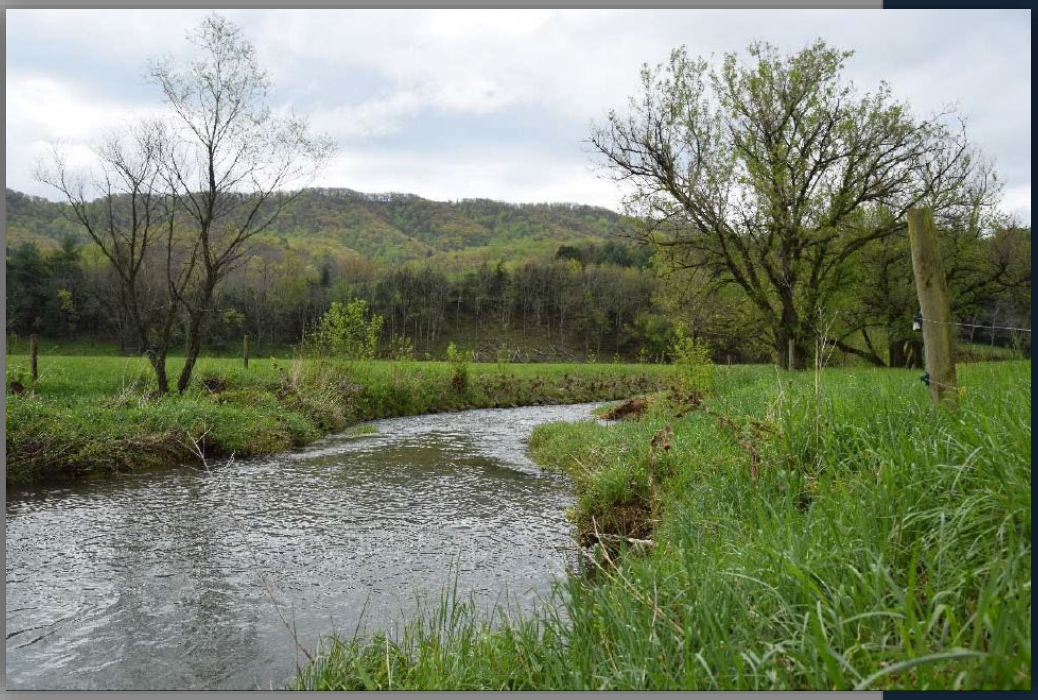
ROANOKE RIVER SEDIMENT TMDL ACTION PLAN

A Plan to Address the City's Assigned Wasteload Allocation for the Roanoke River Sediment TMDL

City of Salem



Permit #: VAR040010
Prepared: June 2015
Updated: April 2025

This document addresses Part II B of the General Virginia Pollution Discharge Elimination System (VPDES) Permit for Discharges of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4). This document serves as a City-specific Total Maximum Daily Load (TMDL) Action Plan to identify the best management practices and other interim milestone activities to be implemented to address the sediment waste load allocation (WLA) assigned to the City's regulated MS4 area in the *"Benthic TMDL Development for the Roanoke River, Virginia"* approved by the Environmental Protection Agency on May 10, 2006. For the purposes of this Plan, the 2000 and 2010 Census Urbanized Areas were used to define the City of Salem's regulated MS4 area as defined in 9VAC25-890 Section 1.

SALEM VIRGINIA

Wetland Studies and Solutions, Inc.
a DAVEY company

EXECUTIVE SUMMARY

The City of Salem (City) is authorized to discharge stormwater from its municipal separate storm sewer system (MS4) under the Virginia Pollutant Discharge Elimination System (VPDES) General Permit for Discharge of Stormwater from Small MS4s (MS4 General Permit). To maintain permit compliance, the City implements a MS4 Program Plan that includes best management practices (BMPs) to address the six minimum control measures (MCMs) and special conditions for the "*Benthic Total Maximum Daily Load (TMDL) Development for the Roanoke River, Virginia*." The Benthic TMDL for the Roanoke River, approved by the Environmental Protection Agency (EPA) on May 10, 2006, was required to be developed under the authority of the Clean Water Act (CWA) in response to the river's listing as impaired by the Virginia Department of Environmental Quality (DEQ) for not meeting water quality standards.

The Environmental Protection Agency (EPA) describes a TMDL as a "pollution diet" that identifies the maximum amount of a pollutant the waterway can receive and still meet water quality standards. In the case of the Roanoke River TMDL, sediment was identified as a pollutant of concern and MS4s within the watershed of the impaired segment of the river were assigned a wasteload allocation (WLA). A WLA determines the required reduction in sediment loadings from the MS4s to meet water quality standards and is represented as a 69.5% reduction in sediment loads from urban, agricultural, and transitional land-based sources and instream erosion. The MS4 General Permit serves as the regulatory mechanism for addressing the load reductions described in the TMDL, predominantly through the requirement of a TMDL Action Plan.

Consistent with an approach taken by numerous MS4s throughout the country to achieve significant sediment load reductions, this Action Plan identifies street sweeping as the primary practice to achieve the water quality standard described in the TMDL. The City has been sweeping to achieve the targeted sediment reductions for its street sweeping program.

Implementation of this Action Plan is consistent with the provisions of an iterative MS4 Program, which constitutes compliance with the MS4 General Permit requirements for reducing pollutants to the maximum extent practicable (MEP).

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TABLES

ACRONYMS

BMP	Best Management Practice
CBP	Chesapeake Bay Program
CN	Curve Number
CWA	Clean Water Act
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
EPA	United States Environmental Protection Agency
ESC	Erosion and Sediment Control
GIS	Geographic Information System
GP	General Permit
GPS	Global Positioning System
GWLF	Generalized Watershed Loading Function
HSG	Hydrological Soil Group
IDDE	Illicit Discharge Detection and Elimination
IP	Implementation Plan
LA	Load Allocation
MCM	Minimum Control Measure
MEP	Maximum Extent Practicable
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
MS4 GP	General Permit for Discharge of Stormwater from Small MS4s
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PEOP	Public Education and Outreach Plan
POC	Pollutant of Concern
SWCB	State Water Control Board
SWM	Stormwater Management
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Sediment
VAC	Virginia Administrative Code
VDOT	Virginia Department of Transportation
VPDES	Virginia Pollutant Discharge Elimination System
VSMP	Virginia Stormwater Management Program
WLA	Wasteload Allocation
WTM	Watershed Treatment Model

1.0 INTRODUCTION AND PURPOSE

> *"The Roanoke River flows through southcentral Virginia before crossing the North Carolina state line and discharging into the Albemarle Sound in North Carolina."*
>
> *- Benthic TMDL Development for the Roanoke River, Virginia*

Mandated by Congress under the Clean Water Act (CWA), the National Pollutant Discharge Elimination System (NPDES) storm water program includes the Municipal Separate Storm Sewer System (MS4), Construction, and Industrial General Permits. In Virginia the NPDES Program is administered by the Department of Environmental Quality (DEQ) through the Virginia Stormwater Management Program (VSMP) and the Virginia Pollutant Discharge Elimination System (VPDES) Program. The City of Salem (City), Virginia, is authorized to discharge stormwater from its MS4 under the VPDES General Permit for Discharge of Stormwater from Small MS4s (MS4 GP). As part of the permit authorization, the City developed and implements an MS4 Program Plan that includes best management practices (BMPs) to address the six minimum control measures (MCMs) and special conditions for applicable total maximum daily loads (TMDLs) outlined in the MS4 GP. Implementation of these BMPs is consistent with the provisions of an iterative MS4 Program, which constitutes compliance with the standard of reducing pollutants to the "maximum extent practicable," or MEP.

1.1 Total Maximum Daily Load

A TMDL is the amount of pollutant a water body can assimilate and still meet water quality standards for its designated use. Typically, TMDLs are represented numerically in three main components:

- WLA for point source contributions and MS4 Permit operators.
- Load Allocations (LA) for non-point source contributions and natural background sources.
- Margin of Safety (MOS)

Point source pollution is any single identifiable source from which pollutants are discharged. If point source discharges, including a permitted MS4, are present in the TMDL watershed, then any allocations assigned to that permittee must be in the form of a WLA. The City's MS4 outfalls are defined as point source discharges; and therefore, fall under this category in the TMDL. Pollution that is not from an identifiable source, such as a pipe or a ditch, but rather originates from multiple sources over a relatively large area, are considered to be non-point source pollution. These sources are typically categorized into agricultural, atmospheric, and non-regulated areas, with Load Allocations (LAs) assigned for each. The Margin of Safety (MOS) is a required component that accounts for the modeling uncertainty in the response of the waterbody to loading reductions and is implicitly incorporated into a TMDL computation. The TMDL is expressed in the following equation:

$$TMDL = \sum WLA + \sum LA + MOS$$

1.2 Roanoke River TMDL

A TMDL is defined as the total amount of a given pollutant that a waterbody can assimilate and still meet water quality standards. Typically, TMDLs are represented numerically in three main components: Wasteload Allocations (WLAs), a Load Allocation (LA), and a Margin of Safety (MOS). A WLA is the allocated amount of pollutant from areas discharging through a pipe or other conveyance considered a point source. Point sources include sewage treatment plants, industrial facilities and storm sewer systems. In contrast, an LA is the amount of pollutant from existing non-point sources and natural background sources such as farmland runoff and atmospheric deposition. For the Roanoke River TMDL, an explicit MOS of 10% of the calculated TMDL pollutant load is used to reflect uncertainty in representative modeling computations. In this context, MS4 permittees are assigned a WLA representing the annual loading of the pollutant of concern (POC) that can be discharged from its regulated MS4 area.

The Virginia DEQ listed segments of the Roanoke River on their biennial 303(d) list in 1996 due to benthic impairments. Subsequent to the initial listing, a TMDL for Roanoke River, entitled Benthic TMDL for Roanoke River, Virginia was developed. This document is referred to herein as the Roanoke River TMDL. As part of the approved TMDL, the City's permitted MS4 (VAR040010) was assigned a WLA for sediment discharge to the Roanoke River.

The Roanoke River TMDL assigns a WLA for permitted MS4s within the watershed, which represents an annual sediment load resulting from a percent reduction of the existing and projected future load from the MS4 to meet water quality standards for the watershed. The WLA represents a percent reduction from City's MS4 load. Specifically, the WLA requires a 69.5% reduction of sediment, the pollutant of concern, across specified land use types in the City's MS4 regulated area.

1.3 TMDL Special Conditions

The special conditions of the MS4 GP are triggered where a permittee has been assigned a WLA under the TMDL. Since the Roanoke River TMDL assigned a WLA to the City's MS4, the City is required to develop a local TMDL action plan designed to reduce loadings for pollutants of concern and to complete implementation of the TMDL action plans as soon as practicable. TMDL action plans may be implemented in multiple phases over more than one permit cycle using the adaptive iterative approach provided adequate progress is achieved in the implementation of BMPs designed to reduce pollutant discharges in a manner that is consistent with the assumptions and requirements of the applicable TMDL (Part II.B.3).

Per Part II.B.4 of the MS4 GP, each local TMDL action plan developed by the permittee shall include the following:

a. The TMDL project name;
b. The EPA approval date of the TMDL;

c. The wasteload allocated to the permittee (individually or in aggregate), and the corresponding percent reduction, if applicable;
d. Identification of the significant sources of the pollutants of concern discharging to the permittee's MS4 and that are not covered under a separate VPDES permit. For the purposes of this requirement, a significant source of pollutants means a discharge where the expected pollutant loading is greater than the average pollutant loading for the land use identified in the TMDL;
e. The BMPs designed to reduce the pollutants of concern in accordance with Part II B 5, B 6, B 7, and B 8;
f. Any calculations required in accordance with Part II B 5, B 6, B 7, or B 8;
g. For action plans developed in accordance with Part II B 5, B 6, and B 8, an outreach strategy to enhance the public's education (including employees) on methods to eliminate and reduce discharges of the pollutants; and
h. A schedule of anticipated actions planned for implementation during this permit term.

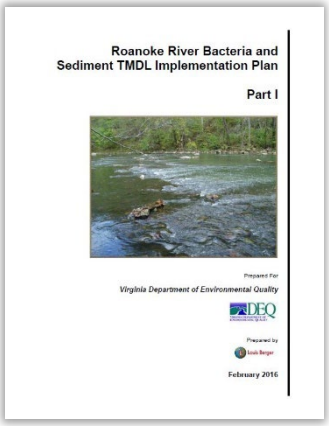
Additionally, per Part II.B.6 of the MS4 GP, the following items specific to local sediment, phosphorus, and/or nitrogen TMDLs apply:

a. The permittee shall reduce the loads associated with sediment, phosphorus, or nitrogen through implementation of one or more of the following:
   (1) One or more of the BMPs from the Virginia Stormwater BMP Clearinghouse listed in 9VAC25-875-590 or other approved BMPs found on the Virginia Stormwater BMP Clearinghouse website;
   (2) One or more BMPs approved by the Chesapeake Bay Program. Pollutant load reductions generated by annual practices, such as street and storm drain cleaning, shall only be applied to the compliance year in which the annual practice was implemented; or
   (3) Land disturbance thresholds lower than Virginia's regulatory requirements for erosion and sediment control and post development stormwater management.
b. The permittee may meet the local TMDL requirements for sediment, phosphorus, or nitrogen through BMPs implemented to meet the requirements of the Chesapeake Bay TMDL in Part II A as long as the BMPs are implemented in the watershed for which local water quality is impaired.
c. The permittee shall calculate the anticipated load reduction achieved from each BMP and include the calculations in the action plan required in Part II B 4 f.
d. No later than 36 months after the effective date of this permit, the permittee shall submit to the department an update on the progress made toward achieving local TMDL action plan goals and the anticipated end dates by which the permittee will meet each wasteload allocation for sediment, phosphorus, or nitrogen. The proposed end date may be developed in accordance with Part II B 3.

The City submits reporting on the implementation of the MS4 program annually to DEQ. The TMDL Action Plan was submitted by May 1, 2020, and in subsequent years when any significant modifications occur. Implementation will be reported annually as described in Section 5.3.

1.4 Roanoke River Bacteria and Sediment TMDL Implementation Plan

Following approval of a TMDL, various stakeholders may create an Implementation Plan (IP). Although such plans are alluded to in the Federal CWA legislation, they are not a specific requirement. However, such IPs are a state requirement through Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act. The Roanoke River Bacteria and Sediment TMDL Implementation Plan, referred to herein as the IP, was developed "to reduce bacteria and sediment to the levels stated in the TMDLs and to restore the waterbodies to conditions that support the primary contact recreation use and attain the aquatic life use standard."



In regard to the City, the IP includes sediment reductions to be achieved through street sweeping and continued implementation of the City's stormwater management program. According to the IP, the City estimated significant sediment reductions in 2013 (533 tons) and plans to expand the City's street sweeping program to address the TMDL. The IP projects that the expansion to the City's street sweeping program would amount to an annual net increase of approximately 270 tons of sediment (see Table 1).

Table 1: Estimated Load Reductions by Street Sweeping Programs in the TMDL Watershed

Municipality	Existing Program		Proposed Program		Total Annual Sediment Reduction
	Miles Swept Annually	Annual Sediment Reduction (tons)	Additional Miles Swept Annually	Annual Additional Sediment Reduction (tons)	
City of Roanoke	10,763	9,226	2,526	2,165	11,391
City of Salem	2,115*	533	1,058*	267	800
County of Roanoke	-	-	5,092	2,824	2,824

* Estimated with ArcGIS

** Table 5-12 of the IP

2.0 ROANOKE RIVER TMDL WLA

The Roanoke River TMDL wasteload allocation for MS4s is land use based and applies to all MS4s in the TMDL watershed, including Roanoke County, the City of Roanoke, the Town of Vinton, Botetourt County, the City of Salem, VDOT Roanoke and Montgomery County Urban Areas, Virginia Western Community College, the Virginia Medical Center, the Town of Blacksburg, and the Town of Christiansburg's MS4s. The TMDL directs that the WLA is achieved with a "Percent Reduction Method" that compares water quality data to applicable water quality criteria. It identifies a percent reduction of the current sediment load required to meet water quality standards for the watershed.

2.1 TMDL Model Approach

The Roanoke River TMDL describes a modeling approach that used a biomonitoring station at river mile 224.54 of the Roanoke River to develop a "reference watershed" approach to meet the water quality standard. Sediment load reduction throughout the impaired watershed, scaled up from the reference watershed location, is "expected to restore support of the aquatic life use for the Roanoke River." An area-weighted sediment load for land-based sources was determined for the MS4s and WLAs for MS4s were based on an equal percent reduction (including a 10% margin of safety) across the applicable land use types. The WLA specific to the City is 428.8 tons/year, equivalent to a 69.5% reduction in the existing loads computed at the time of the TMDL development.

2.2 TMDL Implementation Plan WLA Modifications

The IP updated the percent reduction from 69.5% as described above to 75.1% for updated land uses depicted in Table 2. This is a 5.6% increase from the reduction rate of 69.5% across land uses in the 2006 TMDL. Having been developed in 2006 using 1992 land use data, updates to the land use distributions in the modeling scenarios were necessary for a clearer understanding of existing sediment loads. Most notably, there was a drastic increase in urban areas of the TMDL watershed with a corresponding decrease in forested and agricultural areas in the 2006 NLCD (National Land Cover Dataset) data. Updates were also considered due to an overestimation in the original TMDL regarding instream erosion loads in the impaired and reference watersheds.

The IP states, "IPs may be utilized by localities for pollutant reduction strategies; however, they are not considered a requirement for permit compliance." Therefore, this Action Plan is reliant upon the reduction requirements from the approved TMDL.

As an iterative MS4 program, the City will update this Action Plan as necessary to meet the reduction requirements as more refined information becomes available.

Table 2: TMDL Load Allocation for Salem

Consolidated Source Category Land Use	TMDL Wasteload Allocation (% reduction)	Draft IP Wasteload Allocation (% reduction)
Agriculture (pasture/hay/row crop)	69.5%	75.1%
Residential (high/low intensity)*	69.5%	75.1%
Commercial/Industrial/Mining*	69.5%	75.1%
Transitional*	69.5%	75.1%
Urban/Recreational Grasses*	69.5%	75.1%
Instream Erosion	69.5%	75.1%

* Applicable for potential discharge to the City's MS4.

As indicated in Table 2, sediment from agriculture and instream erosion would not be applicable to the City's MS4 since sediment from stream bank erosion would not be likely to enter the storm sewer and agricultural land use within the city is less than 3% of the total land area. Table 3 provides an updated land use summary for the City using the 2011 NLCD data.

Table 3: Land Use Summary for the City of Salem based on NLCD 2011

Land Use	Area* (Acres)	% of Total Area	Sediment Source Characteristics	Significant Sediment Source to the MS4?
Developed, High Intensity	822	9	Reduced vegetation and developed exposes soils	yes
Developed, Low Intensity	3,183	35		
Developed, Med. Intensity	2,009	22		
Developed, Open Space	1,729	19		
Evergreen Forest	63	1	Loads from forest are natural condition	no
Mixed Forest	27	0		
Deciduous Forest	947	10		
Hay/Pasture	227	3	Small contributing area	no
Herbaceous Grassland	11	0		
Cultivated Crops	8	0		
Open Water	2	0	Not a sediment source	no

* Total area is 9,030 acres.

2.3 Quantification of Required Reductions

To determine the sediment load reduction required to achieve the WLA of 428.8 tons/year, the required percentage reduction of 69.5% is simply used as:

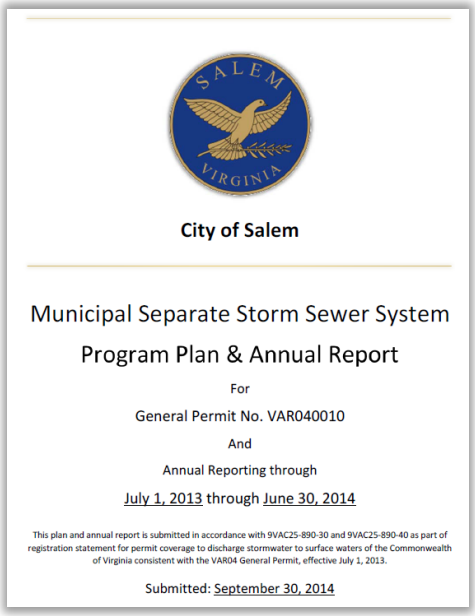
$$Existing\ TMDL\ Load\ from\ Salem's\ MS4\ = \frac{428.8\ \frac{tons}{year}}{(1-0.695)} = 1{,}405\ \frac{tons}{year}$$

The existing load was computed since it was not explicitly provided in the TMDL. The resulting required reduction in sediment is computed as:

$$Required\ Sediment\ Reduction\ from\ Salem's\ MS4 = 1{,}405\ \frac{tons}{year} - \ 428.8\ \frac{tons}{year}\ = 976.2\ \frac{tons}{year}$$

The required load reduction computation is based on the explicit WLA in the TMDL. It is understood that the TMDL incorporated potential sources such as instream erosion that would not contribute to the City's regulated MS4 area; therefore, the existing computed load may be inaccurate. The resulting calculated loadings likely exceed the actual sediment contribution from the City's MS4. The City reserves the right to modify the characterization of sediment loadings from its MS4 in the future and modify this Action Plan. Any modifications will be based on refined data inputs and the measures of effectiveness obtained by the means and methods to achieve the WLA, as described in Section 4.

3.0 MS4 PROGRAM ASSESSMENT


City of Salem

Municipal Separate Storm Sewer System

Program Plan & Annual Report

For

General Permit No. VAR040010

And

Annual Reporting through

July 1, 2013 through June 30, 2014

This plan and annual report is submitted in accordance with 9VAC25-890-30 and 9VAC25-890-40 as part of registration statement for permit coverage to discharge stormwater to surface waters of the Commonwealth of Virginia consistent with the VAR04 General Permit, effective July 1, 2013.

Submitted: September 30, 2014

The City maintains compliance with the MS4 GP through implementation of BMPs defined in the *City of Salem MS4 Program Plan*. The majority of the BMPs in the Program Plan are nonstructural rather than structural BMPs. Structural BMPs such as retention ponds capture pollutants after they have washed off the ground surface and been conveyed to the pond through stormwater runoff. Nonstructural BMPs can be considered as "source controls" where the pollutant is either prevented from accumulating or collected from the ground surface prior to exposure to precipitation that would convey the pollutant downstream. Source controls are typically performed at some defined frequency to minimize pollutant build-up and downstream wash-off during a rainfall event. Examples of nonstructural BMPs include community education programs, staff training, good housekeeping and pollution prevention procedures, catch basin cleanout, and street sweeping. There is limited data available for quantifying the pollutant removal efficiencies of nonstructural BMPs. However, the limited research indicates significant reductions are achieved with a higher degree of cost effectiveness than with structural practices. Removal estimates for total suspended solids (TSS) are estimated to range from 30 – 70%.

Consistent with the special conditions described in Section 1.2, the following sub-sections characterize the City's existing MS4 program in context of the Roanoke River TMDL pollutant of concern, sediment.

3.1 MS4 General Permit Minimum Control Measures

The City maintains compliance with the MS4 GP through implementation of their MS4 Program that addresses the Minimum Control Measures (MCMs) outlined in the permit. Inherently, most are applicable to addressing reduction or elimination of sediment.

3.1.1 MCM 1 Public Education and Outreach on Stormwater Impacts

The City has incorporated information regarding POCs into the relevant message of the high-priority water quality issues #1, #2 and #3 in the City's Public Education and Outreach Plan (PEOP). Sediment concerns related to water quality are included in the public education and outreach efforts to the general public.

To enhance the City's public education and outreach program, the City partners with the Clean Valley Council (CVC). The CVC implements public education and outreach strategies to promote methods to eliminate or reduce the discharge of sediment in the Roanoke River watershed. Examples of locations where this information could be presented include Stream School Seminars, Stormwater Educational Programs, Conferences, Booths, etc.

3.1.2 MCM 2 Public Involvement and Participation

MCM 2: Public participation events are developed in conjunction with the PEOP and incorporate sediment as a POC. To enhance the City's public education and outreach program, the City partners with the Clean Valley Council (CVC). The CVC implements public involvement and participation activities to promote methods to eliminate or reduce the discharge of bacteria in the Roanoke River watershed. Examples of locations where this information could be presented include:

- Stream School Seminars
- Stormwater Educational Programs
- CVC Website
- Fall Waterways Cleanup
- Clean Valley Day Clean Up
- Earth Day
- Party for the Planet with Mill Mountain Zoo
- Many More

3.1.3 MCM 3 Illicit Discharge Detection and Elimination

The City conducts dry-weather outfall screenings for non-stormwater discharges, including sediment, and implements written procedures for detecting and eliminating identified discharges. The City has also conducted a city-wide assessment to identify potential sources of sediment. Where applicable per the permit, stormwater pollution prevention plans (SWPPPs) are developed to address potential pollutant discharges, including discharges of sediment. The City also disseminates information to the public for the reporting of illicit discharges. A prohibition of illicit discharges in the City is established through the municipal code.

3.1.4 MCM 4 Construction Site Stormwater Runoff Control

Regulated land disturbance projects in the City are required to be consistent with the City's erosion and sediment control (ESC) and stormwater management (SWM) Ordinances, which require approved plans that minimize sediment discharge from construction activity and post-construction. Inspections are required to be performed during construction activity and on any post-construction facilities built to address stormwater management.

3.1.5 MCM 5 Post Construction

The City's ESC and SWM programs require regulated land disturbance projects to address post-construction water quality. The MCM also requires a long-term inspection and maintenance program for stormwater management facilities to ensure functionality. Although facilities are designed to target phosphorus reductions; facilities that remove phosphorus inherently also remove sediment from passing downstream.

3.1.6 MCM 6 Good Housekeeping

The City has developed good housekeeping procedures that are incorporated into staff training. The potential for discharge of sediment was also included in the City's assessment to identify high priority facilities that will be targeted for site-specific SWPPPs.

For further detail on the PEOP, the City's MS4 Program Plan and Annual Report are available at https://www.cityofsalem.net/government/shaping-salem-s-future/reports-studies/stormwater-permits-and-annual-reports

3.2 Additional Applicable Practices

The City's efforts to reduce sediment loads to the Roanoke River go beyond the requirements of the MCMs in the MS4 GP. The additional efforts incorporated into the current MS4 program that are applicable to the reduction of sediment discharges from the MS4 include:

- Restrictions for development within floodplains; and
- Partnership in the Clean Valley Council

3.3 Facilities Assessments

The City has performed a city-wide evaluation for the identification of areas that are significant and/or potential sources of sediment to stormwater runoff. The City has also identified high priority areas as part of their MS4 Program consistent with the MS4 GP. The facilities are considered to have a high potential to discharge pollutants and site-specific Stormwater Pollution Prevention Plans have been developed to minimize pollutant discharges. The following City-owned and operated facilities were identified as potential significant sediment sources:

- The City of Salem's Street and General Maintenance Facilty
- Mowles Spring Park

Stormwater Pollution Prevention Plans have been developed to minimize pollutant discharges consistent with the schedule requirements of the MS4 GP and the City's MS4 Program Plan.

3.4 Evaluated Methods to Achieve the WLA

The City has served as an active participant in efforts to address the impairments described in the Roanoke River TMDL through maintained compliance with the MS4 General Permit and with implementation of the BMPs described in the IP. The below represents methodologies that have been evaluated and are proposed as potential options for achieving the TMDL reductions to MEP.

3.5 Implementation of MS4 Program

Consistent with the intent of the TMDL and IP, the City intends to achieve reductions with implementation of the City's MS4 Program Plan. Quantification of sediment reduction resulting from implementation of a stormwater program is difficult; however, peer-reviewed literature indicates significant reductions can be achieved. Ports (2009) campaigns for the importance of source controls as a cost-effective approach to improve water quality, specifically discussing reductions achieved from urban forestry controls (i.e. urban leaf removal), pet waste management and lawn management. Nonstructural practices may also include day-to-day activities of public works staff or educational efforts to change the behavior of the public. Riggs (2010) recognizes the need to reduce pollutant loads from existing developed lands, citing load reductions resulting from a social marketing approach to educate and excite landowners into participating in efforts, specifically water conservation. Research conducted within Florida MS4s by Raje (2013) analyzed particulate matter from street sweeping, catch basin cleanout, and structural BMPs finding pollutant removal is significantly more economical (by several orders of magnitude) than the use and maintenance of structural BMPs ($/pound removed). Research applying quantification of reductions is summarized as:

- Murphy and Lokey (1999) developed a spreadsheet model using a Monte Carlo style simulation module to accommodate the uncertainty in published removal efficiencies and other solicited efficiency data for the 36 nonstructural BMPs included the City of Phoenix's MS4 program. The spreadsheet sums up the cumulative effect of the BMPs. Removal efficiency is further estimated based on both a physical and implementation factor. Results found the cumulative load reductions of the MS4 Program BMPs to fall between 30 – 51% of a baseline estimate.
- Taylor (2002) reports that city-wide urban stormwater quality management programs are thought to range from roughly 25 – 40% in their cumulative pollutant removal efficiency. Monitoring for the City of Tulsa Oklahoma before and after implementing a stormwater quality management program resulted in reductions of 13% for sediment, 17% for phosphorus, and 18% for nitrogen.
- Taylor and Wong (2002) reference preliminary results from a monitoring-based study by Smith and Simmons (2002a, 2002b, and 2000) to estimate the following removal efficiencies for good housekeeping on an industrial site: 8% for TSS (sediment), 40% for N, and 49% for P. With the inclusion of a pollution prevention plan, removal efficiencies are increased to 60% for TSS, 43% for TN, and 56% for TP.

The literature indicates that the implementation of the City's MS4 Program Plan results in significant reduction in pollutant discharges, including sediment. An initial conservative estimate of the reductions achieved by the MS4 program is based on the cited research and provided in Table 4.

Table 4: Summary of Cited Data & Estimated Reductions from Program Implementation

Reference	Median (%)	Additional Reduction (tons/year)
Murphy and Lokey (1999)	40*	562
Taylor (2002)	13**	183
Taylor and Wong (2002)	60***	605

* General reduction, specific pollutant not specified

** Specific sediment reduction based on monitoring for implementation of an overall program

*** Specific sediment reduction from site with SWPPP

Table 4 gives insight into the potential sediment reduction from implementation of nonstructural BMPs. As a conservative estimate, this Plan considers Taylor (2002) to predict reductions for sediment from implementation of the City's MS4 program as:

$$1{,}405\ \frac{tons}{year} \times 0.13 = 182.65\ \frac{tons}{year}$$

The required Sediment Reduction is reduced by 13% for the implementation of the City's MS4 Program as calculated below:

$$Required\ Sediment\ Reduction\ from\ Salem's\ MS4 = \ 976.2\ \frac{tons}{year} - 182.65\frac{tons}{year} = \mathbf{793.55}\ \boldsymbol{\frac{tons}{year}}$$

3.6 Resilience Plan Efforts

The City's Resilience Plan includes a thorough evaluation and field assessment of potential resilience projects that have the co-benefit of sediment reduction to help meet the TMDL waste load allocation which may include outfall stabilization, stream restoration, stormwater system upgrades/repair and dredging projects. Moving forward, the City plans to apply for grants to obtain the necessary funding to implement these projects.

3.7 Lower Land Disturbance Thresholds

An option in the new MS4 permit is to reduce the loads associated with sediment by lowering land disturbance thresholds below Virginia's regulatory requirements for erosion and sediment control and post development stormwater management. The City has reduced these thresholds from 10,000 square feet to 5,000 square feet but intends to develop a methodology to quantify the reductions based on the Revised Universal Soil Loss Equation (RUSLE) A = R * K * LS * C * P where:

A = estimated average annual soil loss (tons/acre/year).

R = rainfall/runoff factor, quantifying the effect of raindrop impact and the amount and rate of runoff associated with the rain, based on long term rainfall record.

K = soil erodibility factor based on the combined effects of soil properties influencing erosion rates.

LS = slope length factor, a combination of slope gradient and continuous extent

C = cover and management factor, incorporating influences of crop sequence, residue management, and tillage.

P = practice factor, incorporating influences of conservation practices such as contouring or terraces.

3.8 Street Sweeping

The City of Salem has historically taken significant credit toward its street sweeping efforts, particularly under the “mass loading approach.” This approach allowed Salem to account for the effectiveness of its street sweeping program in reducing stormwater pollution by tracking the mass of debris and contaminants collected during each sweeping operation. By using this method, the City was able to demonstrate a commitment to improving stormwater quality and fulfilling regulatory requirements related to pollution prevention. This credit was important in meeting environmental goals and showcasing the City's dedication to maintaining clean streets and reducing the potential for contaminants entering the stormwater system.

However, with the shift in methodology from the “mass loading approach” to the “lane mile approach,” which emphasizes the length of streets swept rather than the mass of debris removed, Salem has not formalized a structured street sweeping program that aligns with the new requirements. The change in approach has prompted the need for a reevaluation of how the City measures and tracks its street sweeping efforts, as the lane mile approach involves more specific metrics related to the area covered by street sweeping operations. While the City has continued its street sweeping activities, the transition to the new methodology has highlighted the need for Salem to develop a more organized and structured program that aligns with the updated standards.

Despite these challenges, Salem continues to prioritize street sweeping as a vital part of its stormwater management efforts. The City recognizes that street sweeping is an essential tool for reducing the accumulation of pollutants on roadways, which can eventually wash into the stormwater system and impact water quality. Salem has plans to develop a more structured and formalized street sweeping program that incorporates the lane mile approach.

4.0 IMPLEMENTATION OF STRATEGIES TO REDUCE SEDIMENT

The following section outlines current strategies that have been identified to address sediment reduction, improve water quality, and support the long-term resilience of the City's stormwater management system. These initiatives are designed to be adaptive, ensuring the City's approach remains effective and responsive to changing conditions and regulatory requirements.

4.1 Evaluation of the Results Achieved by the 2018 - 2023 Action Plan

MS4 Program Credit

As shown in Section 4.1 above, the City proposed to take credit for the implementation of the six minimum control measures of the MS4 Program to the maximum extent practicable, which resulted in a sediment reduction of 182.65 tons per year. These measures include public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site runoff control, post-construction stormwater management, and pollution prevention and good housekeeping for municipal operations which are crucial for managing stormwater quality and reducing pollution. **Therefore, the demonstrated reductions in the 2018 - 2023 permit year were 182.65 tons per year.**

Resilience Plan

The City has also developed a resilience plan aimed at securing funding for projects that will reduce sediment and assist with meeting the TMDL WLA. This plan focuses on identifying and prioritizing key projects, such as stormwater system upgrades, stream restoration, and floodplain stabilization, which are designed to minimize sediment runoff and improve water quality. The City plans to actively pursue grant opportunities and collaborate with state, federal, and nonprofit organizations to obtain the necessary financial resources to implement these projects. By aligning these efforts with the goal of sediment reduction, the City's resilience plan not only helps meet regulatory requirements but also strengthens the long-term sustainability and climate resilience of local infrastructure and natural ecosystems.

4.2 Adaptive Management Strategies for the 2023 – 2028 Action Plan

By continuously assessing and refining strategies based on monitoring results and evolving environmental conditions, the City can adjust its approach as needed to ensure ongoing progress toward meeting sediment reduction goals. This adaptive management framework allows for flexibility in responding to unforeseen challenges or changes, ensuring that the City remains responsive to new data, technological advancements, and regulatory updates. Through this iterative process, the City is committed to achieving and maintaining the WLA while continuously improving its stormwater management practices for long-term environmental protection and resilience. The following are proposed strategies from Section 4.0 to be evaluated in the 2023 - 2028 MS4 GP.

(1) Resilience Plan Project
(2) Lower Land Disturbance Thresholds
(3) Street Sweeping Program Development

4.3 Progress Reporting

Progress will be reported through explicit accounting of sediment reductions for the strategies proposed in Section 4.0. The City will track the effectiveness of these strategies by documenting sediment removal and reductions achieved through various initiatives outlined in the plan. The City's Annual Report will serve as the primary documentation for tracking and communicating progress, providing a comprehensive review of the activities and outcomes related to sediment reduction efforts.

5.0 SCHEDULE

Table 5 summarizes the schedule for the implementation of the strategies in Section 4.0. This table outlines the specific milestones and timelines for each phase of the program, detailing when key actions will be taken. This schedule ensures that the City stays on track to complete each step in a timely manner and can effectively monitor and adjust as needed.

Table 5: Schedule for Salem's TMDL Action Plan Street Sweeping Program

Step	General Description	Measurable Goal	Completion Date
1	Programmatic Planning of Reductions	Coordination with DEQ on credit for the implementation of City's MS4 Program. Evaluate a credit for the reduced land disturbance threshold written in the City's ordinance. Evaluate the street sweeping program. Determine lane miles swept potential of City streets. Select a street sweeping scenario for implementation. Obtain funding for resilience plan projects.	June 30, 2026
2	Implementation and planning of Strategies	Refine street sweeping program and develop necessary street documentation per expert panel report. Continue resilience plan efforts and projects. Assess the numerical progress toward meeting the WLA. Consider implementation of additional strategies.	June 30, 2027
3	Continued Implementation and planning of Strategies. Program Evaluation.	Implement a formal street sweeping program if deemed feasible. Continue resilience plan efforts. Implement and/or plan projects. Programmatic evaluation of practices and assessment of future efforts to meet the WLA.	June 30, 2028 – June 30, 2040

6.0 REFERENCES

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