Design Specifications and Nutrient Accounting for Storm Drain Cleanout

I. Summary

A. Description:

The practice of Storm Drain Cleanout involves the periodic removal of gross solids from storm drain catch basins. Gross solids may include organic debris, litter, or coarse sediments. Gross solids may be collected from unaltered catch basins, or catch basins with gross solids collection devices installed. Devices are designed to alter catch basins such that they store more gross solids than unaltered catch basins. To determine the nutrient removal credit, the wet weight of gross solids removed is converted to a representative labile weight of nitrogen and phosphorus removed from the system.

B. Utility:

The practice is potentially useful in any stormwater collection setting involving structural inlets and may also provide ancillary pollutant removal benefits. Credit is directly quantified, proportional to the amount of gross solids collected. Targeted placement of collection devices in storm drains receiving the greatest gross solids loads can increase practice efficiency. This would include areas with the greatest tree canopy or outfalls with the highest sediment or debris loads.

C. Applicability

This practice applies toward compliance with Existing Development rules and may be implemented by local governments. Use in new development settings would require adoption of the practice by the NC Division of Energy, Mineral and Land Resources stormwater permitting program.

D. Credit Overview

To obtain nutrient reduction credits for this practice, the wet weight of gross solids collected is measured, and conversion factors of 0.00207lb T N/lb and 0.00014lb TP/ lb of wet weight gross solids are applied to determine the weight of labile N and P removed from the system. Gross solids collection shall occur at a (target) minimum frequency of every 3 months to avoid leaching significant amounts of nitrogen or phosphorus and thereby merit the assigned credit factors (though this frequency is watershed dependent)

II. Practice Design and Implementation

A. Qualifying Conditions and Limitations

1. Preconditions

- Practice requires the facilities to transport and weigh removed solids.
- It also requires a sound and lawful method for disposal of the collected solids.

2. Practice Constraints

- This nutrient reduction practice does not include credit for materials collected via street sweeping, streetside leaf pickup, instream devices, or removal of leaves and other gross solids from ditches, gutters, or swales.
- A storm drain gross solids collection system shall not be placed in a manner which inhibits the passage of aquatic organisms in intermittent or perennial streams, particularly during low flow conditions.
- To receive credit, a storm drain collection system shall not be placed in a manner that solids will remain soaking or be continually flushed between rain events.

B. Design Guidance

1. Required Elements

For flood-prone locations, hydraulic analysis shall be performed to ensure that the practice does not exacerbate conditions.

2. Recommended Elements

Collection devices used may be commercially available proprietary devices, each with its own manufacturer guidelines for installation, maintenance, and operation. Local governments are responsible for evaluating any device used for flooding or other safety concerns. The credit provided in this practice guidance is based on the study of 3 different devices: Trash Guard by Trash Guard Inc., Storm Basin by Fabco, Storm Sack by Fabco.

C. Installation/Implementation

1. Required Elements

None.

2. Recommended Elements

- Local governments are encouraged to evaluate and consider following the manufacturers' guidelines for storm drain gross solids collection devices.
- Programs may want to target placement of storm drains to inlets that receive the greatest amount of organic matter to maximize cost-effectiveness. These would include drainage areas with the greatest tree canopy or the highest sediment or debris loads, which may be

influenced by tree canopy area, leaf area index, tree species, and stormwater flow, among other variables.

- Sag points are most likely to have localized flooding.

D. Operation and Maintenance

1. Required Elements

- Initially, devices shall be field-checked for collection need, and harvested as needed, no less frequently than every 3 months. A program may develop a record of seasonal accumulation with which it then designs a modified field-checking and harvesting schedule. It shall obtain Division approval for such a schedule prior to implementing.
- Solids shall be weighed wet as soon as practicable following collection..
- Solids shall be disposed of in a manner approved by the NC Division of Waste Management that prevents them and associated nutrients from reaching surface waters.

2. Recommended Elements

- Local governments are encouraged to follow manufacturers operation and maintenance guidelines for commercial devices.
- Local governments should establish a standard operating procedure regarding staff training, prioritizing locations, collection methods, frequency, tracking, reporting, verification, disposal, equipment maintenance, and other program elements discussed below.
- Research from NCSU recommends collection devices be inspected (and potentially maintained and emptied) every 1-2 months and before and after major storm events such as tropical storms.
- More frequent collection from a given unit may yield greater annual biomass as well as preserve higher unit-mass nutrient concentrations if a program is interested in evaluating nutrient content.
- Collection frequency may need to be optimized in relation to tree canopy, operating costs, staff costs, return on investment for equipment, flooding, street sweeping, and resident complaints.

E. Credit Award and Renewal

This is a retrospective credit that shall be calculated for each collection and totaled for the year. To receive nutrient reduction credit, the local government shall submit annual records to DWR which include:

- the number of sites, types of devices, and frequencies of cleaning
- the wet weight gross solids collected per collection, per site, and the annual total,
- the total pounds of labile N and P removed per collection, per site, and the annual total,
- custom conversion factors (needed for the above bullet) and supporting documentation (if used). Custom conversion factors of wet mass to nutrient mass may be developed based on laboratory analysis and proposed for use in place of the factors provided. Contact DWR if you are interested in developing custom conversion factors.

III. Nutrient Credit Estimation

A. Credit Method Description

The credit calculation involves the simple application of N and P mass conversion factors from the wet weight of gross solids collected regardless of solids composition. Gross solids can include organic matter, litter, and coarse sediments. Leaf litter can contain concentrations of 0.41% - 1.04% TN and 0.08% - 0.29% TP. (Rogers, 2017)

B. Calculation Instructions

The following equation shall be used to determine N and P removal credit for a given collection.

$$RC = W \times F$$

Where:

- RC = Reduction credit (lbs of nutrient) $RC_{N\ or}\ RC_P$
- W = Wet Weight of collected gross solids (lbs of debris)
- F = Conversion factor (lbs nutrient/lbs debris) F_N or F_P (Table 1)

Table 1: Gross Solids Nutrient Conversion Factors (F) (Waickowski, 2015)

$$F_N = \frac{0.00207 \text{ lb TN}}{\text{lb wet debris}}$$

$$F_P = \frac{0.00014 \text{ lb TP}}{\text{lb wet debris}}$$

IV. Supporting Technical Information

A. Reductions Obtained

Based on the studies used for this credit (Waickowski 2015; Rogers et al. 2017) the range of nutrient reductions that may be expected range from 0.10 to 11 lb/ac/yr for labile TN and from 0.01 to 1 lb/ac/yr for labile TP. Data collected from Rogers et al. (2017) determined the capture efficiencies for gross solids collection devices, and data from Waickowski (2015) identified the pollutant loading rates for gross solids. Ranges are function of the collection device efficiency, tree canopy, season, drainage area, and rainfall intensity.

B. Credit Basis and Relative Confidence

Overall, relative confidence in the reductions estimated for the practice is moderate. The studies supporting this practice have high levels of confidence in the loading source, study sites, real-world adaptation, nutrient measurements, and data analysis, but only two replicates of each device were conducted with only a fraction of year of monitoring.

This credit is based on field studies by Waickowski, 2015 and Rogers et al., 2017. Four Piedmont and Coastal Plain cities were used with drainage basins incorporating high and low density housing as well as urban/downtown sites. Municipal officials assisted with site selection. Only one type (curb throat) storm drain inlet was used. This established loading rates.

To determine gross solids collection device efficiency, five devices were installed and sampled for 3-7 months each in Cary, spanning different parts of the year. Annual ranges of nutrient reductions were not developed from the available information given recognition of seasonal leaf fall and collection differences. All the devices studied were successful in capturing 50% - 75% of gross solids.

Previous studies, Donner, 2016 and Stack, 2013, assigned nutrient content based on % organic matter and % sediment found in the collected samples. Waickowski determined the relative nutrient content based on the entire collected debris sample. While assignment of different conversion factors for organic and mineral fractions is technically preferable, in practice it appears that separation of these fractions for weighing would prove practically infeasible.

Differences in monitoring periods complicated overall assessment of the practice. Seasonal variations in leaf-drop are not accounted for because the data collection range does not span a full year for each device.

C. Cost Analysis

Costs were not included in the scope of the studies used. The following qualitative factors may be worth considering in undertaking this practice. Costs incurred from any storm drain cleaning programs, whether collection devices are involved, include staff time such as field verification of sites, monitoring, maintenance, collection, weighing, and disposal. Vacuum trucks, their purchase, operation and maintenance, are a significant program cost. Already owning a vacuum truck is a distinct advantage in set up cost. Some communities may find private contractors an economically viable alternative to vacuum truck purchase.

Concentrating efforts at locations where the highest nutrient loads can be collected per trip can improve the economy of scale of the program. A first step toward identifying these locations may be in records of flooding, complaints, and responses.

As a local government program progresses and gathers data, its records may help to fine tune the collection frequency at sites to optimize harvest, or to suggest that devices can be removed and redeployed to other sites, improving efficiency and thereby reducing costs.

D. Risks and Benefits

Potential benefits of storm drain cleaning beyond nutrient credit include: reduced flooding, reduced property damage, reduced customer complaints, reduced litter in streams, increased awareness of system problems, and reduced organic matter and sediment in streams which can reduce scouring and improve habitat.

Potential risks may include increased risk of flooding if collection schedules are not held to.

E. References & Resources

Donner, Sebastian. Frost, Bill. Goulet, Mary Hurd. et.al. 2016. Recommendations of the Expert Panel to define Removal Rates for Street and Strom Drain Cleaning Practices. Final Report

Stack, B. Law, N and Drescher, S. 2013. Gross solids Characterization Study in the Tred Avon Watershed, Talbot County, MD. Prepared by the Center for Watershed Protection as fulfillment of the Chesapeake and Atlantic Coastal Bay Trust Fund 14-11-1415 TRF08 and Tred Avon Local Implementation Grant FY 2011.

Tetra Tech. 2013. North Carolina Piedmont Nutrient Load Reducing Measures Technical Report. Report Submitted to Division of Water Resources, September 2013.

Waickowski, S.E. 2015. Gross Solids in Urban Catch Basins: A Pollutant Accounting Opportunity? (Master's thesis). Retrieved from http://www.lib.ncsu.edu/resolver/1840.16/10611

Rogers, L.R. Carey, E.S. Waickowski, S.E. 2017. Gross Solids and Catch Basin Inserts: A Comparison of Multiple Products - Evaluation of Gross Solids Proprietary Devices. March 2017.

F. Credit Development Documentation

Table 2: Wet Weight Gross Solids Labile N and P Collected (Waickowski 2015; Rogers et al. 2017)

Location	Land Use	50% Capture Efficiency			75% Capture Efficiency		
		Collected Debris (lb/ac/yr)	Labile N Collected (lb/ac/yr)	Labile P Collected (lb/ac/yr)	Collected Debris (lb/ac/yr)	Labile N Collected (lb/ac/yr)	Labile P Collected (lb/ac/yr)
Burlington	High-Density	106.62	0.22	0.01	159.93	0.33	0.02
	Low-Density Old	557.32	1.15	0.08	835.98	1.73	0.12
	Low-Density New	85.40	0.18	0.01	128.10	0.27	0.02
	Downtown	674.48	1.40	0.09	1011.71	2.09	0.14
Greensboro	High-Density	138.80	0.29	0.02	208.20	0.43	0.03
	Low-Density Old	6303.08	13.05	0.88	9454.63	19.57	1.32
	Low-Density New	843.92	1.75	0.12	1265.88	2.62	0.18
	Downtown	2013.31	4.17	0.28	3019.96	6.25	0.42
Raleigh	High-Density	694.68	1.44	0.10	1042.01	2.16	0.15
	Low-Density Old	2980.96	6.17	0.42	4471.44	9.26	0.63
	Low-Density New	1656.26	3.43	0.23	2484.39	5.14	0.35
	Downtown	3751.14	7.76	0.53	5626.71	11.65	0.79
Wilmington	High-Density	2786.82	5.77	0.39	4180.23	8.65	0.59
	Low-Density Old	885.28	1.83	0.12	1327.92	2.75	0.19
	Low-Density New	949.33	1.97	0.13	1423.99	2.95	0.20
	Downtown	1682.33	3.48	0.24	2523.50	5.22	0.35