made to verify and/or identify the best point of contact to receive the survey. In many cases, the surveys were completed by more than one person from various departments. To improve quality control, CWP staff phoned key contacts to verify information.

Table 1. Communities surveyed within and outside of the Chesapeake Bay Basin.

Returned Surveys	Incomplete Surveys
Chesapeake Bay Basin Phase I	
Anne Arundel County, MD Arlington, VA Baltimore City, MD Baltimore County, MD Chesapeake, MD Chesterfield County, VA Fairfax County, VA Frederick, MD Hampton, VA Harford County, MD Howard County, MD Maryland State Highway Authority Montgomery County, MD Norfolk, VA Prince George's County, MD Virginia Beach, VA	Carroll County, MD Charles County, MD Henrico County, VA Newport News, VA Portsmouth, VA Philadelphia, PA
Chesapeake Bay Basin Phase II	
Rockville, MD Fairfax City, VA Fairfax County, VA* Williamsburg, VA	Morgantown, WV Albermarle County, **
Outside of Chesapeake Bay Basin	
Allentown, PA Austin, TX Madison, WI Orlando, FL San Jose, CA Santa Monica, CA Sunnyvale, CA	St. Paul, MN
* Virginia Department of Transportation responded to the survey given road ownership and street sweeping program ** Responded to survey but indicated Albermarle County did not have a street sweeping or storm drain cleanout program	

Figure 1. Population distribution of surveyed communities in the Chesapeake Bay.



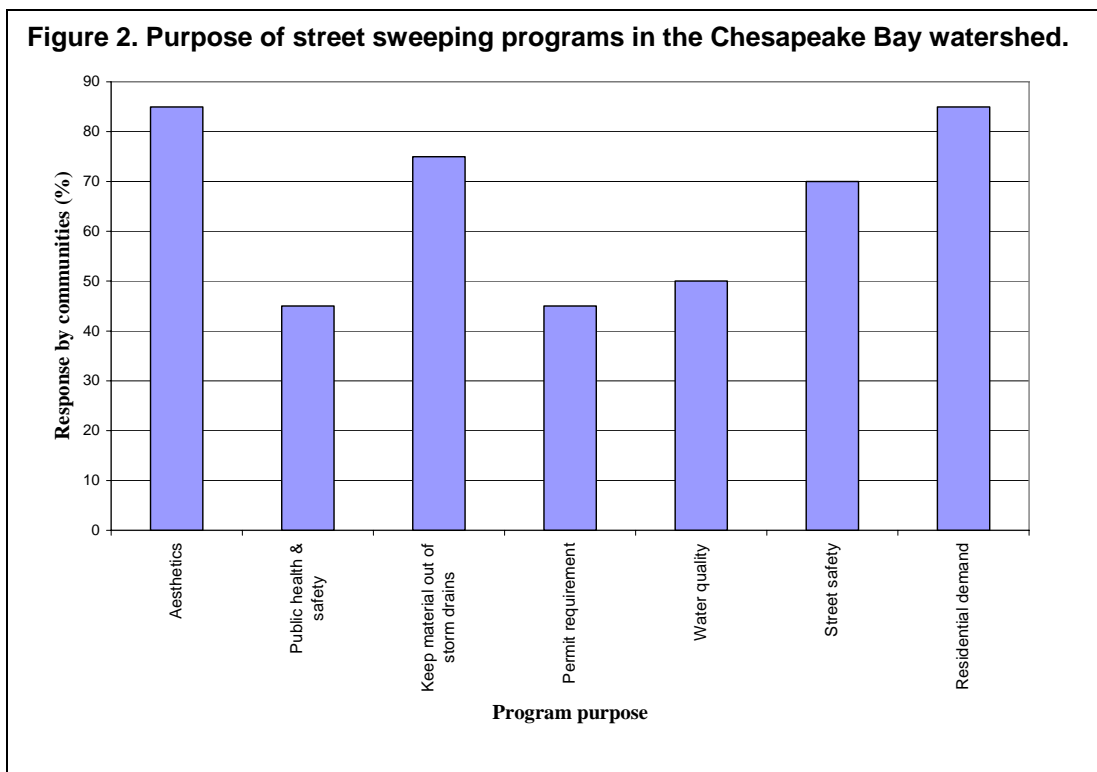
3.0 Street Sweeping Practices in the Chesapeake Bay Watershed

Only one community surveyed (Chesterfield County) did not have a street sweeping program. The survey results for street sweeping practices are summarized below.

3.1 Program Purpose

The purpose of street sweeping programs has not changed over the past thirty years. Communities were asked to select as many of the drivers shown in Table 2 that best describes the purpose of their street sweeping program. The most common purposes for street sweeping programs in the Chesapeake Bay are aesthetics, followed by residential demand (Figure 2). Keeping material out of storm drains and street safety were also common responses. Public health and safety, permit requirements, water quality were not amongst the most frequent cited reasons for street sweeping, but are considered important by a significant proportion of communities.

Given that many street sweeping programs do not focus on water quality, few communities targeted specific pollutants as part of their program. In fact, only one community in the Chesapeake Bay targeted nutrients as part of their street sweeping program. The majority of the other respondents only saw the benefit of reducing street sediment (55%), and to a lesser extent litter (40%) and leaves (25%) through street sweeping.



Communities indicated that traffic volume, commercial location, and residential demand were the most common factors used to determine which streets are swept and the sweeping frequency (Table 2). Other factors cited when selecting streets to sweep include the presence of curb and/or gutters. Additional factors that influence sweeping frequency include: the number of de-icing days in the preceding winter, adjacent construction activity, and whether street dirt is a road hazard.

Table 2. Factors to select streets for enrollment in street sweeping program and sweeping frequency (n=20). Expressed as % of communities.

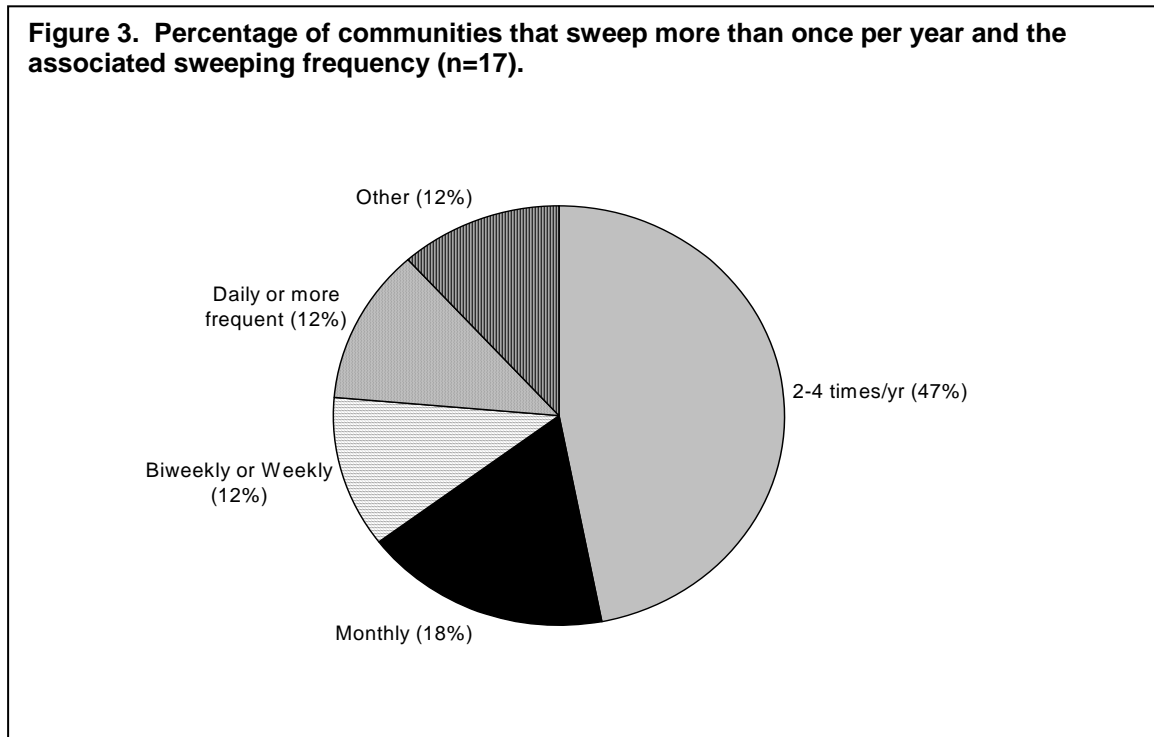
	Traffic Volume	Land use	Target commercial areas	Residential demand	Proximity to ESA	Loading rates
Street Selection	45%	5%	45%	40%	10%	5%
Frequency	30%	5%	35%	35%	10%	5%

3.2 Frequency

The survey indicates that on average 70% of the public streets in the Chesapeake Bay are swept at least on an annual basis. The proportion of streets swept ranges widely from 6% of all streets to 100% of public streets, ranging from 50 to 80,000 lane miles in each community. Arlington, VA, Fairfax, VA, Williamsburg, VA, Fairfax, VA, Norfolk, VA, Montgomery County, MD, Baltimore County, MD (curb and gutter only) and Rockville MD are the only jurisdictions reported to sweep all of their streets at some frequency. In addition to a regular sweeping schedule, eight communities schedule an early Spring

street sweeping to remove sand and other de-icing material used during the preceding winter, whereas only four communities schedule one for Fall leaf pick-up.

The majority of the Chesapeake Bay communities report street sweeping frequencies of more than once per year (17 out of 20 respondents). However, only a select set of communities were able to provide data on the proportion of streets that are swept more frequently than once per year. Figure 3 illustrates the percent of communities that sweep more than once per year and the associated street sweeping frequency.



Sweeping frequency varies by road or land use type in some jurisdictions. For example, Arlington, VA sweeps streets in commercial areas and bike lanes on an approximately monthly basis (13 passes/year) whereas streets in residential areas are swept half as often (e.g. 7.25 passes/year). Rockville, MD also varies frequency by street type where streets in commercial and business areas are swept twice a week while residential streets are swept only twice a year (January and May) and major arterial streets are swept monthly.

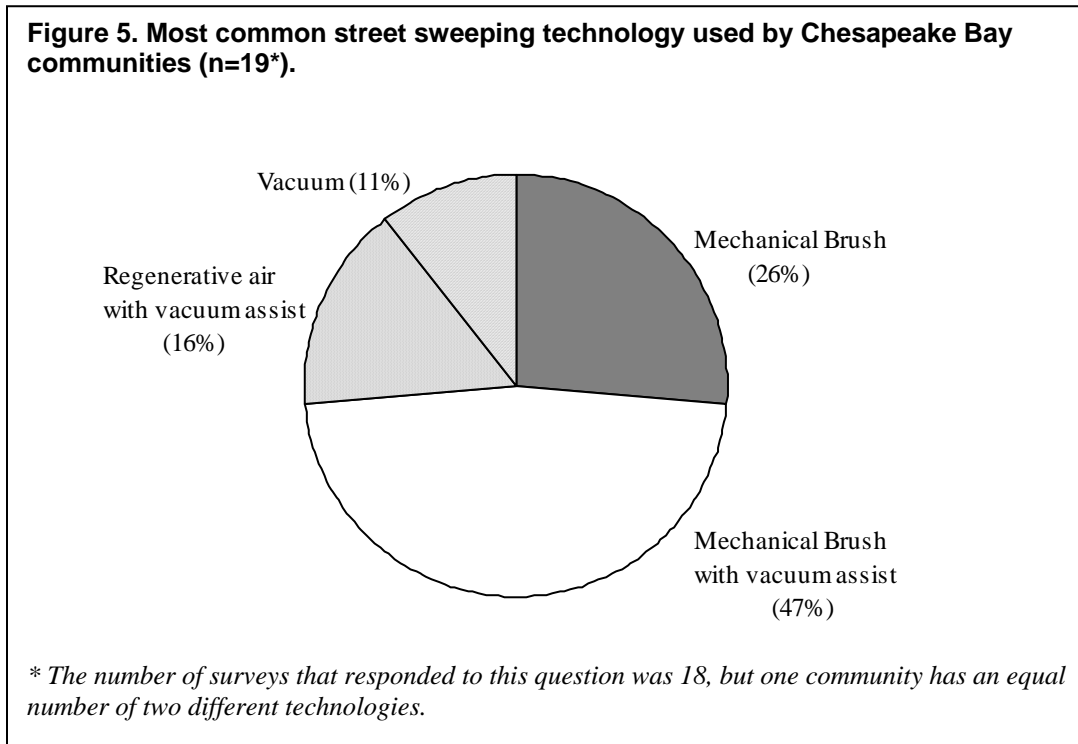
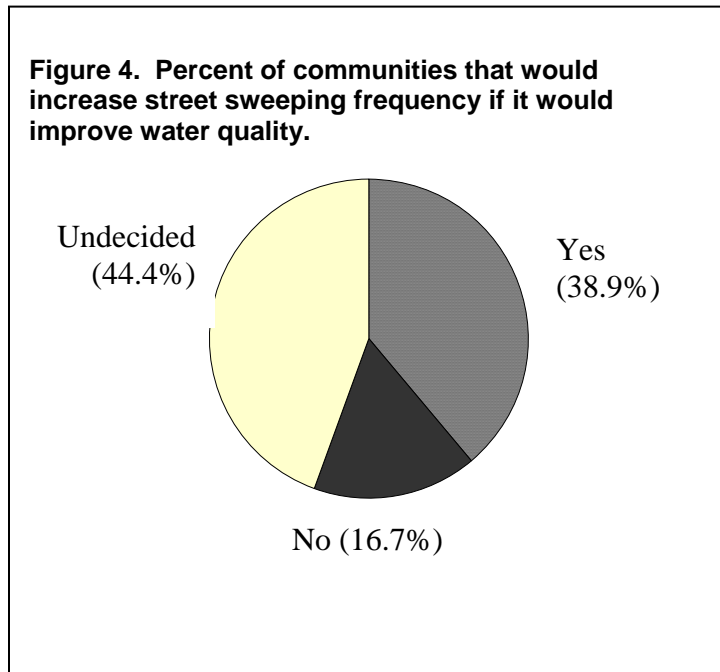
The survey findings are similar to those reported by Schilling (2005), who found most communities in Minnesota, the U.S., and Canada sweep their streets more frequently than once per year. The most common street sweeping frequency is twice a year in Minnesota, whereas elsewhere in the United States and Canada it was most common to sweep three times per year or more. Schilling (2005) found that streets within the Central Business District were swept most frequently (e.g., weekly).

Less than half of the communities in the Bay indicated that they would increase sweeping if it resulted in improved water quality and if adequate funding was available (Figure 4).

3.3 Technology

The technology used for street sweeping can greatly influence the street dirt pickup efficiency. In general, sweepers that rely on vacuum and/or regenerative air with vacuum assists have a better pick-up efficiency compared to mechanical brush sweepers or older technology. As can be seen in Figure 5, only 27% of Chesapeake Bay communities rely on this modern sweeping technology. The most

common types of street sweepers used are the mechanical brush and mechanical brush with vacuum assist. These findings are consistent with Schilling (2005) who found that 70% of communities used mechanical brush and mechanical brush with vacuum assist.



3.4 Factors Affecting Street Sweeping

Communities were asked to rank the most common factors that constrain the street sweeping program on a scale from 1 to 5, or if the factors was not considered a problem. Table 3 summarizes the responses ranked as most important (1 or 2), or important (3), and least important (4 or 5). The Chesapeake Bay communities consistently reported that on-street parking is the most common factor affecting the performance of street sweeping. Poor street conditions and ineffective technology were generally regarded as moderately important in influencing street sweeping. The least important factor was poorly trained operators, which is surprising since most communities allocated a very small portion of their budget to operator training, or it was not considered a problem. Additional factors that were noted include: equipment breakdown, piles of leaf debris and inclement weather. Street sweepers generally do not operate when it is raining, snowing or there is snow on the ground.

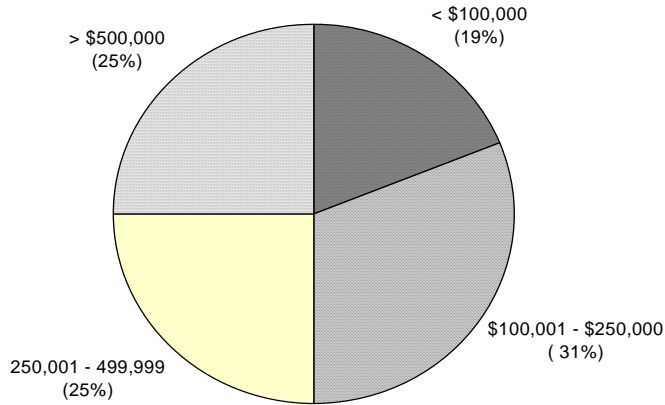
Table 3. Common problems that affect the performance of street sweeping programs in the Chesapeake Bay				
<i>Problem</i>	<i>Expressed as percentage (%)</i>			
	<i>Most Important</i>	<i>Important</i>	<i>Least important</i>	<i>Not a problem</i>
On-street parking	76	18	6	0
Inadequate budget	56	6	25	13
Untrained or poorly-trained operators	0	7	50	43
Poor street conditions	0	17	42	42
Older or ineffective sweeping technology	7	14	29	50
Other	Equipment breakdown, leaf piles, weather			

3.5 Street Sweeping Costs

There is considerable variability in cost per curb mile to operate street sweeping programs in the Chesapeake Bay basin. Based on the seven surveys that provided data, street sweeping costs varied between \$14.75 to \$158/curb mile, with an average of \$62.45/curb mile. Two communities had budgets of \$2,000,000 (Figure 6). The average cost per lane mile is about \$102/lane mile. Curb miles include the curb length of the median in addition to the street curb, while lane miles only include the length of street curb. The ratio of curb miles to lane miles is typically around 2:1 or 4:1. A few communities reported sweeping costs by street type or land use. Streets within the Central Business District were generally the least expensive to sweep.

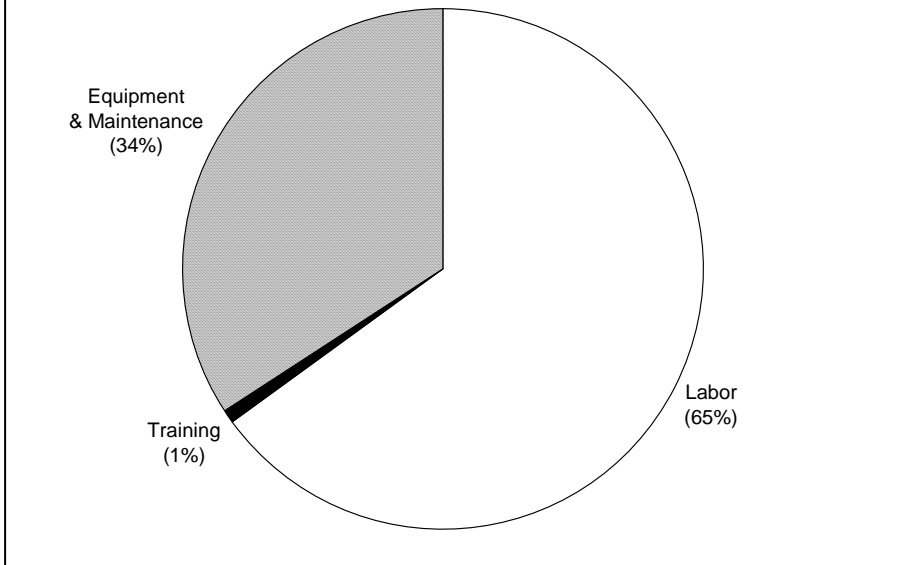
Sixteen communities provided the annual budgets for their street sweeping programs (Figure 6). About half of the communities spent \$250,000 or less on their street sweeping program while the other half spent more than \$250,000. Two communities had budgets of \$2,000,000.

Figure 6. Distribution of street sweeping program budgets for Chesapeake Bay communities



On average, the bulk of municipal sweeping budgets in the Chesapeake Bay are allocated to labor, although equipment purchase and maintenance can be significant. Few communities allocated funds to training. Communities, who did allocate funds to training, allotted less than one percent of the total budget (with the exception of one community that used five percent of the total budget for training) (Figure 7).

Figure 7. Distribution of street sweeping program costs for Chesapeake Bay communities.



The annual budgets for street sweeping are not related to population size of the survey communities. It does appear that communities (including non-Chesapeake Bay) with a

more stable revenue source, such as stormwater utility fees, spend more on street sweeping. Seven out of the top ten street sweeping budgets were communities that had a stormwater utility fee; whereas 9 of the ten smallest budgets were funded by general or operating funds. The survey respondents as a whole were more likely to spend money on a training program if they had a stormwater utility.

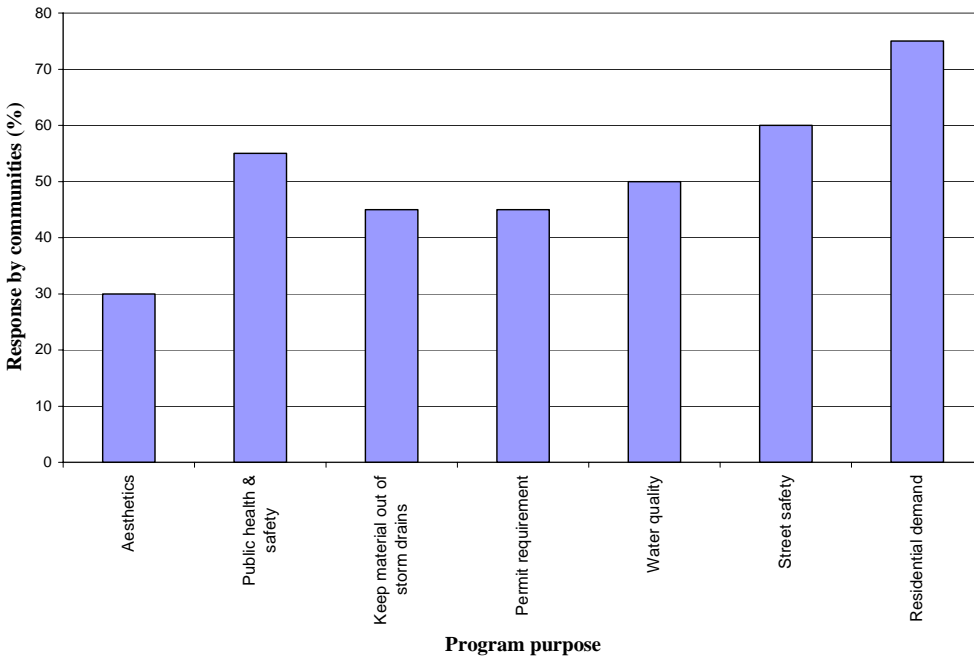
4.0 Storm Drain Cleanout Practices in the Chesapeake Bay Watershed

Most communities have thousands of storm drains as part of their infrastructure. All communities surveyed within the Chesapeake Bay watershed perform some type of storm drain cleanouts to maintain their stormwater infrastructure and prevent flooding problems caused by clogged storm drains. However, less than half of the communities in the Bay (40%) schedule regular cleanouts, while the remaining 60% cleanout storm drains only in response to complaints or clogging problems.

4.1 Program Purpose

With the exception of residential demand for cleanouts, there was not a strong common purpose amongst communities within the Chesapeake Bay for storm drain cleanout programs (Figure 8). The purpose of storm drain cleanout programs were more varied amongst survey communities compared to the purpose of street sweeping programs. Similar to street sweeping, permit requirements and water quality were not a common reason for a storm drain cleanout program.

Figure 8. Purpose of storm drain cleanout programs in the Chesapeake Bay watershed.



4.2 Frequency

A total of 16 communities provided data on the proportion of storm drains they clean out each year. Based on this data, less than one-third of the total number in each community is cleaned out on an annual basis within the Bay (Table 4). Of the storm drains that are cleaned, the majority (75%) of communities reported they only conducted storm drain cleanouts once every 2 years or less (Table 5). This represents a typical cleanout frequency, whether it be regularly scheduled or based on complaints. A much higher proportion of storm drains are cleaned out by communities surveyed outside of the Bay.

Table 4. Proportion of storm drains cleaned out annually in the Chesapeake Bay (n=16).

Type	Average	Range
Inlets	25.8%	0.2% to -50%
Inlets and Storm Drains	32.7%	5% to 51%

Table 5. Storm drain cleanout frequency in the Chesapeake Bay (n=19).

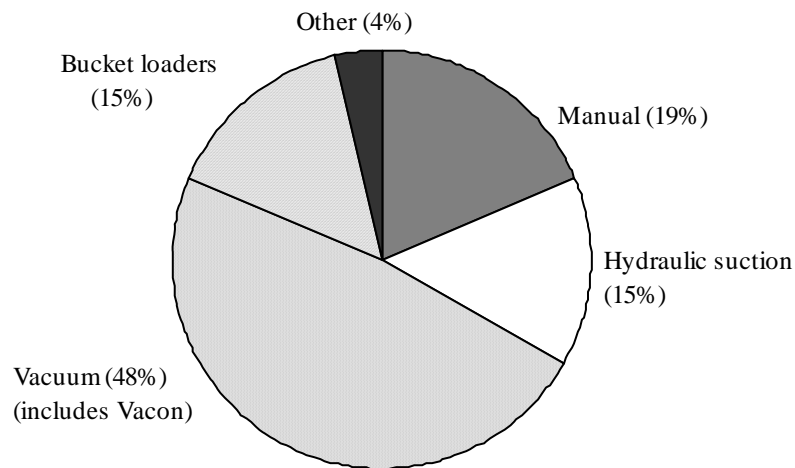
Frequency	Percent response
Seldom, if ever	23.5%
Once every 3-5 years	29.4%
Every 2 years	23.5%
Annual	5.9%
Twice a year	0
Other	17.6%

4.3 Technology

Almost 65% of the Chesapeake Bay communities used vacuum-based technology or hydraulic suction to cleanout storm drains (Figure 9). The remaining communities use more basic technology such as manual removal or bucket loaders. In a few communities, more than one technology was used.

Although a little more than half of the communities use a database and spatial referencing systems (e.g. Global Positioning System, Geographic Information System) to track the location and maintenance of their storm drains (e.g. 11 out of 20), only eight communities quantified the amount of material removed from cleanouts, in terms of mass (e.g., tons) or volume (e.g. yd³). Based on this data, the amount of material removed ranged from 0.5yd³ per cleanout to 1,019 yd³ on an annual basis. The per cleanout numbers were based on infrequent storm drain cleanouts, while the annual numbers came from Baltimore County, who has a regular storm drain cleanout program.. The Baltimore County cleanout program includes approximately 1.5% of the total storm drains and 3% of the inlets within the County. In 2004, the typical volume of material removed from an inlet was 1.3 yd³ and 0.021 yd³/linear feet of pipe. The survey indicates that the material removed from storm drains is taken to landfills.

Figure 9. Most common street sweeping technology used in Phase I and II Chesapeake Bay communities (n=27*).



* The number of surveys that responded to this question was 16, but some communities indicated multiple technologies and were treated as separated responses.

4.4 Storm Drain Cleanout Costs

Only eight Chesapeake Bay communities provided annual budgets for their storm drain cleanout program, which ranged \$50,000 to \$2,000,000, with a median of about \$312,500. Unlike street sweeping, too few data on program costs were provided to associate cleanout budgets with utility fees.

Although costs for training personnel were not requested, it appears that 65% of the communities train the maintenance staff to report water quality problems and illicit discharges observed while cleaning out storm drains. Far less data was available to characterize the cleanout cost per inlet or per foot of storm drain pipe (only 4 responses). Based on these responses, the average cost for catch basin cleanouts is approximately \$58 per inlet, \$1.39 per linear foot of storm drain pipe, or \$415.56 to cleanout out both storm drains and inlets.

5.0 Pollutant Characterization of Street and Catch Basin Sediment

Chesapeake Bay communities have limited data to characterize the chemical nature of street dirt or storm drain sediment removed and no longer available for runoff. One example has been the City of Baltimore pilot street sweeping program that indicated the potential for street sweeping to reduce pollutant loadings, but overall was inconclusive (City of Baltimore, 2004). Outside of the Bay, Allentown, PA has a five-year database on street dirt and catch basin sediment quality. From July 1998 to April 2004, the average trapping efficiency for catch basins was 1.5% for total solids. The City reports that regular street sweeping picks-up on average 68% of the solids on the street that includes

daily sweeping on a proportion of some streets while all streets are swept at least twice a year. The fall sweeping program that includes a separate leaf pick-up removes an average of 22% of the solids. Table 6 summarizes the most recent data on the distribution of nutrients and select metals for street dirt and catchbasin sediment removed in Allentown, PA. It is significant to note that the majority of the metals are associated with the leaf and fall cleanup that only comprises 22% of the total annual weight of street dirt collected. The majority of the nutrients are associated with the bulk of the material collected during regularly scheduled street sweeping.

Table 6. Nutrient composition (% by weight) of street dirt and catch basin sediments in Allentown, PA for solids removed from 5/1/2004 through 4/30/2005.

Parameter	Street Sweeping Solids					Catchbasin solids
	Spring cleanup	Regular cleanup*	Leaves	Final Fall cleanup	Winter cleanup	
Ammonia	0.5	71.1	10.3	16.6	0.5	0.9
TKN	3.3	56	5.6	31.5	3.3	0.4
Organic N	3.5	54.1	5.0	33.4	3.5	0.4
TP	0.0	82.1	9.6	7.7	0.0	0.7
Copper	2.5	18.0	25.3	50.5	2.5	1.2
Lead	4.2	14.1	0.0	76.6	4.3	0.8
Zinc	3.3	34.1	8.9	48.4	3.4	1.8

* All of the streets are swept at least 2x/year where 10% of the streets are swept daily.

Baltimore County was the only community in the Bay that had data to estimate accumulation rates of pollutants in the storm drains. The material removed from the storm drains and inlets from selected watersheds was multiplied by concentrations found by Mineart and Singh (1994) (Baltimore County DEPRM, 2005). The resulting accumulation rates for Baltimore County are significantly lower than those found by Pitt and Bissonnette (1984) in Bellevue, WA (Table 7). The relatively low accumulation rates may be due to the regular cleanout program instituted in Baltimore County.

With the exception of these programs, most communities rely on less quantitative methods to assess the effectiveness of their program. For example, the ability to determine if communities are meeting its objectives for street sweeping are largely based on visual determination of observed street or roadway cleanliness.

Table 7. Estimated annual accumulation rates for metals removed from catch basins (lb/contributing acre/year)

Parameter	Baltimore County, MD*	Bellevue, WA**	
Copper	0.003	n/a	n/a
Lead	0.005	0.33	0.03
Zinc	0.002	0.07	0.01

* Estimated based on catch basin solids concentration from Mineart and Singh (1994) and pounds of material removed in 2004 based on selected volume of material removed on a watershed basis.
 **Source: Pitt and Bissonnette (1984)

Only one community, the City of Baltimore, has monitoring data to determine the potential effectiveness of street sweeping (City of Baltimore, 2004). Other measures used to determine the effectiveness of sweeping or cleanout programs is based on the material removed on an annual basis using a maintained database or model simulations that have prescribed removal efficiencies for these practices. However, this type of measure is only relative within a community and does not provide information on how the amount of material removed may impact stormwater quality. Overall, it appears that communities use street sweeping and storm drain cleanout practices as part of a maintenance program rather than a stormwater practice to reduce pollutant loadings.

6.0 Survey and Its Application to the Conceptual Model

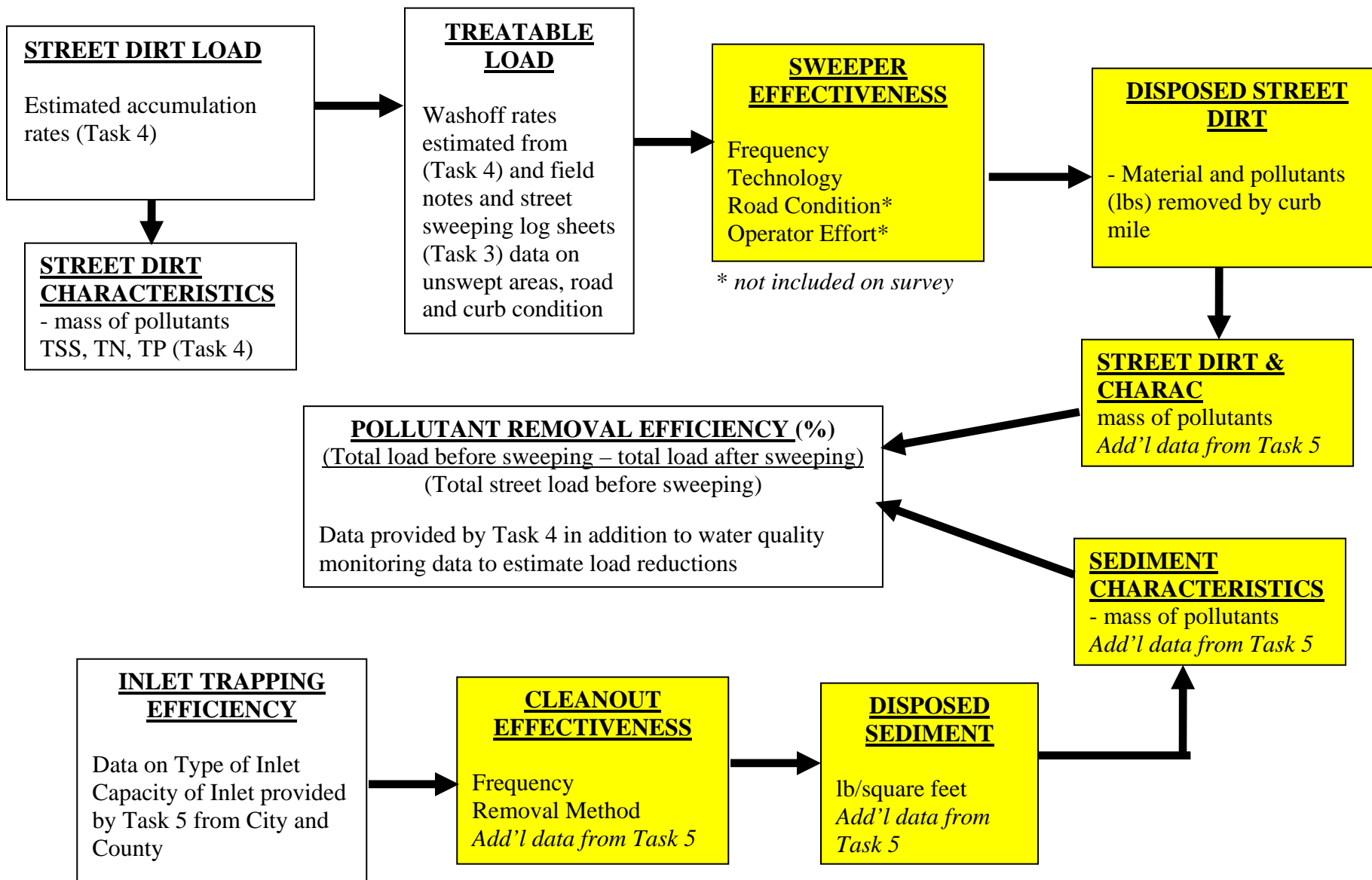
In Technical Memo 1, a conceptual model was used to define interim pollutant removal efficiencies based on values taken from literature and other research. The survey requested detailed information on the equipment and sweeping frequencies used by municipalities. The survey also asked questions in regard to storm drain cleanout methods. Limited information was obtained on the amount of pollutants removed by street sweeping and storm drain cleanouts, the chemical characterization of solids removed, and pollutant accumulation rates. At this time, survey data is insufficient to improve upon the interim pollutant removal rate presented in Technical Memo 1. Data generated from the survey will be used in conjunction with monitoring data and the conceptual model to further define the interim pollutant removal rates.

Figure 10 expands upon the conceptual model defined in Technical Memo 1 to include how the pollutant removal rate will be defined based on each task of this project. The shaded boxes indicate data generated from the municipal survey on street sweeping and storm drain cleanout practices. Where indicated, additional information for some boxes, such as street dirt and sediment characterization, will also be generated from the monitoring component of the project. Data on road conditions will be generated from field and street sweeper log sheets from Tasks 3 and 4 of the project. Accumulation rates for street dirt will be estimated in Task 4 of the project from source area sampling of the streets in Catchment O of Watershed 263.

The following data from the survey will be used to estimate the amount of sediment removed by curb mile:

- Sweeping frequency
- Technology used
- Amount of sediment collected
- Total length of streets swept
- Monitoring data to characterize pollutant content of sediment

Figure 10. Conceptual model for defining pollutant removal efficiencies for street sweeping and storm drain cleanouts. Shaded boxes indicate data collected from survey.



The following 5-step process will be used to make these estimates:

1. Calculate total amount of material removed by street sweeping
2. Calculate amount of sediment in weight by assuming one ton per cubic yard (use actual amount of known).
3. Quantify characteristics of street dirt collected.
4. Calculate total curb miles of streets swept annually (curb miles x annual frequency of sweeping)
5. Calculate average amount of material and pollutant removed per curb mile on an annual basis

A similar process is followed to estimate the amount of sediment removed by storm drain cleanouts. The survey provides data on cleanout frequencies, type of equipment used, and some data on the average amount of material removed per cleanout, which will be used to estimate an annual rate. The trapping efficiency and chemical quality of catch basins sediment will be better defined from sampling efforts by Baltimore County and the City of Baltimore.

Another important use of the survey data is to determine the increased level of effort that may be required by a community to achieve potential nutrient reductions from street sweeping. Based on the findings of Technical Memo 1, the survey results suggest that most communities surveyed are not sweeping at a great enough frequency to use street sweeping as nutrient reduction BMP. The City of Williamsburg has the most intensive street sweeping program where all of the streets are swept every other week and may be the only community sweeping enough to achieve nutrient reduction from sweeping. Based on the survey data, example calculations were made for three communities to estimate the increased level of effort that may be needed to use street sweeping as a nutrient reduction BMP. To maintain confidentiality, the community names are not used. Table 8 summarizes street sweeping efforts in the three communities, by the total miles swept per year, and the percentage and length of roads swept by frequency as reported in the surveys. Interim pollutant removal rates of 5% for total phosphorus and 6% for total nitrogen were proposed in Technical Memo 1 for street sweeping frequencies of monthly and weekly. It is assumed a community would need to sweep at least every two weeks to achieve some nutrient load reduction based on research studies to date, or even more frequent (e.g. Pitt and Bissonette 1984, Zariello et al. 2002). For the purposes of these calculations, it is also assumed that all streets are treated equally, whereas in reality more frequent street sweeping is likely required in more high-traffic areas such as streets in commercial areas or central business districts where greater pollutant loadings are likely.

Table 9 provides an indication of the likely increase in lane miles or curb miles that would need to be swept annually to achieve a nutrient reduction of about 5%. This would be associated with a cost increase if the average cost per curb mile as reported by Chesapeake Bay communities is around \$62 per curb mile (see Section 2.4).

Table 8. Current street sweeping effort in three Chesapeake Bay communities based on survey results.

			% of roads swept by frequency				
Community	<i>Current miles swept each year</i>	<i>Lane or curb miles</i>	<i>Annual</i>	<i>2x/year</i>	<i>4x/year</i>	<i>Monthly</i>	<i>2x/week</i>
Community A	670*	Lane miles			100		
Community B	1500**	Lane miles	94		5	1	
Community C	150**	Curb miles		91.1		4.8	4.1
			Length of roads swept by frequency				
Community	<i>Current miles swept</i>		<i>Annual</i>	<i>2x/year</i>	<i>4x/year</i>	<i>Monthly</i>	<i>2x/week</i>
Community A	670*	Curb miles			1340		
Community B	1500	Lane miles	1410	15	75		
Community C	150	Curb miles		136.65		7.2	6.15
This represent 70% of roads (all curb and gutter)							
** Represents 100% of all roads							

Table 9. Increased level of effort for street sweeping from existing practices to every two weeks.

Community	Increase in lane or curb miles swept
Community A	6.5 times
Community B	25 times
Community C	12 times

7.0 Program Recommendations

Initial program recommendations are made by comparing the potential level of effort needed to achieve a measurable nutrient reduction from Technical Memo 1 and the extent of street sweeping and storm drain cleanout practices reported in the Bay. In the first Technical Memo, the range in pollutant removal efficiencies for street sweeping ranged from 4-8% for total phosphorus and 4-9% for total nitrogen based on a number of sweeping conditions, technology and sweeping frequency. Survey results indicate that most Chesapeake Bay communities surveyed are not currently sweeping at a frequency or using the best available technology to achieve measurable nutrient reductions from street sweeping. Although a shift to more frequent street sweeping or storm drain cleanouts are not specifically recommended at this time, it is suggested that communities consider the following steps if these practices are to be considered a nutrient reduction BMP:

1. Increase monitoring of street sweeping residuals and storm drain sediment
2. Provide greater operator training for street sweeping
3. Improve tracking and maintenance of a spatially-referenced database for storm drain cleanouts to identify the dirtiest streets and the worst storm drains
4. Chesapeake Bay MS4s should pool their resources for further research on, and monitoring of, nutrient reduction practices such as street sweeping and storm drain cleanout practices, to determine their impact on stormwater quality. For example, each community could allot 1% of its annual budget from the combined expenditures that exceed \$13 million/year to a common research goal.
5. Use more consistent or standard reporting of street sweeping and storm drain cleanout efforts in the annual NPDES Stormwater permit reports.

8.0 References

- City of Baltimore. (2004). *Annual NPDES Report*. City of Baltimore Department of Public Works.
- Mineart, P. & Singh, S. (1994). *Storm Inlet Pilot Study*. Performed by Woodward Clyde Consultants for Alameda County Urban Runoff Clean Water Program.
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- Schilling, J.G. (2005). *Street Sweeping - Report No. 2, Survey Questionnaire Results and Conclusions*. Prepared for Ramsey-Washington Metro Watershed District (<http://www.rwmdwd.org>). North St. Paul Minnesota. June 2005.
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- United States Geological Survey (USGS). (2005). *Evaluation of Street Sweeping as a Water-Quality Management Tool in Residential Basins in Madison*, Scientific Investigations Report, September 2005.
- Zarriello, P.J., Breault, R. F., & Weiskel, P. K. (2002). Potential Effects of Structural Controls and Street Sweeping on Stormwater Loads to the Lower Charles River, Massachusetts. U.S. Geological Survey Water Resources Investigations Report 02-4220.

Appendix A

Survey Letter of Introduction
Copy of Survey

Hye Yeong Kwon
Executive Director

Thomas R. Schueler
Director of Watershed Research and Practice

BOARD OF DIRECTORS

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Baltimore Landmark Homes, LLC

William Street
James River Association

8390 Main Street, 2nd Floor
Ellicott City, MD 21043
410.461.8323
FAX 410.461.8324
EMAIL center@cwpp.org
www.cwpp.org
www.stormwatercenter.net

Date

Dear _____,

The Center for Watershed Protection is conducting a survey of stormwater coordinators in the Chesapeake Bay Watershed and selected communities throughout the United States, on municipal street sweeping and storm drain cleanout practices. The survey is part of a two-year research project sponsored by the U.S. EPA Chesapeake Bay Program on the effectiveness of street sweeping and storm drain cleanout practices in improving surface water. The project will define improved estimates of the potential nutrient and sediment reductions achieved through municipal street sweeping and storm drain cleanouts.

The attached survey will characterize street sweeping and storm drain cleanout practices within the Bay and provide valuable data on costs, removal efficiencies and program operation. By answering this survey, you will also provide information to better understand how such practices are used and their extent within the Bay watershed.

Please take some time to fill out the survey and return it in the post-paid envelope, **no later than February 24, 2006**. All responses will be anonymous and confidential. As a small token of our appreciation for taking the time from your busy schedule, we will share the survey findings with you and provide “.pdf” versions of our Pollution Source Control and Urban Stream Repair Manuals with the receipt of the completed survey.

Thank you in advance for taking the time to complete this survey. Your response to the survey is voluntary and would greatly aid our understanding how street sweeping and storm drain cleanouts can help protect the water quality of the Chesapeake Bay and urban watersheds! If you have any questions about the survey, please contact Neely L. Law or Tiffany Wright at the Center for Watershed Protection for more information.

Neely Law, Survey Coordinator
Center for Watershed Protection
E-Mail: nll@cwpp.org

Tiffany Wright
Center for Watershed Protection
Phone: 410-461-8323
E-Mail: tw@cwpp.org

Sincerely,

Tom Schueler
Center for Watershed Protection
Email: trs@cwpp.org



**CHESAPEAKE BAY SURVEY ON MUNICIPAL STREET SWEEPING AND
STORM DRAIN CLEANOUT PRACTICES**

Please review the survey and identify who in your community is most knowledgeable to answer the questions. You may find that in addition to yourself, you may need to consult additional staff or agencies to provide the most correct answers possible given program organization and data availability.

A. CONTACT INFORMATION

This information is used for internal survey purposes. The contact information may be used for follow-up questions or clarifications, if needed. All information collected from the survey will be anonymous and confidential.

Name:	_____
Position title:	_____
Address:	_____

Phone Number:	_____
E-mail:	_____
<i>(so we can send you electronic results)</i>	
Fax Number:	_____

1. Please **circle** if your community operates under a Phase I or Phase II NPDES stormwater MS4 permit, or no permit.

Phase I Phase II No permit

2. Please estimate the approximate physical area of your community (e.g. square miles). _____
3. Please estimate the population of your community _____

If you don't know the population, please circle from the list below the range that most closely estimates the population.

10,001 – 25,000	25,001 – 50,000
50,001 – 100,000	100,001 – 250,000
500,000 – 750,000	750,000 – 1,000,000

B. STREET SWEEPING PROGRAM CHARACTERISTICS

4. Does your community have a current street sweeping program?

- Yes
- No

If you answered NO, GO TO Section C.

The following questions ask about the nature of the street sweeping program in your community. The information will help to identify the extent of street sweeping within the community and program operation.

5. Please select from the list what street sweeping equipment is most commonly used in your community. **Check only one.**

- Sweeper: mechanical brush
- Sweeper: mechanical brush with vacuum assist
- Sweeper: regenerative-air with mechanical brush
- Sweeper: vacuum
- Other (please specify): _____

6. Please indicate the number of each type of street sweeper that is part of the fleet used in your community.

- ___ Sweeper: mechanical brush
- ___ Sweeper: mechanical brush with vacuum assist
- ___ Sweeper: regenerative-air with mechanical brush
- ___ Sweeper: vacuum
- ___ Other (please specify): _____

7. Do you target any of the following specific pollutants as part of the street sweeping program?

- Litter (paper products, glass, metal and other road hazards)
- Leaves
- Sediment/dirt
- Nutrients
- Not applicable (e.g., there are no targeted pollutants)

8. What is the proportion of public streets in your community that are swept at least on an annual basis? _____%

9. Please estimate the approximate total length of streets in your community that are swept at least once a year? _____

If you do not know, please check the category of street miles below that best estimates the total street length that are swept at least once a year.

- <100 miles
- 101-250 miles
- 251-500 miles
- 501-750 miles
- 751 – 1000 miles
- >1000 miles
- Don't know

10. Are some streets swept more frequently than on an annual basis?

- Yes
- No
- Don't know

11. Please complete the following list to estimate the proportion of streets that are swept more than once per year. (Please use additional paper if needed to complete the list). *Use the street segment length that is swept to determine the proportion of total miles swept.*

- 2x/year: Proportion of total miles swept _____%
- Monthly: Proportion of total miles swept _____%
- Bi-weekly: Proportion of total miles swept _____%
- Weekly: Proportion of total miles swept _____%
- Daily: Proportion of total miles swept _____%
- Other frequency (please list):
_____ Proportion of total miles swept _____%
_____ Proportion of total miles swept _____%
_____ Proportion of total miles swept _____%

12. Would your community increase street sweeping frequency if it could be documented that it improved local water quality?

- Yes
- No
- Undecided

13. What factors do you use to select the streets that are included in your street sweeping program and their frequency?

Street Selection	Frequency Swept	Factor
<input type="checkbox"/>	<input type="checkbox"/>	Traffic volume
<input type="checkbox"/>	<input type="checkbox"/>	Adjacent land use (please specify what type of land use is targeted _____)
<input type="checkbox"/>	<input type="checkbox"/>	Target commercial or downtown areas
<input type="checkbox"/>	<input type="checkbox"/>	Residential demand or public complaints
<input type="checkbox"/>	<input type="checkbox"/>	Proximity to environmentally sensitive areas
<input type="checkbox"/>	<input type="checkbox"/>	Perceived or measured loading rates
<input type="checkbox"/>	<input type="checkbox"/>	Other factors (please specify)
<input type="checkbox"/>	<input type="checkbox"/>	_____
<input type="checkbox"/>	<input type="checkbox"/>	_____
<input type="checkbox"/>	<input type="checkbox"/>	_____

The next two questions ask about additional sweeping practices to address leaf fall and de-icing material such as sand.

14. Do you schedule street sweeping to pick up leaves and debris in the Fall?

- Yes
- No

15. Do you schedule sweeping to pick-up sand, de-icing material and winter debris in the early Spring?

- Yes
- No

16. Briefly describe how you dispose of material collected from the street sweeper.

17. Do you have an estimate of the weight or volume of sediments collected from street sweeping?

- Yes
- No

If you answered NO, GO TO Question 19.

18. Please indicate how you measure the quantity of material collected by the street sweeper(s).

Arrival of total all swept streets per sweeper?	Yes	No
Per curb mile swept?	Yes	No
Per daily sweeping operation?	Yes	No

➡ Please attach any information on how you calculate these quantities.

19. Please rank from the list below the problems that most affect the performance of your street sweeping program, where 1 is the most common and 5 is the least common problem. Use a "0" to indicate there is not a problem.

Rank	Problem
_____	On-street parking
_____	Inadequate budget
_____	Untrained or poorly trained operators
_____	Poor street conditions
_____	Older or ineffective sweeping technology
_____	Others (please specify AND rank):
_____	_____
_____	_____
_____	_____

20. Do you have a training program for street sweeper operators?

- Yes
- No

➡ If so, please attach any education or training material used.

21. What is the source(s) of funding to support the street sweeping program?

22. Please provide an estimate for each of the 4 areas or total annual expenditure to conduct your street sweeping program? *Total annual expenditure* \$ _____

1) Labor	\$ _____	3) Equipment	\$ _____
2) Training	\$ _____	4) Maintenance	\$ _____

23. Do you have any data on the average sweeping cost per mile?

- Yes
- No

➡ If so, please attach any information you may have or provide the cost estimate.

C. STORM DRAIN CLEANOUT PROGRAM

This set of questions asks about the nature of the current storm drain cleanout program. Following the questions, please circle to indicate if your answer pertains to storm drains, inlets or both, where indicated.

24. Does your community clean out storm drains and/or inlets?

- Yes, cleanouts are regularly scheduled
- Yes, but only in response to complaints or clogging problems
- No

If you answered NO, GO TO Section D

25. Estimate how many storm drains and/or inlets are cleaned out annually in your community, OR select a range from the following list.

_____ storm drain _____ inlet _____ both

- 1 – 500
- 501 – 2000
- 2,001 – 5,000
- 5001 – 10,000
- more than 10,000

26. Estimate the total proportion of all storm drains and/or inlets that are cleaned out on an annual basis? _____% **storm drain inlet both**

27. Based on the storm drains and/or inlets that are cleaned out, what is the typical clean out frequency? **Storm drain inlet both**

- Seldom, if ever
- Once every 3 to 5 years
- Once every 2 years
- Once a year
- Twice a year
- Other (please specify): _____

28. Please select from the list what equipment is most commonly used to clean out storm drains and/or inlets. Check all that apply. **Storm drain inlet both**

- Manual
- Hydraulic-suction cleaner
- Vacuum
- Bucket Loaders
- Other (please specify) _____

29. Please indicate the number of each type of equipment used to clean out storm drains and/or inlets in your community. **Storm drain inlet both**

- ___ Hydraulic-suction cleaner
- ___ Vacuum
- ___ Bucket Loaders
- ___ Other (please specify): _____

30. Do you have a database (e.g. Excel, Access, or GIS) to track the location and/or maintenance of the storm drains and/or inlets in your community?

- Yes
- No

31. Are your crews trained to report water quality problems and illicit discharges they see when they are cleaning?

- Yes
- No

32. What is the average volume of material removed per cleanout? (please specify units of measurement, cubic yards, ton, etc.)

Amount of material removed from storm drains is estimated as _____

Amount of material removed from inlets is estimated as _____

Amount of material removed from storm drains and inlets is estimated as _____

- Don't know

Please provide any comments that may clarify your answer:

33. Briefly describe how you dispose of the material collected from storm drain and/or inlet cleanouts.

34. What is the source(s) of funding to support the storm drain cleanout program?

35. What is the best estimate of annual expenditure for the storm drain cleanout program, to include inlets (labor, equipment, etc.)?

_____	Total cost/year
_____	Cost per storm drain cleanout
_____	Other cost (please specify)
_____	Check if you don't know

D. MONITORING AND DATA COLLECTION

36. Please check from the list below all statements that best describe the purpose of the street sweeping program and storm drain cleanout program. **CIRCLE** if the statement applies to street sweeping and/or storm drain cleanout program. If none of the statements match your program, please use the space provided after the question to briefly describe the program purpose.

- | | | | |
|--------------------------|------------------------------------|-----------------|----------|
| <input type="checkbox"/> | Aesthetics | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Public Health and Safety | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Keep materials out of storm drains | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Stormwater permit requirement | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Water quality improvement | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Street and road safety | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Residential demand | Street Sweeping | Cleanout |
| <input type="checkbox"/> | Other: | | |

37. Do you have any measures or indicators to quantify the effectiveness of your street sweeping and storm drain cleanout programs?

- Yes
- No

If you answered 'yes' to Question 37, please check from the list below what measures are used to determine the effectiveness of the street sweeping and/or storm drain cleanout programs?

- | | | |
|--|-----------------|----------|
| <input type="checkbox"/> Customer feedback | Street Sweeping | Cleanout |
| <input type="checkbox"/> Observed cleanliness | Street Sweeping | Cleanout |
| <input type="checkbox"/> No objectives in place | Street Sweeping | Cleanout |
| <input type="checkbox"/> Storm water runoff monitoring | Street Sweeping | Cleanout |
| <input type="checkbox"/> Other (please specify): | Street Sweeping | Cleanout |

38. Have you conducted any monitoring studies to characterize the type and amount of sediment removed by the street sweeping program?

- Yes
- No

39. Do you have any monitoring data to characterize the chemical composition of the solids removed by street sweeping or storm drain cleanouts?

- Yes
- No

40. Would you be willing to share the data collected from street sweeping and/or storm drain cleanouts to be included as part of the Chesapeake Bay Street Sweeping and Storm Drain Cleanout study?

- Yes
- No

41. Do you compute a nutrient or pollutant removal rate for street sweeping and storm drain cleanout activities as part of your annual NPDES stormwater requirements?

➔ Please attach a sample calculation, or in the space provided below describe the data or equation used to determine the nutrient removal efficiency.

Thank you for completing the survey. Please return the completed survey in the envelope provided, to:

Neely L. Law and Tiffany Wright
Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 20143
Re. Street Sweeping Storm Drain Cleanout Survey

SURVEY CHECKLIST

In addition to the completed survey, we asked you to provide the following additional information.

- ___ Question 18: Quantity of material collected from street sweeping
- ___ Question 20: Education or training material
- ___ Question 23: Cost estimate per mile for street sweeping
- ___ Question 41: Sample calculation for pollutant removal efficiency
- ___ Most recent NPDES Annual Report

Appendix B

Compilation of Survey Results

Note:

The attached survey reflects responses of 27 municipalities toward the Chesapeake Bay survey on municipal street sweeping and storm drain cleanout practices.

*The replies of the communities have been consolidated and condensed, and are expressed in the values in **blue**.*

The numbers in this compilation reflect all responses.

**CHESAPEAKE BAY SURVEY ON MUNICIPAL STREET SWEEPING AND
STORM DRAIN CLEANOUT PRACTICES**

Please review the survey and identify who in your community is most knowledgeable to answer the questions. You may find that in addition to yourself, you may need to consult additional staff or agencies to provide the most correct answers possible given program organization and data availability.

A. CONTACT INFORMATION

This information is used for internal survey purposes. The contact information may be used for follow-up questions or clarifications, if needed. All information collected from the survey will be anonymous and confidential.

Name:	_____
Position title:	_____
Address:	_____

Phone Number:	_____
E-mail:	_____
<i>(so we can send you electronic results)</i>	
Fax Number:	_____

1. Please **circle** if your community operates under a Phase I or Phase II NPDES stormwater MS4 permit, or no permit.

Phase I – 23 communities

Phase II – 4 communities

No permit - 0

2. Please estimate the approximate physical area of your community (e.g. square miles). _____

Range of Area (sq miles)
6
8
9
13
18
26
54
55
78.8
81
110
178
238
248
250
341
400
416
446
450
485
500
600
663
689
NA

3. Please estimate the population of your community _____

If you don't know the population, please circle from the list below the range that most closely estimates the population.

Community Population	
Population	Population Range
13400	1
21000	1
52375	3
85000	3
106632	4
131700	4
135000	4
190000	4
205648	4
216411	4
217000	4
225000	4
225000	4
234000	4
271118	5
280000	5
367466	5
450000	5
508572	6
628670	6
656562	6
761000	7
842967	7
930000	7
945000	7
1000000	7
NA	NA

Population Range		
category	population range	# of populations within range
1	10,001 – 25,000	2
2	25,001 - 50,000	0
3	50,001 – 100,000	3
4	100,001-250,000	10
5	250,001-500,000	4
6	500,001-750,000	3
7	750,001-1,000,000	3
8	no answer	1

E. STREET SWEEPING PROGRAM CHARACTERISTICS

4. Does your community have a current street sweeping program?

- Yes **25**
- No **1**
- No answer **1**

If you answered NO, GO TO Section C.

The following questions ask about the nature of the street sweeping program in your community. The information will help to identify the extent of street sweeping within the community and program operation.

5. Please select from the list what street sweeping equipment is most commonly used in your community. **Check only one.**

- Sweeper: mechanical brush
- Sweeper: mechanical brush with vacuum assist
- Sweeper: regenerative-air with mechanical brush
- Sweeper: vacuum
- Other (please specify): _____

Sweeper Type	Most Common Sweeping Equipment of Surveyed Communities
mechanical brush	8
mechanical brush with vacuum assist	9
regenerative-air with mechanical brush	7
vacuum	1
other	
no answer	2

6. Please indicate the number of each type of street sweeper that is part of the fleet used in your community.

- ___ Sweeper: mechanical brush
- ___ Sweeper: mechanical brush with vacuum assist
- ___ Sweeper: regenerative-air with mechanical brush
- ___ Sweeper: vacuum
- ___ Other (please specify): _____

Sweeper Type	Number of Sweepers of Surveyed Communities
mechanical brush	45
mechanical brush with vacuum assist	52
regenerative-air with mechanical brush	62
vacuum	2
other	1, ID 21, Hampton uses separate mechanical brush and vacuum sweepers

7. Do you target any of the following specific pollutants as part of the street sweeping program?

- Litter (paper products, glass, metal and other road hazards)
- Leaves
- Sediment/dirt
- Nutrients
- Not applicable (e.g., there are no targeted pollutants)

Pollutants	Number of communities that target specific pollutants
litter	15
leaves	12
sediment/dirt	18
nutrients	1
NA	7

8. What is the proportion of public streets in your community that are swept at least on an annual basis? _____%

% streets swept 1x/year
30
6
not answered or all greater frequency
100
60
50
99
80
100
100
96
70
100
100
100
no answer
no answer
specific information available
57
no answer
no answer
specific information available
100
100
50
100
100

9. Please estimate the approximate total length of streets in your community that are swept at least once a year? _____

If you do not know, please check the category of street miles below that best estimates the total street length that are swept at least once a year.

- <100 miles
- 101-250 miles
- 251-500 miles
- 501-750 miles
- 751 – 1000 miles
- >1000 miles
- Don't know

Approx length of streets swept a least once a year		
Range	# of communities within range	Specific miles
<100 miles	1	50
101-250 miles	3	190; 150; 170
251-500 miles	5	318; 440; 350
501-750 miles	3	670
751 – 1000 miles	4	900; 854
>1000 miles	8	321; 44,059; 1,960; 2,200; 5,177; 3,000; 1,500
Don't know	3	

10. Are some streets swept more frequently then on an annual basis?

- Yes – **24**
- No – **1**
- Don't know – **2**

11. Please complete the following list to estimate the proportion of streets that are swept more than once per year. (Please use additional paper if needed to complete the list). *Use the street segment length that is swept to determine the proportion of total miles swept.*

- 2x/year: Proportion of total miles swept _____%
- Monthly: Proportion of total miles swept _____%
- Bi-weekly: Proportion of total miles swept _____%
- Weekly: Proportion of total miles swept _____%
- Daily: Proportion of total miles swept _____%
- Other frequency (please list):
 _____ Proportion of total miles swept _____%
 _____ Proportion of total miles swept _____%
 _____ Proportion of total miles swept _____%

Proportion of streets swept more than once per year		
Range	# of communities within range	Proportion of total miles swept, %
2x/year	5	60; 1; 100; 91.1; 10
Monthly	7	25; 2; 98; 39; 60; 1; 100; 4.8
Bi-weekly	3	90; 2.65; 100
Weekly:	6	1; 75; 9; 0.93; 21; 50 (commercial areas)
Daily	5	10; 25; 1; 10; 10
Other frequency	9	per sign 23, every other month 66 ; 5 clearing hazards; 68 twice week; 70 quarterly; 90 6x/yr; 5 quarterly; 1x/yr gov parking lot; 100 quarterly

12. Would your community increase street sweeping frequency if it could be documented that it improved local water quality?

- Yes - **11**
- No - **3**
- Undecided – **11**
- No response - **2**

13. What factors do you use to select the streets that are included in your street sweeping program and their frequency?

Street Selection	Frequency Swept	Factor
<input type="checkbox"/>	<input type="checkbox"/>	Traffic volume
<input type="checkbox"/>	<input type="checkbox"/>	Adjacent land use (please specify what type of land use is targeted _____)
<input type="checkbox"/>	<input type="checkbox"/>	Target commercial or downtown areas
<input type="checkbox"/>	<input type="checkbox"/>	Residential demand or public complaints
<input type="checkbox"/>	<input type="checkbox"/>	Proximity to environmentally sensitive areas
<input type="checkbox"/>	<input type="checkbox"/>	Perceived or measured loading rates
<input type="checkbox"/>	<input type="checkbox"/>	Other factors (please specify) _____
<input type="checkbox"/>	<input type="checkbox"/>	_____
<input type="checkbox"/>	<input type="checkbox"/>	_____

Factors for street sweeping identification and frequency			
Factor	Street selection	Frequency swept	Both
Traffic volume	5	2	7
Adjacent land use			2
Target commercial or downtown areas	3	4	9
Residential demand or public complaints	6	6	4
Proximity to environmentally sensitive areas	1	3	
Perceived or measured loading rates	1	2	
Other factors	1; must have curb	4; dependent on winter events, construction, road surface hazard, leaf drop season, etc.	3; curb and gutter streets swept 1x/month and residential areas

The next two questions ask about additional sweeping practices to address leaf fall and de-icing material such as sand.

14. Do you schedule street sweeping to pick up leaves and debris in the Fall?

- Yes - **8**
- No - **17**
- No Answer - **2**

15. Do you schedule sweeping to pick-up sand, de-icing material and winter debris in the early Spring?

- Yes - **14**
- No - **9**
- No Answer - **2**
- NA - **2**

16. Briefly describe how you dispose of material collected from the street sweeper.

Disposal of collected material	
landfill	24
compost	1
landfill & compost	1
no answer	1

17. Do you have an estimate of the weight or volume of sediments collected from street sweeping?

- Yes – 16
- No – 9
- No Answer – 2

If you answered NO, GO TO Question 19.

18. Please indicate how you measure the quantity of material collected by the street sweeper(s).

Arrival of total all swept streets per sweeper?	Yes	No
Per curb mile swept?	Yes	No
Per daily sweeping operation?	Yes	No

Method of swept material measurement				
	yes	no	no answer	NA
Arrival of total all swept streets per sweeper	5	2	17	3
Per curb mile swept	3	4	17	3
Per daily sweeping operation	10	1	13	3

➡ Please attach any information on how you calculate these quantities.

19. Please rank from the list below the problems that most affect the performance of your street sweeping program, where 1 is the most common and 5 is the least common problem. Use a "0" to indicate there is not a problem.

Rank	Problem
_____	On-street parking
_____	Inadequate budget
_____	Untrained or poorly trained operators
_____	Poor street conditions
_____	Older or ineffective sweeping technology
_____	Others (please specify AND rank):
_____	_____
_____	_____
_____	_____

From: *Technical Memorandum Task 2 survey*

Table 3. Common problems that affect the performance of street sweeping programs in the Chesapeake Bay								
Problem		Percent Importance of problem from least (0) to most (5)						
		0	1	2	3	4	5	NR**
Phase I (n=16)*	On-street parking	0	43.8	18.8	12.5	0.0	6.3	18.8
	Inadequate budget	6.3	37.5	12.5	6.3	6.3	12.5	18.8
	Untrained or poorly-trained operators	31.3	0.0	0	6.3	12.5	25	25.0
	Poor street conditions	25.0	0.0	0	12.5	25.0	0.0	37.5
	Older or ineffective sweeping technology	31.3	0.0	6.3	12.5	12.5	6.3	31.3
	Other		equipment breakdown	Leaf piles; equipment problems	weather			
Phase II (n=4)*	On-street parking	0	50	25	25	0	0	0
	Inadequate budget	25	25	0	0	0	25	25
	Untrained or poorly-trained operators	25	0	0	0	0	25	50
	Poor street conditions	25	0	0	0	0	25	50
	Older or ineffective sweeping technology	50	0	0	0	0	25	25
	Other	0	0	0	0	0	0	0
Notes: All 16 Phase I communities within the Chesapeake Bay indicated one of the above problems. *n = number of communities that have reported the problem. **NR = no response								

20. Do you have a training program for street sweeper operators?

- Yes – **14**
- No – **8**
- No Answer – **4**
- NA – **1**

➡ If so, please attach any education or training material used.

21. What is the source(s) of funding to support the street sweeping program?

Funding sources	
Budget	17
Grants	1
Utility Fee	7
No answer	2

22. Please provide an estimate for each of the 4 areas or total annual expenditure to conduct your street sweeping program? *Total annual expenditure* \$ _____

- 1) Labor \$ _____ 3) Equipment \$ _____
 2) Training \$ _____ 4) Maintenance \$ _____

Annual expenditure					
Total annual expenditure	1) Labor	2) Training	3) Equip	4) Maint.	5) Other
221,000	150,000	1000	50000	20000	
27,884.25	7,854.25				20,000
2,000,000	1,100,000	5,000	400,000	300,000	
891318	439088	0	412713	39517	
413,000	149,000	2,300		179,000	
213,000	150,000	0	50,000	13,000	
696,179.61	341,811.61			354,368	
149,458.20	50,953.29		60,438.91	38,066	
2,800,000					
320,000					
2,880,000					
400,000					
1,451,667					
1,500,000					
547,715.93	152,330.22	in house	295,007.65	100,378.06	
820,000	574000	41000	82000	123000	
103413	86521			16892	
60,000					
2,000,000					
487,000	207,000	20,000	260,000 for both equip and maintenance		
77,000					
400,000					
212,000					

23. Do you have any data on the average sweeping cost per mile?

- Yes – **9**
- No – **10**
- No Answer – **8**

➡ If so, please attach any information you may have or provide the cost estimate.

F. STORM DRAIN CLEANOUT PROGRAM

This set of questions asks about the nature of the current storm drain cleanout program. Following the questions, please circle to indicate if your answer pertains to storm drains, inlets or both, where indicated.

24. Does your community clean out storm drains and/or inlets?

- Yes, cleanouts are regularly scheduled - **10**
- Yes, but only in response to complaints or clogging problems - **12**
- No
- No Answer - **5**

If you answered NO, GO TO Section D

25. Estimate how many storm drains and/or inlets are cleaned out annually in your community, OR select a range from the following list.

_____ storm drain _____ inlet _____ both

- 1 – 500
- 501 – 2000
- 2,001 – 5,000
- 5001 – 10,000
- more than 10,000

Estimated number of storm drains/ inlets cleaned out annually						
storm drains	114,083 l.ft.	54,000 l.ft.	100,000			
# inlets		1,379	680	28,500	9,500	600
# both	494	70,708	2,684	4,700	755	1,800

Storm drains cleaned out annually			
Range of storm drains	# storm drains	# inlets	# both
(1-500)		3	1
(501-2000)		3	4
(2001-5000)	2	1	
(5001-10,000)	1	1	
more than 10,000	1		1

26. Estimate the total proportion of all storm drains and/or inlets that are cleaned out on an annual basis? _____% **storm drain** **inlet** **both**

storm drains	0
inlets	7
both	12
no answer	7

% cleaned 1x/yr
33
20
51
100
20
75
0.2
100
5
26
50
20
20
87
4.5
3
5
40-60
100
1
2

27. Based on the storm drains and/or inlets that are cleaned out, what is the typical clean out frequency? **Storm drain inlet both**

- Seldom, if ever
- Once every 3 to 5 years
- Once every 2 years
- Once a year
- Twice a year
- Other (please specify): _____

Clean Out Frequency						
Range		# of each from total surveys	storm drain	inlet	both	unknown
1	Seldom, if ever	4		2	2	
2	Once every 3 to 5 years	6		1	2	3
3	Once every 2 years	6		3	2	1
4	Once a year	3		2		1
5	Twice a year	0				
6	Other (please specify):	6 total: 2 as needed, 1 based on complaints, 3 other reasons unknown		1	4	1
	No answer	1				
	Unknown	1				

28. Please select from the list what equipment is most commonly used to cleanout storm drains and/or inlets. Check all that apply. **Storm drain inlet both**

- Manual
- Hydraulic-suction cleaner
- Vacuum
- Bucket Loaders
- Other (please specify) _____

Common cleaning equipment used for:			
storm drain	inlet	both	no answer
0	8	14	5

Common Cleaning Equipment	
Manual	12
Hydraulic-suction	9
Vacuum	14
Bucket Loaders	5
Other	4, contractor (vacuum); VacCon pipe washer/ sewer cleaner; sewer jet/vac; excavator

29. Please indicate the number of each type of equipment used to clean out storm drains and/or inlets in your community. **Storm drain inlet both**

- Hydraulic-suction cleaner
- Vacuum
- Bucket Loaders
- Other (please specify): _____

Type of equipment used for:			
storm drain	inlet	both	no answer
0	6	12	9

Number of cleaning equipment	
Hydraulic-suction cleaner	22
Vacuum	27
Bucket Loaders	133
Other	12; 8 unspecified, 3 sewer jet, & 1 manual vacuum

30. Do you have a database (e.g. Excel, Access, or GIS) to track the location and/or maintenance of the storm drains and/or inlets in your community?

- Yes – **14**
- No – **8**
- No Answer – **5**

31. Are your crews trained to report water quality problems and illicit discharges they see when they are cleaning?

- Yes – **21**
- No – **5**
- No Answer – **1**

32. What is the average volume of material removed per cleanout? (please specify units of measurement, cubic yards, ton, etc.)

Amount of material removed from storm drains is estimated as _____

Amount of material removed from inlets is estimated as _____

Amount of material removed from storm drains and inlets is estimated as _____

- Don't know

Average volume of material removed per cleanout	
Participating Communities (x)	
Material removed from storm drains (1)	1.5 yds ³
Material removed from inlets (1)	10-20 ton/year
Material removed from storm drains and inlets (6)	52.3 tons/yr, 250 tons/yr, 900 tons/yr, 12.42 yds ³ , 0.5 yds ³ , 0.1 yds ³
Don't know (15)	
No answer (4)	

Please provide any comments that may clarify your answer:

33. Briefly describe how you dispose of the material collected from storm drain and/or inlet cleanouts.

Disposal of material	
landfill	21
unknown	1
no answer	6

34. What is the source(s) of funding to support the storm drain cleanout program?

Sources of funding for storm drain cleanout	
budget	15
tax	2
utility fee	8
no answer	2

35. What is the best estimate of annual expenditure for the storm drain cleanout program, to include inlets (labor, equipment, etc.)?

_____ Total cost/year
 _____ Cost per storm drain cleanout
 _____ Other cost (please specify)
 _____ Check if you don't know

Estimated annual expenditure		
Total	Per storm drain cleanout	Other
\$250,162.58	\$1.39/l.f.	\$66.10 each
\$75,000.00		\$110/inlet
\$137,236.81	51.04	
\$400K		
\$908,000		
\$150,000		
1 mil/yr		
\$1.1 mil/yr		
\$375,000	415.56	
2 mil		
\$398,000		
\$200,000		
\$50,000		

Estimated annual expenditure	
Don't know	9
No answer	4

G. MONITORING AND DATA COLLECTION

36. Please check from the list below all statements that best describe the purpose of the street sweeping program and storm drain cleanout program. **CIRCLE** if the statement applies to street sweeping and/or storm drain cleanout program. If none of the statements match your program, please use the space provided after the question to briefly describe the program purpose.

- | | | |
|---|-----------------|----------|
| <input type="checkbox"/> Aesthetics | Street Sweeping | Cleanout |
| <input type="checkbox"/> Public Health and Safety | Street Sweeping | Cleanout |
| <input type="checkbox"/> Keep materials out of storm drains | Street Sweeping | Cleanout |
| <input type="checkbox"/> Stormwater permit requirement | Street Sweeping | Cleanout |
| <input type="checkbox"/> Water quality improvement | Street Sweeping | Cleanout |
| <input type="checkbox"/> Street and road safety | Street Sweeping | Cleanout |
| <input type="checkbox"/> Residential demand | Street Sweeping | Cleanout |
| <input type="checkbox"/> Other: | | |

Purpose of street sweeping and storm drain clean out program for 27 participating communities				
	street sweeping	clean out	both	no answer
Aesthetics	15	1	7	4
Public Health and Safety	3	5	11	8
Keep materials out of storm drains	8	2	12	5
Storm water permit requirement	1	2	12	12
Water quality improvement	1	2	13	11
Street and road safety	6	2	13	6
Residential demand	6	1	16	4
Other	Flood control 2 - ID 11 & 27			

37. Do you have any measures or indicators to quantify the effectiveness of your street sweeping and storm drain cleanout programs?

- Yes - **16**
- No - **11**

41. Do you compute a nutrient or pollutant removal rate for street sweeping and storm drain cleanout activities as part of your annual NPDES stormwater requirements?

Communities who compute a nutrient or pollutant removal rate for street sweeping and storm drain cleanout activities as part of your annual NPDES stormwater requirements	
yes	3
no	20
no answer	1
NA	2
not current	1

➔ Please attach a sample calculation, or in the space provided below describe the data or equation used to determine the nutrient removal efficiency.

Thank you for completing the survey. Please return the completed survey in the envelope provided, to:

Neely L. Law and Tiffany Wright
 Center for Watershed Protection
 8390 Main Street, 2nd Floor
 Ellicott City, MD 20143
 Re. Street Sweeping Storm Drain Cleanout Survey

SURVEY CHECKLIST

In addition to the completed survey, we asked you to provide the following additional information.

- ___ Question 18: Quantity of material collected from street sweeping
- ___ Question 20: Education or training material
- ___ Question 23: Cost estimate per mile for street sweeping
- ___ Question 41: Sample calculation for pollutant removal efficiency
- ___ Most recent NPDES Annual Report