PVCC
PIEDMONT VIRGINIA COMMUNITY COLLEGE
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PVCC Rivanna River TMDL Action Plan

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This Action Plan is developed to address Part II.B.1a, 3 and 5 of the Commonwealth's General VPDES Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems. This Action Plan is developed for consistency with the *Benthic TMDL Development for the Rivanna River Watershed, Final Report (dated March 2008),* EPA approval date June 11, 2008.

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Appendices

Executive Summary

Piedmont Virginia Community College (PVCC) is permitted to discharge stormwater from the college's municipal separate storm sewer system (MS4) by maintaining coverage under the General Virginia Pollutant Discharge Elimination System (VPDES) Permit for Discharges of Stormwater from Small MS4s (MS4 General Permit). In part, the MS4 General Permit requires the college to meet special conditions for Total Maximum Daily Load (TMDL) when the college has been assigned a waste load allocation (WLA). PVCC has been assigned a WLA in an Environmental Protection Agency (EPA) approved total maximum daily load (TMDL) for the Rivanna River, necessitating the development and implementation of this Action Plan. The WLA requires PVCC implement best management practices to reduce 3.14 tons/year of sediment discharge from the college's MS4.

This Action Plan includes the specific information required by the MS4 General Permit. This plan provides background of the TMDL purpose and development specific to PVCC and quantification of the required annual sediment reductions. Assessment of BMP options finds continued implementation of the college's street sweeping program achieves the required annual reduction to satisfy the WLA. Effectiveness and quantification of pollutant reduction from street sweeping is supported with results of a study within which PVCC continues to participate with other MS4s in the Commonwealth to analyze swept material and characterize the fraction of swept material that is removed from stormwater. Changes to this plan may occur, as necessary, as part of an iterative process to ensure the sediment reduction target is achieved. Updates will ensure annual reporting regarding plan implementation.

1.0 Introduction

PVCC has developed, maintains, implements and enforces a municipal separate storm sewer system (MS4) program designed to reduce the discharge of pollutants from the college's MS4 to the maximum extent practicable (MEP). The program is designed in accordance with the *General Virginia Pollutant Discharge Elimination System (VPDES) Permit for Discharges of Stormwater from Small MS4s*, also known as the MS4 General Permit. The program is intended to protect water quality and to satisfy the water quality requirements of the State Water Control Law and its attendant regulations. PVCC utilizes the legal authority provided by the laws and regulations of the Commonwealth of Virginia to control discharges, into and from, the college's MS4 consistent with the MS4 General Permit, college policies and specific contract language, as applicable.

Compliance with the MS4 General Permit is dependent on the implementation of best management practices (BMPs) to address the requirements described in the permit, including special conditions associated with applicable total maximum daily loads (TMDLs). A TMDL is a study producing a calculation of the maximum amount of an impairing pollutant allowed to enter a waterbody so that the waterbody will meet and maintain water quality standards. A TMDL assigns pollutant reduction targets and allocates allowable loadings of the pollutant(s) to point source discharges, including discharges from regulated MS4s. The allocations to MS4s, known as waste load allocations (WLAs), represent the amount of the pollutant the MS4 permittee is allowed to discharge annually, often translated to a percent reduction of the existing annual pollutant loading, as calculated by the TMDL. PVCC has been assigned a WLA in an Environmental Protection Agency (EPA) approved total maximum daily load (TMDL) for the Rivanna River.

The Louis Berger Group, Inc., prepared the report entitled "Benthic TMDL Development for the Rivanna River Watershed," approved by the EPA on June 11, 2008. The TMDL was developed as required by Section 303(d) of the Clean Water Act (CWA) and the EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) since segments of the Rivanna River had been listed as impaired on Virginia's Section 303(d) Report of Impaired Waters (see Figure 1). The impairment designation is due to violations of the general aquatic life (benthic) standards, with the most probable stressor identified as excessive sediment due to higher runoff flows.

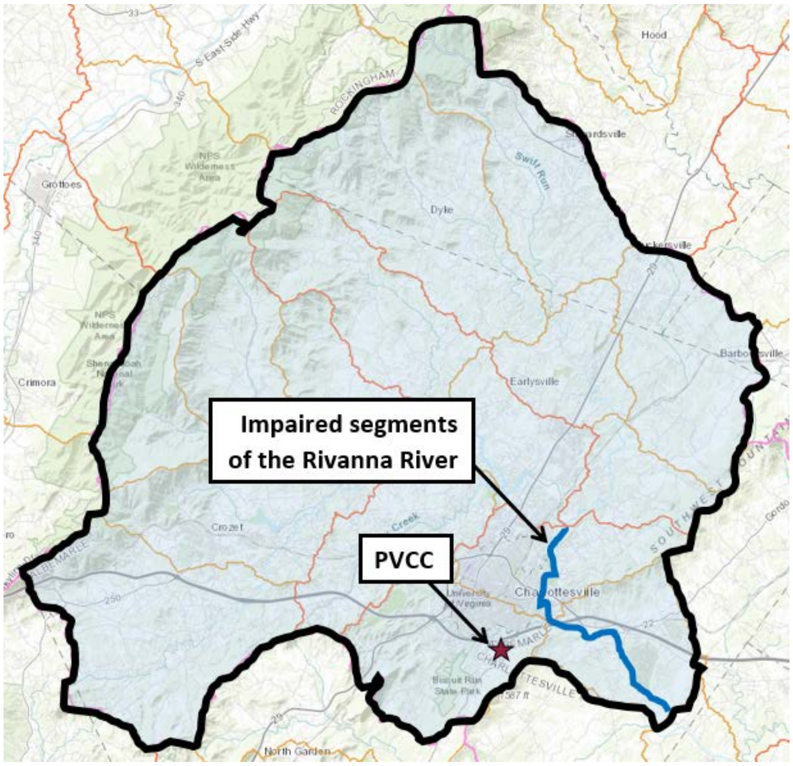

Figure 1. Rivanna River TMDL watershed.

As a result of the assignment of a WLA, the college is required to develop and implement a TMDL Action Plan. This plan updates, and replaces, a previously developed PVCC Action Plan for the Rivanna River for consistency with the current MS4 General Permit. For consistency, this action plan is required to include the following:

- ✓ TMDL Project Name and EPA approval date (**Project name is the name of this Action Plan and EPA approval date is provided on the Cover and Page 1**);
- ✓ The WLA allocation and the corresponding percent reduction (**Section 2.2**);
- ✓ Identification of the significant sources of sediment discharging to the college's MS4 (**Section 2.3**);
- ✓ The BMPs designed to reduce sediment, including a calculation of the anticipated load reduction achieved from each BMP and the anticipated end date that the WLA will be achieved (**Sections 3 and 4**);
- ✓ Schedule of anticipated actions planned for implementation during the permit term (**Section 4.3**); and an
- ✓ Outreach strategy to enhance the public's education on methods to eliminate and reduce discharges of sediment (**Section 4.4**).

2.0 MS4 Sediment Discharge Characterization

The annual sediment load discharged from PVCC's regulated MS4 area and the required annual reduction per the "Benthic TMDL Development for the Rivanna River Watershed" are provided in this Section. Since the specified WLA, as mass of daily allocated load, is provided by the TMDL in aggregate for all of the MS4-regulated areas in the watershed (Albemarle County, the City of Charlottesville, the University of Virginia, PVCC and VDOT), the percent reduction specified by the TMDL for regulated MS4s of 59.3% is used to determine the required annual sediment reductions based on the sediment loadings from the campus.

2.1 Sediment Loadings

TMDL studies use modeling efforts to estimate pollutant loadings from the land surfaces within a watershed, as is the case with the "Benthic TMDL Development for the Rivanna River Watershed." Land use information that served as a data input for generating sediment loadings was from the National Land Cover Database (NLCD 2001) with updates provided by developing a hybrid of the NLCD (2001) data by incorporating land use data developed by the Virginia Department of Forestry in 2005 (see Figure 2).

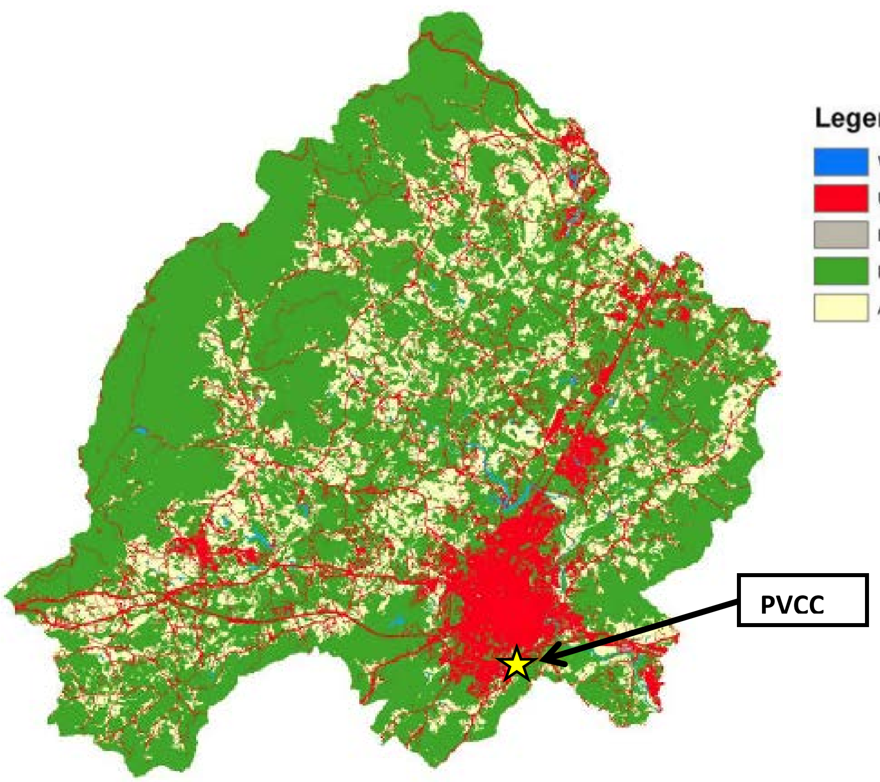

Figure 2. NLCD (2001) – DOF 2005 Land Use data used for the TMDL.

To separate sediment loadings attributed to MS4s from other land-based sediment loading, an area weighted sediment load was determined for the MS4s, in which the percentage of sediment loading from each source area attributed to the MS4s was proportional to the percentage of that source acres in the Rivanna River impaired watershed covered by the various MS4 permits. The land use types used to define model source areas, and proportions within the watershed, shown in Table 1.

Table 1. Land use categories within the Rivanna River watershed.

General Land Use Category	Land Use Area in the Overall Watershed (acres)	Percentage in Watershed
Water/Wetlands	2,720	0.8%
Developed	48,295	14.7%
Agriculture	68,583	20.8%
Forest	209,502	63.6%
Barren	56	0.2%
Totals =	329,156	100%

The TMDL estimates an existing land based sediment load of 7 lbs/day from the PVCC MS4 regulates area. In addition to land based sediment loading, the TMDL also estimates existing (baseline) instream erosion loadings, estimating 21 lbs/day for PVCC. Therefore, the total existing (baseline) sediment load defined in the "Benthic TMDL Development for the Rivanna River Watershed" for PVCC is:

$$Land\ Based\ Load\ \left(\frac{lbs}{day}\right) + Instream\ Erosion\ \left(\frac{lbs}{day}\right) = Baseline\ Load\ \left(\frac{lbs}{day}\right)$$

$$7\ \left(\frac{lbs}{day}\right) + 21\ \left(\frac{lbs}{day}\right) = 28\ \left(\frac{lbs}{day}\right); or$$

$$29\ \left(\frac{lbs}{day}\right) as\ specified\ in\ TMDL\ apparently\ due\ to\ significant\ figures\ (not\ provided).$$

$$\boldsymbol{Annual\ PVCC\ Loading: 29\ \left(\frac{lbs}{day}\right) \times 365\ days = 10,585\ \left(\frac{lbs}{yr}\right) or\ 5.29\ (\frac{tons}{year})}$$

It is noted that PVCC has TMDL Action Plans for two other TMDLs that require sediment reductions from the colleges MS4. The Action Plans are to address WLAs for the Moores Creek Sediment TMDL and the Chesapeake Bay TMDL. Each of these EPA-approved TMDLs use different methods, models and data sources for generating sediment loadings from the college, resulting in varied estimations, as summarized in **Table 2**. With the intent to be consistent with the Rivanna River TMDL for this action plan, the value of 5.29 tons/yr, from the calculations on the previous page, is used for the purposes of determining required reductions. However, the values in **Table 2**, along with sediment reductions required by the other TMDLs, are used for comparison purposes since sediment reductions achieved to address the Chesapeake Bay TMDL can also be applied to address sediment reductions required for local TMDLs.

Table 2. Comparison of modeled annual sediment loadings from the PVCC MS4 regulated area for the three TMDLs that assign PVCC a WLA.

TMDL	TMDL Modeled Sediment Loading (tons/yr)[1]	Area Modeled as Regulated (acres)	Land Use Data Source Notes
Chesapeake Bay	8.81	63.72[2]	Specified loading rate per acre based on detailed delineation of imperious and pervious cover
Rivanna River	5.29	95.00	NLCD (2001) Land Use Data Supplemented with the 2005 DOF data – Refer to Figure 2
Moores Creek	17.26	48.88	RRBC (2009)[3]

[1] From PVCC action plans for each TMDL based on the respective TMDLs, themselves.
[2] Actual regulated area based on detailed delineation.
[3] 2009 Rivanna River Basin Commission's Rivanna Watershed and Vicinity Land Use/Land Cover Map Geodatabase (RRBC, 2009). Refer to the PVCC Moores Creek TMDL Action Plan for additional information.

2.2 Required Annual Pollutant Reductions to Achieve the WLA

The "Benthic TMDL Development for the Rivanna River Watershed" WLA requires a 59.3% reduction of the modeled (baseline) loadings presented in the TMDL of 5.29 tons/year. The annual required reduction is then computed as follows:

$$\textit{Annual Required Reduction}: 5.29 \left(\frac{tons}{year}\right) \times 0.593 = 3.14 \left(\frac{tons}{year}\right)$$

For comparison, the required annual sediment reductions required by PVCC for other applicable TMDLs with assigned WLAs are provided in **Table 3**. As observed from the Table, although the Rivanna River TMDL requires a much higher percent reduction in sediment from the campus (59.3%), the required reduction is comparable (±20% higher) to the required reduction for the Moores Creek TMDL. This is a result of the annual sediment loadings modeled by the Moores Creek TMDL for PVCC being approximately 70% higher than those modeled by the Rivanna River TMDL. Based on the comparison in **Table 3**, achieving the Chesapeake Bay TMDL WLA for sediment also would achieve the WLA for the Rivanna River TMDL.

Table 3. Comparison of required sediment reduction to achieve the targets for the three TMDLs that assign PVCC a WLA.

TMDL	WLA (percent reduction)	Required Sediment Reduction to Achieve WLA (tons/year)
Chesapeake Bay	20% and 8.75% from impervious and pervious cover, respectively	3.80[1]
Rivanna River	**59.3%**	**3.14**
Moores Creek	14.6%	2.52[2]

[1] Represents annual sediment reduction required by 2028.
[2] Generated from aggregated MS4 WLAs in Table 6-5 of the Moores Creek TMDL.

2.3 Identification of Significant Sources of Sediment

The MS4 General Permit requires this Action Plan identify significant sources of sediment discharging to PVCC's MS4. The permit defines a "significant source" of sediment as a discharge where the expected pollutant loading is greater than the average sediment loading for the land use identified in the TMDL. A field inspection of the PVCC campus did not identify any significant source of sediment where sediment discharge would be expected to be greater than the average sediment loading for each land use identified in the Rivanna River TMDL. Potential for a significant source may exist within areas of campus where campus maintenance operations occur, such as stockpiling areas, which could potentially release sediment into stormwater runoff. However, the PVCC Good Housekeeping and Pollution Prevention Manual, along with staff training, addresses these concerns with the implementation of best management practices.

3.0 Methods to Achieve the WLA

Pollutant reductions from stormwater discharge can be achieved using a variety of practices and methods. Selection of the appropriate practices and methods is dependent on variables such as physical opportunities, the scale of required reductions and cost effectiveness. This Section discusses the various options available and identifies the methods designed to reduce sediment to achieve the WLA.

3.1 BMP Options

The MS4 General Permit requires PVCC to reduce the pollutant identified in the WLA through implementation of any of the following:

- One or more of the BMPs from the Virginia Stormwater BMP Clearinghouse (BMP listed in **Table 4)**;
- One or more BMPs approved by the Chesapeake Bay Program (see **Table 5**); and/or
- Land disturbance thresholds lower than Virginia's regulatory requirements for erosion and sediment control and post development stormwater management. (This option is associated with development and provided limited opportunities for PVCC.)

Table 4. BMPs from the Virginia Stormwater BMP Clearinghouse.

• Vegetated Roof	• Wet Swale
• Rooftop Disconnection	• Sheet Flow to Filter/Open Space
• Rainwater Harvesting	• Extended Detention Pond
• Soil Amendments	• Filtering Practice
• Permeable Pavement	• Constructed Wetland
• Grass Channel	• Wet Pond
• Bioretention	• Proprietary Hydrodynamic Devices
• Infiltration	• Proprietary Filtering Devices
• Dry Swale	

The BMPs listed in **Table 4** are mostly known as “structural” BMPs and can provide pollutant reduction from runoff generated from a contributing drainage area. These types of BMPs are typically employed to address stormwater management regulations associated with land development. These BMPs are not efficient towards addressing pollutant load reductions at the scale of a watershed associated with WLAs since they treat discreet areas, limiting their upper threshold of pollution reduction. For example, in the conservative case of a high performing structural BMP that removes 75% of sediment from the contributing drainage area, 12.4 acres of impervious area would need to be directed to the BMP(s) to achieve the reductions required to achieve PVCCs Rivanna River TMDL WLA (based on an impervious area loading rate of 676.94 lbs/ac/yr per the MS4 General Permit for the James River Basin.). Due to physical constraints, this scenario would be challenging, if not impossible, at the PVCC campus. Although structural BMPs could provide a portion of the required reductions, these options are considered as a last resort if the full WLA could not be achieved with other options.

The BMPs listed in **Table 5** are those approved by the Chesapeake Bay Program and provide additional opportunities other than the construction of new structural BMPs. However, several of the options are associated with structural BMPs, such as retrofits and enhancements of existing structural BMPs and the oversizing of BMPs associated with development. These options have similar limitations towards achieving significant pollutant reductions as the structural BMPs, themselves. Of the remaining options, there are not practical opportunities for forest buffers and urban stream restoration on campus. The remaining opportunities include: (1) street sweeping and (2) land use change. In regards to land use change on campus, the only likely scenario would be transition from pervious areas to forest. To achieve the WLA with land use change, nearly 109 acres would need to be converted from grass to forest (based on 57.82 lbs/ac/yr for the conversion as credited in DEQ guidance). This finding demonstrates land use change would have a very limited impact towards achieving the WLA for PVCC since area available would be limited to no more than 10-15 acres. Further, transition of pervious areas to forest would be undesirable since it could impede future development on the college campus. As a result, street sweeping is selected as the primary BMP towards achieving PVCC's WLA.

Table 5. Additional BMPs approved by the Chesapeake Bay Program.

• BMP Retrofits	• Land Use Change
• BMP Enhancements	• Forest Buffers
• Oversizing Development BMPs	• Urban Stream Restoration
• Street Sweeping	

3.2 Street Sweeping

Structural BMPs have been heavily studied to assign pollutant removal efficiencies used to compute pollutant reductions that can be achieved. Methods for determining pollutant removal efficiencies for structural BMPs can be readily performed since runoff into the BMP, and leaving the BMP, can be measured. The impact to water quality from street sweeping has also been extensively studied for decades. However, despite extensive efforts, quantifying the impact from street sweeping remains elusive (Allison et al. 1998; Walker and Wong 1999; Schilling 2005, HEC 2006, Rochfort et al. 2009; Kang et al. 2009; Sutherland 2011; Sorenson 2012; Schueler et al. 2016). Difficulty measuring the impact in downstream receiving waters is attributed to:

- High variability of flow and composition of urban stormwater, both spatially and temporally (Selbig and Bannerman 2007, Ports 2009), resulting in difficulty measuring differences in sediment and nutrient loadings before and after sweeping (Pitt and Bissonette 1984; Zariello et al. 2002; Selbig and Bannerman 2007; Law et al. 2008);
- Unlikelihood of gathering the large number of water samples necessary to detect significant change (Selbig and Bannerman 2007; Schueler et al. 2016); and the
- Inaccuracies in sampling methods and lag effect of sediment transport in the storm sewer between storms (Law et al. 2008).

3.2.1 Sampling Study

Despite the challenges of assessing the impact to water quality in receiving streams, there is potential for street sweeping to reduce significant pollutant loadings towards achieving WLAs within regulated MS4 service areas. This premise is based on transportation cover constituting a significant fraction of the total impervious area in urban areas (Schueler 1994), the presence of an abundance of pollutants on the street surface (Pitt and Shawley 1981), and advancing pickup efficiency of street sweepers, especially the increased ability to collect smaller particles (Breault et al. 2005; USEPA 2006; Rochfort et al. 2009; Sutherland 2009). Results from more recent studies by Weston Solutions (2010) and Selbig (2016) detect significant TSS and nutrient reductions downstream, respectively, in small test areas as a result of street sweeping.
Due to the difficulty of explicitly measuring the impact to water quality from street sweeping in receiving waters, two general approaches have emerged to estimate pollutant reductions from street sweeping, including:

- The use of continuous simulation watershed modeling that rely on application of information and functions derived from past studies to represent numerous variables such as the material loading on the street surface, washoff, impacts from street parking, and sweeper pickup efficiencies (Sutherland and Jelen 1997; Zarriello et al. 2002; Law et al. 2008; Horwatich and Bannerman 2009; Schueler et al. 2016); and

- The direct measure and analysis of swept material to estimate pollutant reductions (Breault et al 2005; EOA 2007; SPU 2012, Bateman 2012, MDE 2014; VDEQ 2015; Hixon and Dymond 2019).

In 2011 the Chesapeake Bay Program (CBP) approved methods for quantifying total suspended solids (TSS) from street sweeping recommended by an expert panel as presented by MDE (2014) and VDEQ (2015). The recommendations include: (1) a method based on a conceptual model (Law et al. 2008) and (2) a method based on the measure of swept material, the latter called the Mass Loading Approach (MLA). However, findings from a second expert panel presented by Schueler et al. (2016) recommends the two methods be phased out, concluding that a continuous simulation modeling effort is necessary due to the inability to measure impacts downstream. The panel employed a consultant to utilize the Source Loading and Management Model for Windows (WinSLAMM) to simulate sediment reductions for various street cleaning scenarios, dependent on sweeper type and frequency of sweeping. The model, reliant on sediment production and washoff modeling functions, resulted in very modest annual reductions unless sweeping occurs at a twice weekly frequency, as summarized in **Table 6**. Schueler et al. (2016) recommends to the CBP that the results from the WinSLAMM model be used for quantifying reductions from sweeping for addressing WLAs associated with the Chesapeake Bay TMDL.

Table 6. Removal efficiency for total suspended solids (TSS) for street sweeping from Schueler et al. (2016).

Sweeping Frequency	Pollutant Removal Efficiency (%)
Twice weekly	21
Once weekly	16
Every other week	11
Monthly	6
Every other month	4
Every three months	2

Despite the recommendation, there are concerns with the use of models to assess the performance of street sweeping. Inconsistencies can include differences in the land use data employed with each model that often aggregate streets as part of other urban or impervious areas (Wu et al. 1998), such is the case with the Chesapeake Bay TMDL Model Progress Run 5.3.2 (Schueler et al. 2016). This can inhibit the ability to assess streets since streets can contain higher pollutant loadings available for transport to surface waters (Endreny and Thomas 2009) and since streets can contribute a majority of the runoff yield in urban areas, such as demonstrated in a low-density residential area by Pitt and Shawley (1981).

Modeling efforts often utilize data obtained from studies related to street material loading, accumulation, and washoff, along with sweeper pickup efficiencies. Software such as WinSLAMM has incorporated data from recent studies to supplement data from early studies by the National Urban Runoff Program (NURP) studies described by USEPA (1983) that were later questioned due to sampling techniques (Sutherland and Jelen 1997; Kang 2009; Winston and Hunt 2017). Application of build-up functions resulting from the NURP studies and used by many models, including WinSLAMM, are based on Pitt (1979) and may result in unreasonable model predictions if not based on direct measurements (Pitt et al. 2005). WLAs can vary significantly dependent on the model employed (Borah et al. 2006; Wallace et al. 2018). Case studies presented by Mohamoud and Zhang (2019) find low predictive performance for water quality constituents from three models, including poor correlation between simulated and observed TSS with the Chesapeake Bay Phase 5.3 Community Watershed Model (VAC 2018). Finally, due to the lack of statistically significant data, application of models to assess street sweeping can be difficult and suspect due to the lack of ability to provide calibration.

Alternatively, the direct measure of swept material reflects efforts unique to an MS4's sweeper program, whether performed intermittently and within targeted locations, or on a regular frequency throughout the regulated area. To determine the fraction of swept material to be quantified towards achieving WLAs, analysis of swept material includes moisture content, particle size distribution, and pollutant concentrations. Although direct measure and analysis of swept material provides a method for explicit quantification of reductions, concern regarding its appropriateness of this method are based on the assumptions made to estimate the component of the swept material that would ultimately impact surface waters.

In part to address this concern of direct measures of swept material, Hixon and Dymond (2019) present findings from a study that measured street sweeping material collected by MS4s in Virginia. Findings demonstrated smaller particles less present in collected sweeping samples when sweeping occurred within 2 days since a rainfall event than in samples collected when there had been more than two days since rainfall. This indicates the effectiveness of rainfall in transporting these smaller particles from paved surfaces since they were much less available on the swept surface after rainfall. Although these particles may not be transported to the receiving stream from a single storm, over the course of time, these particles would continue downstream transport through the MS4 during subsequent runoff events, ultimately being discharged to the receiving stream. Particles with decreasing availability of the swept surface within 2 days since rainfall were those ≤ 841 µm. This is consistent with characterization of TSS since particles up to 841 µm can be associated with suspended particles in the water column of surface waters (Bartram and Balance 1996).

As demonstrated in **Table 7**, variation of the particles ≤ 841 µm transported in runoff was also found dependent on the type of surface swept, either parking lot or street, likely due to drainage efficiency on the streets (i.e. slopes), resulting in higher velocity of runoff. Values in **Table 7** demonstrate a 74.7% and 64.5% increase in particles ≤ 841 µm in swept samples when at least 2 days since rainfall had occurred for streets and parking lots, respectively. This finding provides information for:

1. Estimating the fraction of swept material that could be applied to a WLA for sediment;
2. Choosing the optimal timing for sweeping as after 2 days since a rainfall event. It is noted that significant continued increase in smaller particles was not observed as days increased since rainfall, indicating an equilibrium of stored surface particles to available surface storage for particles is achieved within days after a runoff event; and
3. Prioritizing surface type for sweeping to maximize reduction of smaller particles susceptible to downstream transport, where applicable.

Table 7. Fraction of particles in swept material susceptible to downstream transport from Hixon and Dymond (2019).

Surface Type	Days since rain/runoff	Fraction of swept material susceptible to downstream runoff (%)[1]
Streets	≤ 2	29.2
	> 2	51.0
Parking Lots	≤ 2	40.6
	> 2	66.8

[1] Based on median values in swept samples from Hixon and Dymond (2019) for particles ≤ 841 µm.

3.2.2 PVCC Street Sweeping Program

A street sweeping program is currently implemented by PVCC to provide pollutant reductions towards addressing assigned WLAs for the Chesapeake Bay TMDLs. Annual sediment reductions achieved as part of the current program can also be applied towards addressing the Rivanna River TMDL. PVCC participated, along with other MS4 permittees in Virginia, in the study previously described by Hixon and Dymond (2019) with the tracking, collection and analysis of swept material. The ongoing PVCC street sweeping program continues the tracking, collection and sampling of swept materials to quantify pollutant reductions to:

1. Assess progress towards achieving applicable TMDL WLAs and as
2. A measure of effectiveness as part of an iterative program.

Based on the discussion in the previous section, specifically the inability to verify and calibrate models estimating reductions and the challenges measuring instream, PVCC will continue sampling and analysis of swept material for quantification of pollutant reductions.

PVCC's street sweeping program includes the contracting of a street sweeping company to sweep parking lots and roadways on campus. The contractor sweeps with a high-efficiency regenerative-air sweeper and provides PVCC the total mass of material swept. Representative samples of the swept material are taken at the time of sweeping, along with recording conditional variables, using a data collection form. Samples are transported to a laboratory using chain of custody protocols to ensure integrity of the samples from collection to the lab. Laboratory analysis provides moisture content, results of a sieve analysis and TP and TN concentrations associated with the smaller particles susceptible to runoff. Results for each sample are combined with a pool of results collected from other MS4 permittees, as well, for continued analysis and refinement of estimated pollutant reductions per mass of swept material.

In context to the Rivanna River TMDL, the ability to achieve the WLA with street sweeping is assessed based on past reductions achieved, and reported on, during the three previous MS4 General Permit reporting periods. Sediment reductions, defined as TSS, achieved from street sweeping for each period are provided in **Table 8**. It is noted from the Table that street sweeping would have been effective at achieving the annual sediment reductions for the Rivanna River TMDL for the 2018-2019 and 2019-2020 reporting years since reductions exceeded 3.14 tons/yr. It is also noted that computational methods vary between the reporting years since the sampling study was not yet complete for the 2017-2018 reporting year. Methods may continue to change as part of an iterative process as sampling and analysis continues. A comparison between the VDEQ method and results from sampling finds the VDEQ method estimated smaller TSS reductions; but much larger TP and TN reductions achieved per ton of swept material.

Table 8. Pollutant reductions achieved by PVCC in the three previous MS4 General Permit reporting periods (PVCC 2018, 2019, 2020).

Reporting Period	Material Swept (tons)	Pollutant Removed			Computational Method for Quantifying Reductions[1]
		TSS (tons)	TP (lbs)	TN (lbs)	
2017-2018	6.15	1.29	8.60	21.50	MLA (VDEQ 2015)
2018-2019	8.20	3.25[2]	1.16	3.82	Sampling results & Analysis from Hixon and Dymond (2019). Sweeping ≥ 2 days since rainfall
2019-2020	10.0	4.06[2]	1.44	3.87	Sampling results & Analysis from Hixon and Dymond (2019). Sweeping ≤ 2 days since rainfall

[1] Computations each use a moisture content to compute a dry weight of material swept prior to computing reductions.
[2] Exceeds required annual reduction to achieve the Rivanna River TMDL WLA (3.14 tons/yr).

4.0 BMP Implementation to Achieve WLA

PVCC will continue implementation of the college's street sweeping program towards achieving the annual reductions required for achieving the Rivanna River TMDL WLA. Continued implementation will include:

1. Analysis of swept material and collection of variables that impact contents of the material for quantification and verification of effectiveness;
2. Documentation of the annual mass of material swept; and
3. Program modifications, as needed, based on sample analysis findings and progress towards achieving the WLA.

Results from sampling will continue to be included with sampling results from other participating MS4 permittees that includes collecting and analyzing swept material samples as a means to assist in quantifying reductions achieved by the practice. At this time, approximately 90 samples have been collected.

4.1 Quantification of Pollutant Reductions

Of the samples analyzed thus far, exponential regression has been used to correlate and extrapolate values for computing pollutant reductions for the mass of swept material susceptible to transport downstream to surface waters, reflected in **Table 9**. The values allow for computation of the pollutant reduction achieved within the MS4 regulated area based on the mass of the swept material. Reductions vary dependent on the duration since the last rainfall when sweeping occurs and the type of surface area swept. Refined sampling is now performed on only the fraction of material susceptible to runoff to prevent the need to extrapolate values.

Table 9. Estimate of pollutant reduction to surface waters per ton of swept materials (Hixon and Dymond 2019).

Surface Type	Days Since Rain	TP (< 250 µm) (lbs/ton)[1]	TN (< 841 µm) (lbs/ton)[1]	TSS (< 841 µm) (lbs/ton)[1]
Streets	≤ 2	0.149	0.335	571
	> 2	0.257	0.585	998
Parking Lots	≤ 2	0.141	0.466	794
	> 2	0.320	0.766	1,307

[1] Adjusted using a median moisture content of described by Hixon and Dymond (2019).

4.2 Context to Other Applicable WLAs

For context with other WLAs applicable to PVCC, **Table 10** demonstrates that reductions for the Rivanna River TMDL would be achieved with the required reductions achieved by street sweeping for the Chesapeake Bay TMDL WLA for TSS by the year 2028.

Table 10. Estimates of the tonnage of annual material needed to be collected by street sweeping to achieve PVCC's WLAs.

TMDL	Sediment Reduction to Achieve WLA (tons/year)[1]	Estimate of Required Swept Material to Achieve WLA (tons/year)[2]			
		Streets Swept		Parking Lots Swept	
		≤ 2	> 2	≤ 2	> 2
Chesapeake Bay	3.80	13.3	7.6	9.6	5.8
Rivanna River	**3.14**	**11.0**	**6.3**	**7.9**	**4.8**
Moores Creek	2.57	9.0	5.2	6.5	3.9

[1] Values provided in Table 3.
[2] Based on values from Table 9.

It is noted that the values for the Chesapeake Bay TMDL in Table 10 are only those estimated to achieve the WLA for TSS. The limiting pollutant for street sweeping, defined as the pollutant with the WLA most difficult to achieve with street sweeping appears to be TN. As demonstrated in the PVCC Chesapeake Bay TMDL Action Plan, Phase II, a large increase in swept material would be necessary to achieve the TN WLA, ranging from approximately 18 to 42 tons to meet 2023 reduction targets. With this, PVCC intends to increase sweeping frequency each permit year towards achieving the Chesapeake Bay TMDL WLAs for TN. Since reductions achieved during the 2018-2019 and 2019-2020 reporting year exceeded those required to achieve the Rivanna River TMDL, along with planned increases in sweeping frequency, continuing the on-campus street and parking lot sweeping is sufficient for addressing PVCC's WLA for Rivanna River.

4.3 Implementation and Measures of Effectiveness

The mass of material swept during previous reporting years indicates annual street sweeping has potential to achieve PVCC's WLA for the Rivanna River TMDL. Further, the sampling study and resulting publication support the sampling program as a measure of effectiveness for quantifying reductions resulting from the practice. As part of an iterative process, PVCC will perform the following annual activities respective to address the Rivanna River TMDL WLA:

1. Continue to annually perform street sweeping on campus parking lots and streets, with incremental increases towards achieving the target reductions, as applicable.
2. Continue to conduct analysis on samples extracted from swept material for continued inclusion into the original set of data presented by Hixon and Dymond (2019). Results will be used for continued verification and refinement pollutant reduction estimates.
3. Documentation of variables during sweeping instances that impact the contents of swept material to include, at a minimum, duration since the previous rainfall and type of surface swept. Other variables will also be collected so assessment of sampling results can determine other potential impacts, such as time of year. As part of an iterative program, this information will be used to continue to develop a sweeping program that minimizes discharge of sediment from PVCC MS4 outfalls.
4. Documentation of the total mass of material swept annually and supporting computations to quantify annual sediment reductions. Progress will be reported through the annual reporting process.

If subsequent annual assessments indicate that street sweeping alone will not provide the required pollutant reductions, PVCC will provide modifications to this plan as part of the annual reporting process to achieve the required sediment reductions.

4.4 Public Education Outreach Strategy

PVCC, as a non-traditional MS4, describes the college's public as students, faculty and staff in the 2018 – 2023 PVCC MS4 Program Plan (Program Plan). The Program Plan includes practices to enhance the public's (and contractors) education on methods to eliminate and reduce discharges of sediment, including:

- ✓ Implementing a *Public Education and Outreach Plan* to enhance the public's knowledge regarding high priority stormwater issues such as:
  - Providing materials with information about general stormwater impacts to surface waters and steps to reduce pollution;

- Making the public aware of PVCC's illicit discharge prohibition and enforcement on the PVCC campus; and
- Increasing staff knowledge regarding pollutants of concern for local TMDLs, including sediment and nutrients.

Surveys are conducted every other year and the results used to measure the effectiveness of the college's public education outreach program.

- ✓ Maintaining a dedicated stormwater webpage that includes links to various documents regarding methods to eliminate and reduce discharges of sediment, most notably an MS4 Procedures Handbook with BMPs for various activities focused towards the college's field staff.
- ✓ Implementation and enforcement of the Virginia Community College Systems (VCCS) Standards and Specifications for Erosion and Sediment Control and Stormwater Management. Implementation of the Standards and Specifications is critical to minimizing sediment loadings during times of land disturbance. Further, implementation incorporates the requirement to address post-development stormwater regulations, often resulting in structural stormwater management facility to reduce sediment discharge from developed areas on campus.
- ✓ Written procedures for good housekeeping/pollution prevention that include practices to address sediment discharges.
- ✓ Biennial training for field staff on the college's good housekeeping/pollution prevention procedures.

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Appendix A - Public Input

PVCC will maintain this TMDL Action Plan with request for solicitation and means for public comment on the college's stormwater management webpage. The latest version of the action plan will continue to be maintained on the webpage, along with the solicitation for comment throughout the permit cycle.

PVCC will update the action plan annually as part of the annual reporting process, as applicable and necessary, to include any public comment(s) and plan modifications(s). A summary of any comments received from the public will subsequently be provided in this Appendix with a response from the college and a description of any modifications to the plan.