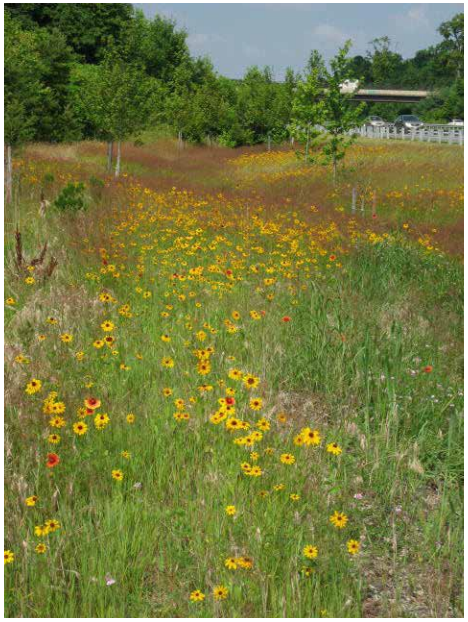
State Highway Administration

Impervious Restoration and Coordinated Total Maximum Daily Load Implementation Plan

October 8, 2016 | Revised: February 22, 2017, July 31, 2017, & October 9, 2017



Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

SHA State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

October 7, 2016

Mr. Raymond Bahr
Sediment, Stormwater, and Dam Safety Program
Water Management Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 440
Baltimore, Maryland 21230

Dear Mr. Bahr,

The State Highway Administration (SHA) is pleased to submit this Impervious Restoration and Coordinated TMDL Plan addressing conditions under the SHA National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (11-DP-3313 MD 0068276) which took effect on October 9, 2015. The plan covers the permit requirements of treating or offsetting 20 percent of currently untreated baseline impervious surfaces, Chesapeake Bay restoration efforts and working toward meeting stormwater wasteload allocations for local watersheds through implementation of a Coordinated TMDL Implementation Plan. This submission includes one hard copy of the plan.

If you have any questions or need additional information regarding this delivery, please contact Ms. Karen Coffman at 410-545-8407 (or via email at kcoffman@sha.state.md.us) or me at 410-545-8640 (or via email at sram@sha.state.md.us).

Sincerely,

Sonal Ram, Director
Office of Environmental Design

Enclosure: Impervious Restoration and Coordinated TMDL Plan

Cc: Mr. Robert Shreeve, Office of Environmental Design, SHA
Ms. Karen Coffman, Office of Environmental Design, SHA
Mr. Brian Cooper, Sediment, Stormwater, and Dam Safety Program, MDE

Larry Hogan, **Governor**
Boyd K. Rutherford, **Lt. Governor**
Pete K. Rahn, **Secretary**
Gregory C. Johnson, **Administrator**

March 9, 2017

Mr. Raymond Bahr
Sediment, Stormwater, and Dam Safety Program
Water Management Administration
Maryland Department of the Environment
1800 Washington Boulevard, Suite 440
Baltimore, Maryland 21230

Dear Mr. Bahr,

The State Highway Administration (SHA) is submitting this letter as evidence of a correction that has been made to the *SHA Impervious Restoration and Coordinated TMDL Plan* that was originally submitted on October 8, 2016 addressing conditions under the SHA National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (11-DP-3313 MD 0068276) which took effect on October 9, 2015.

The List of Tables was revised to delete reference to Table 2-2, which does not exist in the document. Part II.E, Tables 2-2 (b-g) of were revised to correct the accidental inversion of the values shown in the Northing and Easting columns. The October 8, 2016 version of these tables incorrectly displayed the Northing values as Eastings, and Eastings as Northings. The revised table has corrected this issue and displays the coordinate information correctly. The pages with revisions will be published with an updated date, February 22, 2017, in the footer and inserted back into the *Impervious Restoration and Coordinated TMDL Implementation Plan* located on the SHA website at: http://www.roads.maryland.gov/Index.aspx?pageid=336

If you have any questions or need additional information regarding this corrigendum, please contact Mr. Travis Vance at (410) 545- 8623 (tvance@sha.state.md.us) or me at (410) 545-8407 (kcoffman@sha.state.md.us).

Sincerely,

Karen Coffman, Chief
Water Program Division

Enclosure: Corrigendum dated 2/22/2017

Cc: Mr. Brian Cooper, Sediment, Stormwater, and Dam Safety Program, MDE
Ms. Sonal Ram, Director, Office of Environmental Design, SHA
Mr. Robert Shreeve, Deputy Director, Office of Environmental Design, SHA

CORRIGENDA

FEBRUARY 22, 2017 – CORRECTIONS:

List of Tables .... Page V

Deleted entry for Table 2-2.

Part II, Section E, Tables 2-2 (b-g) .... Pages 2-11 to 2-125

Tables revised to correct accidental inversion of the values shown in the Northing and Easting columns. The October 8, 2016 version of these tables incorrectly displayed the Northing values as Eastings, and Eastings as Northings. The revised table has corrected this issue and displays the coordinate information correctly. The pages with revisions will be published with an updated date in the footer and inserted back into the Impervious Restoration and Coordinated Total Daily Maximum Load Implementation Plan.

THIS PAGE INTENTIONALLY LEFT BLANK

REVISIONS

July 31, 2017 – Revisions:

Part II, Section B, Section C, ... Pages 2-3 to 2-7

The revisions to these pages reflect the revised impervious baseline and 20% restoration goal.

Part II, Section C, Table 2-8 .... Page 2-8

Figure 2-8 was revised to reflect the new impervious restoration goal of 4709 impervious acres as opposed to the original impervious restoration goal of 4719 impervious acres.

October 9, 2017 – Revisions:

Part III, Section E, Tables 3-2 & 3-3 .... Pages 3-12 to 3-16

These tables were revised to reflect MDE-SSA suggested modeling approach of percent reduction as suggested in Attachment III of MDE’s comment letter on MDOT SHA 2016 Annual Report. The pages with revisions will be published with an updated date in the footer and inserted back into the Impervious Restoration and Coordinated Total Daily Maximum Load Implementation Plan.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

ABBREVIATIONS

AA	Anne Arundel (County)
AA-DPW	Anne Arundel County, Department of Public Works
AAH	Adopt-A-Highway
AASHTO	American Association of State Highway and Transportation Officials
ac	Acre
AFB	Air Force Base
Alt	Alternative
AMT	Automated Modeling Tool
AMT, Inc.	A. Morton Thomas and Associates, Inc.
ATV	All-terrain vehicle
BA	Baltimore (County)
BARC	Beltsville Agriculture Research Center
Bay	Chesapeake Bay
BBO	Beaverdam Run, Baisman Run, and Oregon Branch Subwatersheds of the Loch Raven Reservoir Watershed
BC-DEPRM	Baltimore County, Department of Environmental Protection and Resource Management
BC-DEPS	Baltimore County, Department of Environmental Protection and Sustainability
BIBI	Benthic Index of Biotic Integrity
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BSID	Biological Stressor Identification
BST	Bacterial Source Tracking
CAFO	Concentrated Animal Feeding Operation
CBP	Chesapeake Bay Program
CBWM	Chesapeake Bay Watershed Model
CC	Charles (County)
CC-BRM	Carroll County, Bureau of Resource Management
CC-DPGM	Charles County, Department of Planning & Growth
CCMS	Customer Care Management System
CFR	Code of Federal Regulations
CIP	Capital Improvement Project
CL	Carroll (County)
CRP	Community Reforestation Program
CSN	Chesapeake Stormwater Network
CSO	Combined Sewer Overflow
CTP	Consolidated Transportation Program
CWA	Clean Water Act
CWAPTW	Clean Water Action Plan Technical Workgroup
CWP	Center for Watershed Protection
DC	District of Columbia
DO	Dissolved Oxygen
DEL	Delivered Loads
DMCF	Dredged Material Containment Facilities
DNR	Maryland Department of Natural Resources
DRMO	Defense Reutilization and Marketing Office
ECD	Environmental Compliance Division (SHA)
E. coli	*Escherichia coli*
ED	Extended Detention
EMC	Event Mean Concentration
EMS	Environmental Management System
EOS	Edge of Stream

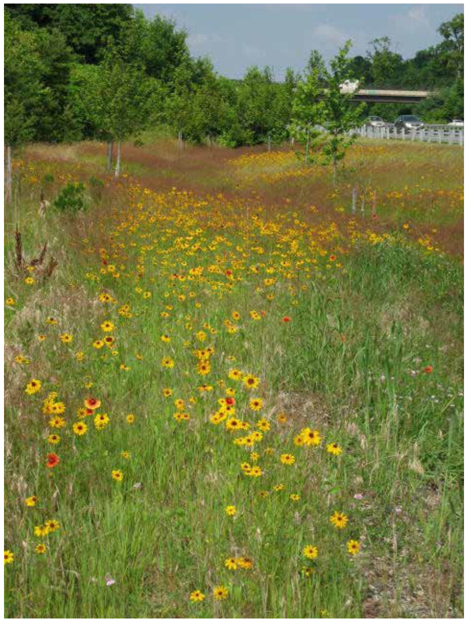
EPA	United States Environmental Protection Agency
EPD	Environmental Programs Division
ESC	Erosion and Sediment Control
ESD	Environmental Site Design
FC	Fecal Coliform
FC-DPW	Frederick County, Division of Public Works
FEMA	Federal Emergency Management Administration
FIB	Fecal Indicator Bacteria
FIBI	Fish Index of Biotic Integrity
FMD	Facility Maintenance Division (SHA)
FR	Frederick (County)
FY	Fiscal Year
GIS	Geographic Information System
HA	Harford (County)
HC-DPW	Harford County, Department of Public Works
HO	Howard (County)
HUC	Hydrologic Unit Code
HWG	Horsley Witten Group, Inc.
ICPRB	Interstate Commission on the Potomac River Basin
IDDE	Illicit Discharge Detection and Elimination
ISWBMPDB	International Stormwater BMP Database
LA	Load Allocations
lbs	Pounds (weight)
LF	Linear Feet
LN	Lower North
LNB	Lower North Branch
LRE	Loch Raven East subwatershed
LJF	Lower Jones Falls (Watershed)
LU	Land Use
MAA	Maryland Aviation Administration
MAST	Maryland Assessment Scenario Tool
MC-DEP	Montgomery County, Department of Environmental Protection
MD	Maryland
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MDP	Maryland Department of Planning
MEP	Maximum Extent Practicable
MEPA	Maryland Environmental Policy Act
MGF	Middle Gwynns Falls (Watershed)
MO	Montgomery (County)
MOS	Margin of Safety
MPR	Maximum Practicable Reduction
MS4	Municipal Separate Storm Sewer System
NBOD	Nitrogenous Biochemical Oxygen Demand
NEPA	National Environmental Policy Act
NFHL	National Flood Hazard Layer
NJF	Northeastern Jones Falls (Watershed)
NPDES	National Pollutant Discharge Elimination System
NSQD	National Stormwater Quality Database
OCRI	Office of Customer Relations and Information (SHA)
OED	Office of Environmental Design
OOM	Office of Maintenance (SHA)
OP	Orthophosphate
OPPE	Office of Preliminary Planning and Engineering

PACD	Pennsylvania Association of Conservation Districts
PB	Parsons Brinckerhoff
PCB	Polychlorinated Biphenyl
PERC	Perchloroethylene
PG	Prince George's (County)
PGC-DoE	Prince George's County, Department of the Environment
RBP	Rapid Bioassessment Protocol
RGP	Regional General Permit
ROW	Rights-Of-Way
Reqd	Required
RR	Runoff Reduction
RSPSC	Regenerative Step Pool System Conveyance
SAH	Sponsor-A-Highway
SB	Spring Branch subwatershed
SCA	Stream Corridor Assessment
SFEI	San Francisco Estuary Institute
SGW	Submerged Gravel Wetlands
SHA	State Highway Administration
SPR	State Planning and Research
SSO	Sanitary Sewer Overflow
ST	Stormwater Treatment
SW	Stormwater
SWAP	Small Watershed Action Plan
SWM	Stormwater Management
SWS	Subwatershed
SW-WLA	Stormwater Wasteload Allocation
TBD	To Be Determined
TBR	Tidal Back River (Watershed)
TBS	To Be Specified
TCWG	Toxic Contaminants Work Group
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
tPCB	Total Polychlorinated Biphenyl
TSS	Total Suspended Solids
TWGCB	Toxics Work Group Chesapeake Bay Partnership
UBR	Upper Back River (Watershed)
UGF	Upper Gwynns Falls (Watershed)
UJF	Upper Jones Falls (Watershed)
US	United States
USACE	United States Army Corps of Engineers
USDA-NRCS	United States Department of Agriculture, Natural Resources Conservation Service
USGS	United States Geological Survey
USWG	Urban Stormwater Work Group
WA	Washington (County)
WC-DPW	Washington County, Division of Public Works
WCSCD	Washington County Soil Conservation District
WIP	Watershed Implementation Plan
WLA	Wasteload Allocation
WPD	Water Programs Division
WQLS	Water Quality Limited Segment
WQSs	Water Quality Standards
WQv	Water Quality Volume
WQGIT	Water Quality Goal Implementation Team

WRAS	Watershed Restoration Action Strategy
WTM	Watershed Treatment Model
WTWG	Watershed Technical Work Group
WWTP	Waste Water Treatment Plant
yr	Year
12-SW	Maryland General Permit for Discharges from Stormwater Associated with Industrial Activities

SHA State Highway Administration
Maryland Department of Transportation

Part I
Program Introduction



I. PROGRAM INTRODUCTION

A. PURPOSE

The State Highway Administration (SHA) is required to reduce water pollution to the maximum extent practicable (MEP) as a condition of the agency's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit 11-DP-3313 (hereinafter referred to as the "MS4 Permit") issued on October 9, 2015. The Maryland Department of the Environment (MDE) issues permits to contributors, such as SHA, under the NPDES program. Urban stormwater runoff is regulated under the MS4 Permit. MS4 permit holders are required to manage their stormwater runoff to prohibit pollution from discharging into water bodies and to attain the targeted wasteload allocations (WLAs) for pollutants.

This Impervious Restoration and Coordinated Total Maximum Daily Load (TMDL) Implementation Plan (Plan) is a required document under SHA's MS4 Permit to establish SHA's protocol for ensuring that wasteloads are reduced and are not exceeding thresholds that would cause excessive pollution in local waterways or the Chesapeake Bay. SHA's approach is unique in each county and watershed. This Plan is divided into four parts:

- **Part I, Program Introduction** provides an overview and introduction to SHA's MS4 Permit, TMDLs, and best management practices (BMPs) used for compliance;
- **Part II, Impervious Restoration and Chesapeake Bay TMDL Compliance** details the strategy, assessment, costs, and schedule for impervious surface treatment in each of the MS4 counties and restoration efforts for Chesapeake Bay TMDL compliance;
- **Part III, Coordinated TMDL Implementation Plan** describes coordination with county MS4 jurisdictions concerning watershed assessments and the development of a coordinated TMDL implementation plan; and
- **Part IV, SHA Watershed TMDL Implementation Plans** detail the strategy, assessment, costs, and schedule for pollution reduction strategies in each of the locally designated TMDL watersheds.

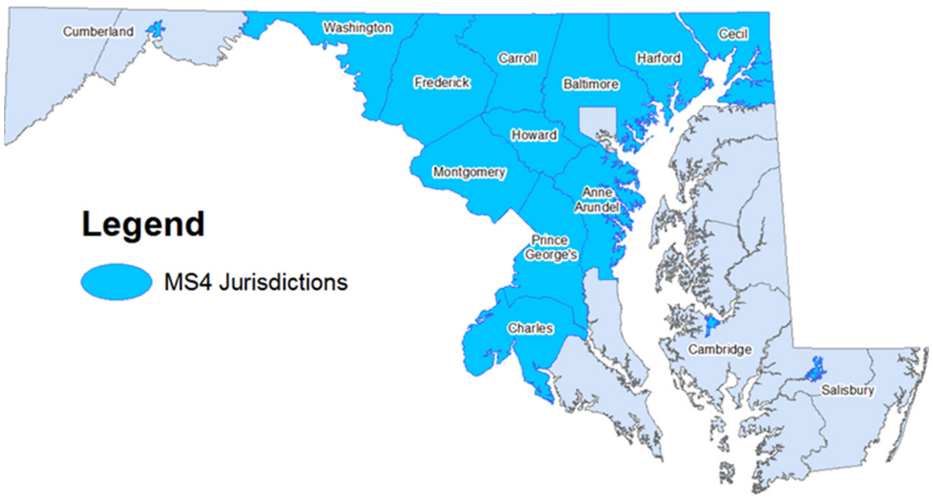


Figure 1-1: MS4 Permit Coverage Area

B. SCOPE

MDE issued MS4 Permits to cover stormwater discharges from the storm drain systems owned or operated by SHA in the NPDES Phase I and II jurisdictions of Anne Arundel, Baltimore, Carroll, Charles, Cecil, Frederick, Harford, Howard, Montgomery, Prince George's, and Washington counties and the cities of Cumberland, Salisbury, and Cambridge. See **Figure 1-1** for a map of the Phase I and II jurisdictions of Maryland where SHA owns and maintains right-of-way (ROW). It is important to note that while Baltimore City is also an MS4 jurisdiction within the State of Maryland. However, SHA does not own any ROW or stormwater management (SWM) facilities within the city limits and therefore is not part of SHA's MS4 permit coverage area.

SHA also owns and maintains several industrial facilities, such as maintenance shops, that are regulated by the State's General Permit for Discharges from Stormwater Associated with Industrial Activities (12-SW). The 12-SW states that impervious restoration requirements for industrial properties shall be included in the jurisdictional MS4 Permit. Therefore, SHA is including maintenance shops within MS4 areas as a part of the MS4 impervious restoration and TMDL implementation strategy. Restoration projects that are located within SHA industrial properties within MS4 jurisdictional areas are included as a part of this Plan. All other 12-SW requirements remain separate from the MS4 Permit requirements.

C. BACKGROUND

C.1. Surface Water Quality Standards

The Clean Water Act (CWA) requires that Maryland manage a water quality program that establishes Water Quality Standards (WQSs) for Maryland waters, monitors the conditions of the waters, and lists water bodies that do not meet WQSs with technology-based controls alone. Results can be found in MDE's biennial *Integrated Report of Surface Water Quality* (MDE, 2015a). This includes water quality assessments and lists of impaired watersheds, which is formally known as the 303(d) List. Furthermore, the State is required to set priority rankings for the water bodies listed and establish TMDLs that meet WQSs for each listed water body.

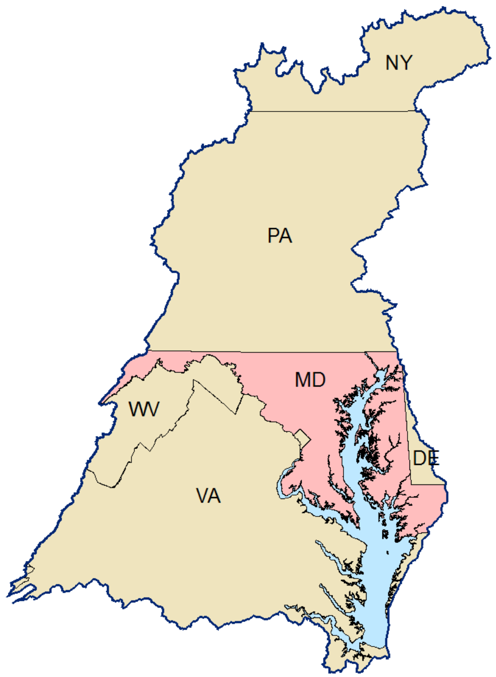


Figure 1-2: Chesapeake Bay Watershed

TMDLs are a tool for implementing State WQSs, and they are based on the relationship between pollution sources and in-stream water quality conditions. The TMDLs are established for the maximum amount of an impairing substance or stressor that a water body can assimilate and still meet WQSs. The TMDL allocates that load among several pollution contributors. Contributors can include point sources, such as sewage treatment plants or regulated municipal storm sewers; and non-point sources, such as runoff from agricultural land. The United States Environmental Protection Agency (EPA) approves TMDLs.

C.2. Chesapeake Bay TMDL Requirements

The Chesapeake Bay (Bay) is a national treasure constituting the largest estuary in the United States and one of the largest and most biologically productive estuaries in the world. Pollution from surface stormwater runoff and other sources that discharge to the Bay have become a serious threat to the ecologic health of the Bay, and prevents the attainment of existing State WQSs for dissolved oxygen (DO), water clarity, and chlorophyll. The pollutants that are largely responsible for impairing the Bay are sediment and the nutrients nitrogen and phosphorus, although other pollutants also present a risk in more specific areas.

In 2009, President Obama issued Executive Order 13508 directing the Federal Government to lead the restoration efforts of the Chesapeake Bay, which has a 64,000 square mile watershed (See **Figure 1-2**) that includes the jurisdictions of Maryland, Virginia, Pennsylvania, Delaware, West Virginia, New York, and the District of Columbia (DC). In 2010, the EPA developed a nutrient and sediment pollution TMDL for the Bay in coordination with these jurisdictions. As a partner with the other Bay watershed jurisdictions and EPA, Maryland played a key role in the development of the Bay TMDL.

EPA has instituted accountability measures to ensure clean-up commitments are met by each State, including short and long-term benchmarks, a tracking and accountability system for activities, and federal contingency actions that can be employed if necessary to promote progress. The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017.

The TMDL addresses impairments for tidal segments of the Bay and identifies necessary pollution reductions for nitrogen, phosphorus, and sediment. These allocations are split between several pollutant sources (also referred to as sectors) including agriculture, urban stormwater, septic, wastewater, and others.

The Bay watershed jurisdictions developed Watershed Implementation Plans (WIPs) in two phases detailing how maximum loads for each pollutant will be met. Maryland's Phase I and Phase II WIPs were developed by MDE, and the initial SHA implementation plan is included in Appendix E of WIP I. The EPA-approved WIPs are available on MDE's website.

SHA is included within the urban stormwater sector, and Bay requirements for this sector are tied to impervious restoration. The MS4 permits include impervious restoration requirements that are discussed below in **Section D**, **MS4 Permit Requirements** and in **Part II.A Urbanization and Impervious Surface Restoration** of this Plan.

C.3. SHA Local TMDL Requirements

TMDLs are issued for local tidal and non-tidal waterways throughout Maryland. These TMDLs are also based on State WQSs, issued by MDE, and approved by EPA. TMDLs are enforced through NPDES permits, including MS4 permits. Because SHA is an MS4 permittee, SHA is required to address local WLAs where SHA is a designated contributor. **Figure 1-3** and **Table 1-1** on the following pages show the current local watershed TMDLs where SHA has an individual wasteload reduction allocation or an aggregated wasteload reduction target. The Bush River watershed representing a local TMDL with SHA responsibility is not shown in Figure 1-3 at this time due to incomplete data from MDE's TMDL Data Center. The TMDL pollutants that SHA is required to address within designated watersheds include bacteria, PCBs, phosphorus, sediment, and trash. The SHA plan to meet local TMDLs is provided in **Part III, Coordinated TMDL Implementation Plan** and **Part IV, SHA Watershed TMDL Implementation Plans**.

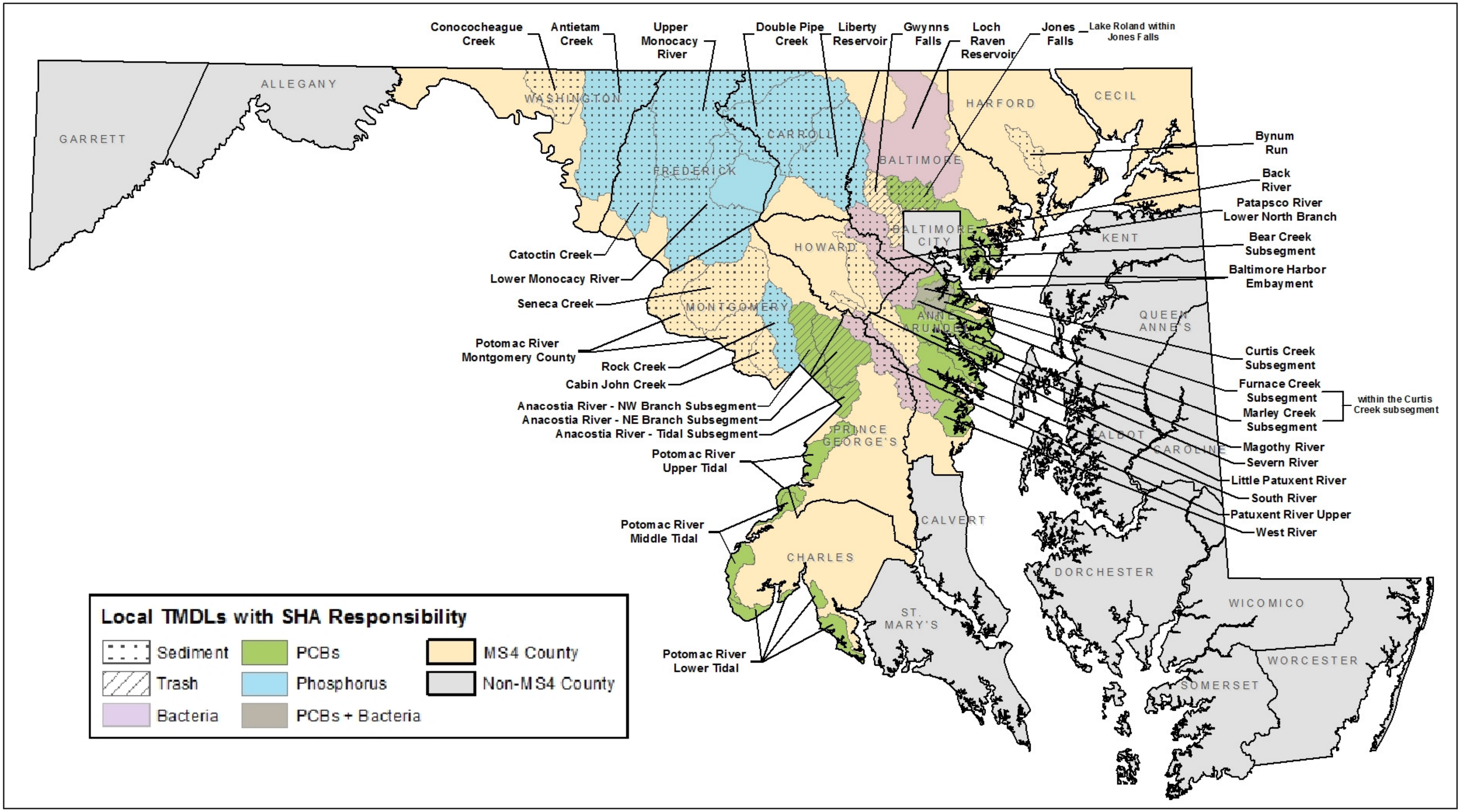


Figure 1-3: Local TMDL Watersheds with SHA Wasteload Reduction Requirement

Table 1-1: Local 8 Digit TMDL Watersheds with SHA Responsibility						
Watershed Name	MD Basin Code/ Assessment Unit ID	Pollutant				
		Bacteria	PCBs	Phosphorus	Sediment	Trash
Anacostia River	02140205		✓			✓
Antietem Creek	02140502			✓	✓	
Back River	MD-BACOH		✓			
Baltimore Harbor	02130903					
• **Baltimore Harbor**	02130903 - EMBAYMENT		✓			
• **Bear Creek Subwatershed**	02130903 MD-PATMH-BEAR-CREEK		✓			
• **Curtis Creek/Bay Subwatershed**	02130903 MD-PATMH-CURTIS_BAY_CREEK		✓			
• **Furnace Creek Subwatershed**	02130903 MD-PATMH-FURNACE_CREEK	✓				
• **Marley Creek Subwatershed**	02130903 MD-PATMH-MARLEY_CREEK	✓				
Bush River Oligohaline	MD-BSHOH-02130701		✓			
Bynum Run	02130704				✓	
Cabin John Creek	02140207				✓	
Catoctin Creek	02140305			✓	✓	
Conococheague Creek	02140504				✓	
Double Pipe Creek	02140304			✓	✓	
Gwynns Falls	02130905				✓	✓

Table 1-1: Local 8 Digit TMDL Watersheds with SHA Responsibility						
Watershed Name	MD Basin Code/ Assessment Unit ID	Pollutant				
		Bacteria	PCBs	Phosphorus	Sediment	Trash
Jones Falls	02130904				✓	✓
• **Lake Roland Subwatershed**	MD-02130904-Lake_Roland		✓			
Liberty Reservoir	02130907			✓	✓	
Little Patuxent River	02131105				✓	
Loch Raven Reservoir	02130805	✓				
Lower Monocacy River	02140302			✓	✓	
Magothy River	MD-MAGMH-02131001		✓			
Patapsco River LN Branch	02130906	✓			✓	
Patuxent River Upper	02131104	✓			✓	
Potomac River MO County	02140202				✓	
Potomac River Lower Tidal	02140101		✓			
Potomac River Middle Tidal	02140102		✓			
Potomac River Upper Tidal	02140201		✓			
Rock Creek	02140206			✓	✓	
Seneca Creek	02140208				✓	
Severn River Mesohaline	MD-SEVMH-02131002		✓			
South River Mesohaline	MD-SOUMH-02131003		✓			

Table 1-1: Local 8 Digit TMDL Watersheds with SHA Responsibility						
Watershed Name	MD Basin Code/ Assessment Unit ID	Pollutant				
		Bacteria	PCBs	Phosphorus	Sediment	Trash
Upper Monocacy River	02140303			✓	✓	
West and Rhode Rivers Mesohaline	MD-WST-RHDMH-02131004		✓			
Note: See Tables 3-2, and 3-3 for details on SHA WLAs, reduction requirements and implementation plan modeling results.						

D. SHA MS4 PERMIT REQUIREMENTS

Requirements in the SHA MS4 Permit that pertain to this impervious restoration and coordinated TMDL implementation plan are listed below and taken from Part III.E of the Permit:

Restoration Plans and Total Maximum Daily Loads (Permit Part III.E)

In compliance with §402(p)(3)(B)(iii) of the CWA, MS4 Permits must require stormwater controls to reduce the discharge of pollutants to the MEP. By regulation at 40 CFR §122.44, BMPs and programs implemented pursuant to this permit must be consistent with applicable WLAs developed under EPA approved TMDLs. In pursuit of these goals, SHA shall coordinate watershed assessments with surrounding jurisdictions and annually report on restoration plans, opportunities for public participation, and TMDL compliance status to MDE. As required below, watershed assessments and restoration plans shall include a thorough discussion of water quality analysis findings based on coordination with surrounding jurisdictions, TMDL documents and other resources when available, identification of water quality improvement opportunities, and a schedule for BMP and programmatic implementation to meet stormwater WLAs included in EPA approved TMDLs. SHA shall address both specific WLAs and target loads when SHA is part of larger aggregate loads. A list of EPA approved TMDLs for SHA in the permit area is included in Attachment B of the permit.

Watershed Assessments (Permit Part III.E.1)

SHA shall coordinate watershed assessments with surrounding jurisdictions, which shall include, but not be limited to the evaluation of available State and county watershed assessments, SHA data, visual watershed inspections targeting SHA ROW and facilities, and approved stormwater WLAs to:

- *Determine current water quality conditions;*
- *Include the results of visual inspections targeting SHA ROW and facilities conducted in areas identified as priority for restoration;*
- *Identify and rank water quality problems for restoration associated with SHA ROW and facilities;*
- *Achieve water quality goals by identifying all structural and nonstructural water quality improvement projects to be*

implemented using the watershed assessments established; and

- *Specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable stormwater WLAs.*

Restoration Plans (Permit Part III.E.2.a)

Within one year of permit issuance, SHA shall submit an impervious surface area assessment consistent with the methods described in the MDE document "Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollutant Discharge Elimination System Stormwater Permits" (MDE, August 2014 or subsequent versions). Upon approval by MDE, this impervious surface area assessment shall serve as the baseline for the restoration efforts required in this permit.

By the end of this permit term, SHA shall commence and complete the implementation of restoration efforts for twenty percent of SHA's impervious surface area consistent with the methodology described in the MDE document cited in PART IV.E.2.a. that has not already been restored to the MEP. Equivalent acres restored of impervious surfaces, through new retrofits or the retrofit of pre-2002 structural BMPs, shall be based upon the treatment of the WQv [Water Quality Volume] *criteria and associated list of practices defined in the 2000 Maryland Stormwater Design Manual. For alternate BMPs, the basis for calculation of equivalent impervious acres restored is based upon the pollutant loads from forested cover.*

Coordinated TMDL Implementation Plan (Permit Part III.E.2.b)

Within one year of permit issuance, a coordinated TMDL implementation plan shall be submitted to MDE for approval that addresses all EPA approved stormwater WLAs (prior to the effective date of the permit) and requirements of Part VI.A., Chesapeake Bay Restoration by 2025 for SHA's storm sewer system. Both specific WLAs and aggregate WLAs which SHA is a part of shall be addressed in the TMDL implementation plans. Any subsequent stormwater WLAs for SHA's storm sewer system shall be addressed by the coordinated TMDL implementation plan within one year of EPA approval. Upon approval by MDE, this implementation plan will be enforceable under this permit. As part of the coordinated TMDL implementation plan, SHA shall:

- *Include a final date for meeting applicable WLAs and a detailed schedule for implementing all structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives necessary for meeting applicable WLAs;*

- *Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;*

- *Evaluate and track the execution of the coordinated implementation plan through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and stormwater WLAs; and*

- *Develop an ongoing, iterative process that continuously implements structural and nonstructural restoration projects, program enhancements, new and additional programs, and alternative BMPs where the EPA-approved*

TMDL stormwater WLAs are not being met according to the benchmarks and deadlines established as part of SHA's watershed assessments.

Public Participation (Permit Part III.E.3)

SHA shall provide opportunity to the public regarding the development of its coordinated TMDL implementation plan by allowing for public participation, soliciting input, and incorporating any relevant ideas and program improvements that can aid in achieving TMDLs and water quality standards according to the actions below. SHA shall provide:

- *Notice in a regional newspaper and on SHA's website outlining how the public may obtain information on the development of the coordinated TMDL implementation plan and opportunities for comment;*
- *Procedures for providing copies of the coordinated TMDL implementation plan to interested parties upon request;*
- *A minimum 30-day comment period before finalizing the coordinated TMDL implementation plan; and*
- *A summary in each annual report of how SHA addressed or will address any material comment received from the public.*

In response to this public participation requirement, SHA posted a draft of the Plan on its website on August 1, 2016. The 30-day public comment period ended on August 31. A summary of comments received will be included in the SHA MS4 annual report submitted to MDE. The annual report will also be posted on SHA's MS4 Permit webpage accessed from the link below:

http://www.roads.maryland.gov/Index.aspx?pageid=336

E. PROJECT IMPLEMENTATION METHODOLOGIES

E.1 Regulatory Guidance and Permitting

Compliance efforts for impervious restoration, the Bay TMDL and local TMDLs are included in this Plan. Because of these multiple areas of compliance (MS4 and separate TMDLs), accounting for progress can be complicated. The MS4 impervious restoration and Chesapeake Bay TMDL compliance can be handled with the same set of practices that reduce nitrogen, phosphorus, and sediment for local TMDLs. Other local TMDLs require reductions of trash, Polychlorinated Biphenyls (PCBs), and bacteria, and these pollutants call for different strategies. Guidance for preparing implementation plans has been developed by MDE and the Chesapeake Bay Program (CBP) listed below.

MDE TMDL Data Center Guidance

The following guidance is available on the MDE TMDL Data Center website:

- Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, MDE, August 2014;
- General Guidance for Developing a Stormwater Wasteload Allocation (SW-WLA) Implementation Plan, MDE, October 2014;
- Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan for Bacteria Total Maximum Daily Loads, MDE, May 2014;
- MDE Recommendations for Addressing the PCB SW-WLA, MDE, July 2013;
- Trash Monitoring Guidance, MDE, July 2014;

- Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Nutrient and Sediment Total Maximum Daily Loads, MDE, November 2014;
- Guidance for Developing Stormwater Wasteload Allocation Implementation Plans for Trash/Debris Total Maximum Daily Loads, MDE, May 2014.

Chesapeake Bay Program (CBP) Guidance

The following guidance is approved by the CBP and is available on the Chesapeake Stormwater Network (CSN) website:

- Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects, CBP Urban Stormwater Work Group (USWG), Watershed Technical Work Group (WTWG) and Water Quality Goal Implementation Team (WQGIT), September 2104;
- U-4 Urban Stream Restoration: Good Recipes for the Bay Pollution Diet, CBP, June 2015;
- Guidance for Verifying Stream Restoration Projects, CBP, January 2014;
- Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards, CBP USWG, WTWG, WQGIT, January 2015;
- Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects, CBP USWG, WTWG, WQGIT, January 2015;
- U-2 Stormwater Practices for New and Redevelopment Projects: Good Recipes for the Bay Pollution Diet, CBP, June 2015;
- U-1 Urban Stormwater Retrofits: Good Recipes for the Bay Pollution Diet, CBP, June 2015;
- Recommendations of the Expert Panel to Define Removal Rates for Street and Storm Drain Cleaning Practices, CBP, May 2016;
- Potential Benefits of Nutrient and Sediment Practices to Reduce Toxic Contaminants in the Chesapeake Bay Watershed, Part 1: Removal of Urban Toxic Contaminants, CBP Toxic Contaminants Work Group (TCW), December 2015.

Permits for Construction Projects

Permits for construction projects are obtained following standard practices to comply with all State and Federal laws. General permits are pursued when possible. Permits include:

- National Environmental Policy Act (NEPA)/Maryland Environmental Policy Act (MEPA) clearances that also include Section 106 cultural resources;
- Maryland SWM and Erosion and Sediment Control Approvals
- Maryland Reforestation Law, Roadside Tree Law and Forest Conservation Act;
- Maryland Aviation Administration (MAA) for projects within airport clear zones;
- Critical Areas Commission;
- Maryland Dam Safety for thermal impacts related to construction in Use III waters and certain stormwater embankments;
- Maryland and Federal Wetland and Waterways for impacts to US waters and wetlands;
- US Army Corps of Engineers (USACE) Chesapeake Bay Total Maximum Daily Load Regional General Permit (Bay TMDL RGP); USACE, July 2015;
- Others as needed.

E.2. Urban Sector Focus

MDE has specified that at least half of the 20 percent impervious restoration should be within the urban sector. At least 10 percent of the impervious restoration must be provided by practices that treat SHA impervious surface runoff directly or are placed within urban land areas if outside SHA ROW.

The Bay TMDL considers Phase I and II MS4 jurisdiction areas the 'urban sector'. An area is considered a Phase I or II MS4 jurisdiction based upon population. Medium sized MS4 jurisdictions are located in an incorporated place or county with a population between 100,000 and 249,999. Large MS4 jurisdictions are located in an incorporated place or county with a population of 250,000 or greater. See **Figure 1-1** for MS4 jurisdictions in Maryland. These counties and cities also hold their own MS4 Permits.

In the Maryland WIP I, the urban sector is required to meet MS4 impervious treatment as the method to address Bay restoration. For purposes of complying with the MS4 Permit, MDE considers all lands within SHA ROW as urban. Under this definition, SHA roads that traverse agricultural, forested, or rural areas are considered urban areas.

SHA plans to provide impervious restoration to at least 10 percent of the untreated impervious area within SHA ROW or urban land use areas as defined by the 2010 Maryland Department of Planning (MDP) land use classifications (MDP, 2010). These classifications include:

11 Low-density residential
12 Medium-density residential
13 High-density residential
14 Commercial
15 Industrial
16 Institutional
17 Extractive
18 Open urban land
191 Large lot subdivision (agriculture)
192 Large lot subdivision (forest)
80 Transportation

E.3. Watershed Focus

For impervious restoration efforts within each county, SHA is prioritizing impaired watersheds that have EPA approved TMDLs with SHA WLAs. Impervious restoration efforts that target local TMDLs count towards the 20 percent MS4 impervious restoration requirement, Bay TMDL, and local WLAs. Because restoration practices in these watersheds count towards compliance with the statewide requirements, increased efficiency in utilizing funding and staffing as well as meeting timeframes for compliance can be achieved by targeting these local TMDLs for impervious restoration efforts.

The anti-degradation policy defined in the CWA and Maryland law requires that high quality waters be maintained in good condition. Maryland has Tier II waters (high quality) but not Tier III (waters of national significance). SHA identifies high quality waters when performing site searches and, if opportunities exist, targets these areas with restoration practices.

Input from counties is also sought regularly and in instances when a local jurisdiction requests SHA to have a stronger focus on certain watersheds, SHA works with the jurisdiction to develop agreements under which the implementation of appropriate practices can be undertaken as a partnership. In most instances, these would be watersheds with an EPA-approved TMDL in place, but they could also be watersheds of other local significance.

E.4 Coordination with Other MS4 Jurisdictions

SHA has established an outreach program tasked with coordinating pollution reduction strategies with each of the MS4 jurisdictions and counties. The purpose is to establish a cooperative relationship and identify partnering opportunities. This coordination is important to ensure that local officials are informed and have the opportunity to provide input on SHA's planned activities. These meetings result in more efficient efforts to address TMDL load reductions in targeted areas and establish relationships to coordinate other MS4 program initiatives.

As discussed above, Memoranda of Understandings or Agreements are being actively sought with other MS4 jurisdictions, government agencies and private organizations with the intent to share resources in restoring local and regional waters.

E.5. Redevelopment Credit

As SHA modifies or expands the existing roadway network to improve safety and mobility, SWM practices are implemented or upgraded to treat runoff from existing, untreated roadway segments and to meet current SWM standards. Per MDE (2014a), "Any project that meets or exceeds the regulatory requirements for redevelopment may be used to claim credit toward impervious acre treatment requirements and pollutant load reductions." This redevelopment credit is computed based on the method agreed upon between MDE and SHA on March 15, 2016 and includes both reconstructed impervious area credit and impervious area removal credit. As the majority of all SHA projects are classified as redevelopment, meaning 40% or more of the site area is impervious, and typically these projects include reconstruction of existing untreated impervious area within the limit of disturbance, SHA can receive credit for pollution reduction with the implementation of these reconstruction projects. For further discussion of redevelopment credit, see **Part II.B.2 Baseline Runoff Treatment Assessment**.

E.6. Existing Grass Channel Inventory

Many of SHA's roadways drain to open channel grass swales that convey flows from the roadway to stormdrains or waterways. See **Figure 1-4** for an example. MDE recognizes that these channels provide water pollution treatment and allow for "open section roads with swales that meet the grass swale criteria in the Manual [MDE, 2009a]" to be considered as providing acceptable water quality treatment (MDE, 2014a, p. 9, Table 1). A full inventory and analysis of existing grass swales along SHA ROW and within the MS4 jurisdictions has been completed. This analysis has been used to calculate actual levels of treatment currently being provided for both pollutant reductions and treated impervious acreages. These existing swales have been documented as spatial features within the SHA NPDES database and the computed treatment added to the impervious baseline calculations. For further discussion of how this analysis affects the SHA baseline impervious calculation and to find the MDE approved *SHA Existing Water Quality Grass Swale Identification Protocol*, refer to **Part II.B.2., Baseline Runoff Treatment Assessment**.

Figure 1-4: Existing Grass Channel along Median of I-70 in Baltimore County

E.7.Nutrient Credit Trading Program

The Maryland Department of Agriculture (MDA) and MDE are partnering to establish a nutrient credit trading and offset program. Although the program is currently under development, principles and draft guidance are available. Under this approach, sectors are given the flexibility to meet their load limits by purchasing credits or offsets generated from load reductions elsewhere. MS4s would be allowed to purchase credits at market rate and enter into cross-sector trading agreements to meet up to half of their impervious surface area treatment required under the MS4 Permit conditions. Cross-sector trading will include point source and non-point sources. For example, transactions can occur between two point sources such as Waste Water Treatment Plants (WWTP) and regulated MS4 jurisdictions, or between a point source and non-point source such as regulated MS4 jurisdictions and agricultural operations.

Trading is proposed to be permitted within three geographic regions called Maryland Trading Regions (see **Figure 1-5**):

- Potomac River Basin;
- Patuxent River Basin; and
- A combination of the remaining Susquehanna River Basin, Eastern Shore, and Western Shore.

The unit of trade is a mass unit in time termed a pollution reduction credit. For example, in the case of sediment, the unit of trade is tons per year and in the case of nitrogen and phosphorus, the unit of trade is pounds per year.

Once the trading program and guidance are finalized, SHA intends to utilize this program as another practice to meet restoration requirements. For example, in areas where opportunities to implement traditional nutrient and sediment reduction strategies are limited, SHA anticipates the ability to utilize credit trading.

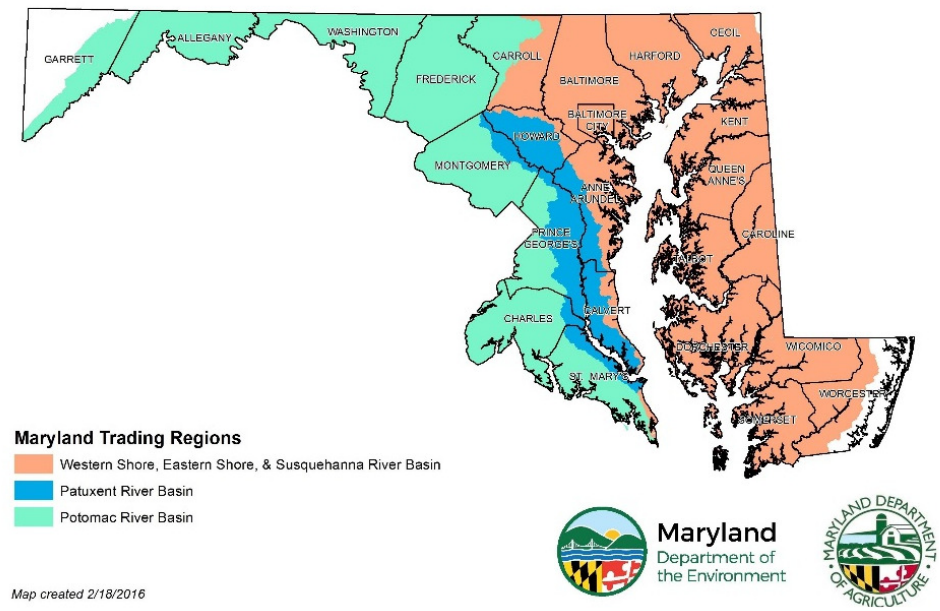


Figure 1-5: Proposed Maryland Trading Regions
(MDE, 2016)

E.8. Research

By employing improvements to practices, SHA can ensure the most effective use of ROW, funding and other resources. Some current practices under study include outfall stabilization crediting for nutrient removal; methods to measure pollutant removal from inlet cleaning and street sweeping; determining effectiveness of stormwater control practices in removing bacteria and toxic contaminants such as PCBs; and development of an outfall inspection protocol for PCBs, bacteria and other health related impairing pollutants.

E.9. Program Funding

SHA utilizes capital funds for planning, engineering, construction, inspections, establishment, remediation and research activities associated with impervious treatment and TMDL implementation. Operations and maintenance funds are used to maintain structural stormwater controls and conduct certain activities such as street sweeping and inlet cleaning. Projected expenditures for impervious restoration are discussed in **Part II, Impervious Restoration Plan and Chesapeake Bay TMDL Compliance** and expenditures for local TMDL implementation are discussed in **Parts III, Coordinated TMDL Implementation Plan** and **Part IV, SHA Watershed TMDL Implementation Plans**.

F. RESTORATION PRACTICE DESCRIPTIONS

This section describes the practices used to meet impervious restoration goals and TMDL pollutant reductions. **Part II** and **Part III** detail how these practices are or will be combined in implementing restoration and TMDL reduction strategies. Current restoration practices are taken from MDE (2014a) and the CBP technical workgroup protocols. As new practices are developed, SHA will consider potential to implement them. Some practices under consideration by SHA that are either currently under development or recently approved by these programs include:

- Floating Treatment Wetlands;
- Urban Filter Strips;
- Disconnecting Impervious Areas;
- Urban Tree Canopy;
- Urban Nutrient Management;
- Enhanced Erosion and Sediment Control;
- Shoreline Management;
- Illicit Discharge Detection; and
- Urban Tree Planting/Forest (revision to current BMP).

For the most efficient treatment or offset of stormwater pollution, combinations of currently approved measures are being implemented. SHA's ROW has been reviewed using geographic information system (GIS) analysis and a myriad of base data to determine the best combination of treatment strategies along any given roadway corridor with the goal of maximizing the use of ROW. Additionally, SHA is partnering with local jurisdictions, other organizations and agencies, and private citizens to implement projects outside of SHA ROW.

F.1. Design, Inspection & Maintenance Standards

A variety of restoration practices are being employed. Some practices produce reductions through an annually conducted activity such as street sweeping, inlet cleaning or educational outreach. Others, such as structural stormwater controls and tree planting, are permanent, built practices and are designed and constructed to certain standards. SHA adheres to the following standards for constructed practices:

- MDE 2000 Maryland Stormwater Design Manual;
- MDE 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control;
- Specifications for Performing Landscaping Activities for the Maryland Aviation Administration;
- AASHTO Roadside Design Guide;
- SHA Book of Standards for Highway & Incidental Structures;
- SHA Standard Specifications for Construction Materials;
- SHA Highway Drainage Manual;

- SHA Stormwater Management Site Development Criteria Manual; and
- SHA Landscape Design Guide.

Built restoration practices are required to be inspected every three years and necessary maintenance or remediation efforts undertaken in order to ensure optimal pollutant removal and to continue to receive credit against the 20% impervious restoration and pollutant load reductions. SHA has developed inspection and maintenance manuals for structural stormwater controls and tree sites. A geodatabase is used to track inspection timeframes, maintenance or remediation requirements and completion dates. Also, the Bay Program requires that pollutant removal credits be renewed for certain practices and these inspections will serve as confirmation of practice functionality.

F.2. Alternative Practices

MDE recognizes that not all of this restoration can be accomplished by building new or upgrading existing structural stormwater controls and allows for construction of alternative practices that are effective at offsetting the pollutant loads generated by impervious surfaces without treating stormwater runoff directly. These alternative practices are assigned impervious treatment equivalencies that calibrate the effectiveness of these practices against equivalent reductions in loading rates from urban land use. MDE (2014a, p. 19, Table 7) has provided a list of acceptable alternative practices. Accordingly, the alternative practices currently used by SHA include tree planting, stream restoration, catch basin cleaning, street sweeping, outfall stabilization, and impervious area removal. Other types of alternative practices may be employed in the future.

F.3. Categories of Practices

Restoration practices can also be organized into four categories: structural stormwater controls, land use changes, environmental restoration, and source controls. These categories are helpful in understanding the mechanisms for pollutant removal. Each category is defined below and detailed descriptions of practices and how they are being used by SHA are included in **Sections F.4** to **F.7**.

Structural Stormwater Controls

Structural stormwater controls are engineered practices that receive stormwater runoff from developed areas and, using a variety of mechanisms, reduce pollutants and slow runoff velocities to minimize impacts when discharged to local waterways. They are engineered to optimize pollutant removal and are designed and built under standards contained in the 2000 Maryland Stormwater Design Manual (MDE, 2009a).

Land Use Changes

Land use change practices reduce pollutants by replacing land cover that generates high levels of pollutants with one that generates lower levels. This will provide an overall decrease in pollutants without capturing and treating stormwater runoff directly. Examples of land use changes are planting trees or removing impervious pavement.

Environmental Restoration

Environmental restoration aims to counteract the effects of urbanization on natural stream channels. Urbanization with increased impervious surfaces, reduced tree canopy and straightened, steepened and less permeable runoff conveyances changes the characteristics of storm runoff by increasing volumes and duration of flows. In other words, there is much more water flowing for longer periods of time often with higher velocities and power. Waterway systems conveying these flows can be impacted by one or more of the following problems: flooding, increased erosion of banks, deeper channel bottoms, changes in channel configuration and location, loss of aquatic habitat and species, and loss of wetlands as floodplains become dryer. Activities that restore natural channels establish equilibrium between the flowing water, structure and configuration of channels, species and habitat. Environmental restoration practices include stream restoration, wetland restoration, and outfall stabilization.

Source Controls

Source controls remove pollutants before they reach waterways and include methods to reduce the generation of pollutants such as recycling/reuse efforts or educational campaigns. They also include physically capturing and removing pollutants for disposal elsewhere, typically in landfills. Catch basin cleaning and street sweeping are examples.

F.4. Structural Stormwater Controls

Grass Swales

Grass swales are grass-lined channels that convey stormwater draining from roadways towards discharge points or outfalls. They are designed to certain cross-sectional geometries, longitudinal, and side slopes in order to control the rate and depth at which stormwater flows through the swale. Pollutant reductions are achieved through vegetative filtering, sedimentation and biological uptake. Swales can attenuate larger flows by slowing and infiltrating runoff during conveyance. They are typically located within roadway median areas or along roadsides. See **Figure 1-6** for an example of a grass swale.

Figure 1-6: Grass Swale Example along MD 220 in Washington County

Bioswales

Bioswales are structural swales designed with a multi-tier filtration system consisting of filter media, transition, and drainage layers working in combination to remove pollutants. Bioswales use an engineered soil filter media that is very porous and consists of sand, soil and organic matter such as mulch or compost. Stormwater flows onto the surface of the facility and as it seeps through the media, it is filtered. Plants within the facility also provide treatment through biological processes in the root systems and uptake of water and nutrients. The process removes sediment, as well as nitrogen and phosphorus. Bioswales can also attenuate flows by storing and infiltrating stormwater runoff to the ground below. They are viable in all soil types (based on United States Geological Survey [USGS] Hydrologic Soil classifications); however underdrain systems are required in soils with low infiltration rates (typically hydraulic soil groups C & D). They can be used in areas with lower infiltration rates if an underdrain is also used. See **Figure 1-7** for an example bio-swale under construction.

Figure 1-7: Bio-Swale during construction along MD 214 in Prince George's County

Wet Swales

Wet swales are structural swales that can be used in poorly drained soil types and are ideal for treating highway runoff in low-lying, flat terrain with high groundwater. Wet swales often intercept shallow groundwater to maintain a wetland plant community. Check dams are placed within the swale to help promote saturated soil or shallow standing water conditions and to temporarily store runoff before returning the treated stormwater to the conveyance system. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity.

Submerged Gravel Wetlands

Submerged gravel wetlands (SGW) are "flow through" filters that use wetland plants, a soil layer, and a gravel chamber to provide water quality treatment. Stormwater runoff draining to an SGW is treated primarily through filtration, but also sedimentation, physical and chemical sorption, microbially mediated transformation, uptake, and attenuation. Stormwater flows to the pretreatment forebay, where sedimentation occurs first; the pretreated runoff is then stored on the surface of the wetland. Filtration, sorption, and transformation occur as the stormwater travels through the wetland vegetation, soil layer, and/or gravel chimneys and passes through the gravel substrate that hosts a microbe-rich environment, removing nitrogen and phosphorus. While some uptake occurs in the wetland vegetation, most of the treatment is within the gravel substrate. To sustain the microbes and the wetland plants, the gravel substrate and soil layers must remain wet between storm events. For this reason, SGWs are used typically in poorly draining soils (typically hydraulic soil groups C & D) and/or areas of high ground water. The outlet invert is located four inches below the soil surface to maintain a subsurface permanent pool. Although hydraulic control is just below the wetland surface, the system is configured so that flow exiting the SGW must first traverse the underground gravel substrate. See **Figure 1-8** for an example of a submerged gravel wetland.

Figure 1-8: Submerged Gravel Wetland in Silver Spring, Montgomery County, MD

Surface Sand Filters

Surface sand filters are practices that capture and temporarily store runoff and pass it through a filter bed of sand media as noted in the Chapter 3/Section F-1 of the MDE Design Manual (MDE, 2009a). Filtered stormwater is either returned to the conveyance system or partially infiltrated into the soil. Surface sand filter facilities are versatile and may be adapted for use almost anywhere. Facilities located in poorly draining soils use underdrain systems to outfall the treated runoff to the conveyance system. See **Figure 1-9** for an example of a surface sand filter.

Figure 1-9: Surface Sand Filter along MD 355 in Montgomery County

Bioretention and Micro-Bioretention Facilities

Bioretention systems use very porous media consisting of sand, soil and organic matter such as mulch or compost for filtering stormwater runoff. Stormwater flows onto the surface of the facility and as it seeps through the media, it is filtered. Plants within the facility also provide treatment through biological processes in the root systems and uptake of water and nutrients.

Filtered stormwater is either returned to the conveyance system or partially infiltrated into the soil. Facilities may use underdrains to discharge the treated runoff to storm drain systems, though underdrains are not necessary in well-drained soils.

Bioretention facilities are versatile and may be adapted for use anywhere there is landscaping, although maintenance considerations prohibit their use in certain contexts. The specific facility type, bioretention or micro-bioretention, is determined based on the size of the area draining to the facility. Micro-bioretention facilities are typically limited to a half acre drainage area, and are typically used in smaller landscaped areas. If properly maintained, micro-bioretention facilities can provide additional water quality treatment while adding aesthetic value to the site. Bioretention systems have proven effective at removing many pollutants from stormwater and increasing infiltration to the ground below. See **Figure 1-10** for an example of a bioretention facility.

Figure 1-10: Bioretention Facility at MD 139 in Baltimore County

Rain Gardens

Rain gardens are shallow, planted depressional areas designed to infiltrate stormwater into the soil. This is an effective method to remove pollutants and recharge groundwater supplies. Soil requirements are an important factor when planning to implement this strategy. Soils must have high infiltration capabilities, low groundwater tables, and be located within a relatively flat area. Also, they must not be located within areas of karst topography, which are areas geologically characterized by soluble bedrock, such as limestone. Water infiltrating into the ground in these areas can dissolve bedrock and increase the potential of causing sink holes.

Infiltration Trenches

Infiltration trenches are relatively deep linear trenches designed to capture and infiltrate a certain amount of runoff volume based on the size of the area draining to them. They are limited by certain infiltration capabilities of the underlying soils and restrictions in karst topography. These trenches are sized to hold the runoff while allowing infiltration into the native soils over a prescribed period of time. They are filled with stone and the sides are lined with geotextile to prevent soils along the sides of the trenches from migrating to the bottom and clogging them with fine sediments that will prevent water from infiltrating. SHA uses this practice when space is limited and the right soils are underlying the area. See **Figure 1-11** for an example of an infiltration trench.

Figure 1-11: Infiltration Trench along US 113 in Worcester County

Wet Ponds and Wetlands

Using permanent pools of water to reduce pollutants in stormwater runoff has been a long standing treatment method in Maryland. Recent SWM practices that encourage infiltration to native soils and emulate natural flow patterns prior to urban development have been determined to be more effective at removing pollutants. For this reason, SHA uses wet pond and surface wetland facilities when necessary due to site constraints such as high ground water and/or large drainage areas.

Stormwater wet ponds and surface wetlands are facilities that have a permanent pool or shallow wetland with deep water zones. These facilities provide water quality treatment through biological uptake from algae growing within the permanent pool/wetland areas. Wetland plants provide additional nutrient uptake, and physical and chemical treatment processes allow filtering and absorption of nutrients. Surface pond/wetlands practices are best suited for areas of high ground water and/or poorly draining soils; however, they can be used if larger drainage areas exist and impermeable liners are placed beneath the facility to ensure the permanent ponding necessary to achieve the pollutant removal is provided. See **Figure 1-12** for an example wet pond.

Figure 1-12: Wet Pond along US 113 in Worcester County

F.5. Land Use Changes

Impervious Area Removal

Impervious surfaces increase runoff because they prevent rainwater from penetrating the ground. As a result, runoff can increase water volumes in nearby streams and cause flooding and erosion. Pollutants that are deposited on impervious surfaces from vehicles or atmospheric deposition, such as gasoline, nitrogen and oil, can wash into streams. Impervious surfaces often increase the temperature of runoff which can raise stream water temperatures. These factors all lead to poor stream health. Replacing impervious surfaces such as abandoned roadways and concrete lined ditches with permeable surfaces allows rainfall to infiltrate into the ground which reduces runoff and pollution entering adjacent waterways.

Impervious area removal is the replacement of impervious surfaces, such as asphalt and concrete, with pervious surfaces, such as grass or trees. Grass surfaces provide increased runoff infiltration and pollutant removal, but trees provide better infiltration and pollutant removal. SHA will choose either grass or trees to replace impervious areas depending upon the site context, roadside safety and sight distance requirement for motorists. See **Figure 1-13** for an example of impervious area removal.

Figure 1-13: Before and After image of a Concrete Ditch Removal along I-70 in Washington County

Tree Planting

Tree plantings are an economical strategy that converts grass or meadow areas to forested land. Tree sites do not usually capture stormwater runoff directly, but provide higher absorption rates of nutrients and sediment for rainwater falling on the site directly. Trees produce less runoff than impervious surfaces and grass areas and can absorb up to 100 gallons of water from the soil per day. By capturing rainfall in the canopy and bark; trees encourage rainwater to evaporate back into the air. Leaves also release moisture in a process call transpiration. Trees also absorb many pollutants through their root systems. In addition, their roots and leaf litter improve soil conditions for infiltration and can transform pollutants into less harmful substances. The roots also bind soils, preventing erosion. See **Figures 1-14** and **1-15** below for photos of recent SHA tree planting sites.

Figure 1-14: SHA Tree Planting Site at Perring Parkway and I-695 in Baltimore County

Figure 1-15: SHA Tree Planting Site along US 15 in Frederick County

F.6. Environmental Restoration

Stream Restoration

Stream restoration reestablishes the structure, function, and self-sustaining behavior of the stream system prior to disturbance. The restoration design focuses on the physical and biological components of the stream system and its watershed. Restoration includes a broad range of measures such as removing watershed disturbances that are causing stream instability; installing structures and planting vegetation to stabilize stream banks and provide habitat; and reconstructing the curves, bends and depth of channels within the stream. See **Figure 1-16** for an example of stream restoration.

Figure 1-16: SHA Stream Restoration Project at MD 139 Before, During, and After Construction

Regenerative Step Pool System Conveyance

Regenerative Step Pool System Conveyances (RSPSCs) are a series of stepped pools and aquatic beds, riffle weirs with an underlying filtration system to treat stormwater runoff. The shallow aquatic beds receive and filter the stormwater runoff and the riffle weirs convey the overflow to the next aquatic bed. This practice is well suited for sites where topography is characterized by steeper slopes, where soils can infiltrate and outfalls may be confined in a steep valley. RSPSCs incorporate native materials including vegetation, cobbles, boulders and woodchips and sand in the underlying filtration system. See **Figure 1-17** for an example of a RSPSC.

Figure 1-17: Regenerative Step Pool System Conveyance in Anne Arundel County

Outfall Stabilization

Outfall stabilization repairs channels when significant erosion occurs due to increase and change in the characteristics of stormwater discharge to ditches, adjacent lands or stream channels. Different methods are used to stabilize outfalls including the use of natural materials and structures, rock riprap, vegetation and matting, or stepped grade changes. The stabilization is designed to control flows for existing storm drains based on the magnitude and frequency of a flow event. See **Figure 1-18** for an example of outfall stabilization.

Figure 1-18: I-97 Outfall Before and After Stabilization in Anne Arundel County

F.7. Source Controls

Street Sweeping

Sweeping roadways is not only an important means to keep them clear of trash and debris, but it also results in a reduction of pollutants associated with roadway debris. This material is collected for disposal into approved landfills resulting in pollutants removed prior to entering waterways. Different types of sweeping equipment exist with different levels of effectiveness at removing debris. SHA currently uses mechanical street sweepers which are considered by the CBP expert panel on street sweeping and inlet cleaning to be not as effective as regenerative-air or vacuum assisted sweepers. This material, such as dirt, sand, and trash, collects along curbs and gutters; bridge parapets; and inlets and outlet pipes. Sweeping prevents buildup along sections of roadway and allows for the free flow of water from the highway to enter into the highway drainage system. SHA typically sweeps roadways approximately twice per month during spring, summer, and fall months from April through November. See **Figure 1-19** for an example of street sweeping.

Figure 1-19 – Typical SHA Mechanical Street Sweeper

Inlet Cleaning

Inlets are compartments in the storm drain that allow stormwater to run off but capture sediment and debris preventing them from entering the waterways. These catch basins must be cleaned periodically. Sediment and trash make up the majority of the material that is removed. SHA operates vacuum trucks in central Maryland, spanning most MS4 Counties. Catch basin cleaning is routinely performed in Anne Arundel, Baltimore, Calvert, Carroll, Charles, Frederick, Harford, Howard, Montgomery, Prince George's and St. Mary's counties. This practice ensures safer roadways through maintaining proper drainage and improves water quality in Maryland streams by removing captured sediment and trash before they enter adjacent waterways. See **Figure 1-20** for an example of inlet cleaning.

Figure 1-20 – Inlet Catch Basin Cleaning Before and After

Structural Stormwater Controls

Structural stormwater controls capture trash and regular maintenance provides removal and disposal.

Litter Education and Outreach Program

SHA's Office of Customer Relations and Information (OCRI) engages in public outreach efforts to discourage littering. Because most littering along roadways originates from motorists, this effort mainly uses radio messaging. Roadway signs are also used at spots that have been identified as frequent dumping areas, rest areas, and other locations as needed. SHA will evaluate the effectiveness of these current programs and identify areas for improvement which may include:

- Public Service Announcements;
- Social Media using SHA's Twitter, Facebook, YouTube, and Instagram accounts;
- Maryland Roads website information;
- Recorded messages played during "on hold' times and for all 511 calls;
- Press releases; and
- Annual SHA customer level of service surveys.

SHA is working to improve these current efforts by initiating a research study to determine target audiences, baseline levels of awareness of the negative impacts of littering, costs associated with littering, motivations for littering, and motivations to stop littering. Based on the results of this research, SHA will develop messages and tactics for each segment of the target audience develop methods to measure the success of the campaign.

The EPA guideline *Getting in Step* (EPA, 2010a) has helped to determine appropriate new efforts that may be implemented. Some additional activities may include:

- Updated SHA webpage for anti-littering message;
- Public outreach efforts such as storm drain stenciling, presentations to community and school groups, activity books stressing the Chesapeake Bay and local waterways, and event booths at pertinent events;

- Partnering with counties and watershed groups;
- Messaging including:
  - Radio;
  - Interpretive signage at SHA rest stops;
  - Social media feeds;
  - Bumper stickers;
  - Press releases and articles; and
- Other activities as determined to augment littering awareness.
-

Recycling and Reuse Program

Reducing trash through recycling and reuse is a practice that can prevent littering and reduce waste. In support of the SHA Business Plan, the Environmental Compliance and Stewardship Key Performance Area launched the SHA Recycles Campaign on April 22, 2008 to raise awareness and encourage change in consumer culture throughout the organization. The goal of this campaign is to reduce waste and litter by making conservation a priority, reusing what was previously discarded, and recycling as much as possible.

The SHA Recycles Campaign is working to build a consortium of stakeholders across the entire SHA organization towards this collective goal. The campaign encourages all employees to give feedback on what can be done to save energy and fuel, reduce or eliminate waste, improve current recycling efforts, or change business practices to conserve resources. It provides education and outreach through displays and presentations at SHA events such as the Annual Earth Day Celebration, and office-wide training and recognition days.

A statewide Recycling Task Force has also been formed at SHA to examine key issues in recycling and identify ways to improve the SHA Statewide Recycling Program.

Litter Collection and Disposal

Litter is trash that is disposed of improperly. For SHA, a large quantity of litter is deposited along roadways. Collecting and removing litter to landfills is a practice necessary to keep Maryland's roadsides attractive, but is also a practice for meeting trash reduction requirements in TMDLs. SHA conducts the following programs for litter collection and disposal:

- Maintenance Crew Clean-ups – SHA's maintenance crews are responsible to perform a number of routine activities including litter clean-up (as well as mowing, plowing, and other activities to ensure safety and environmental stewardship) along the ROW. Litter clean-ups are performed regularly before mowing and supplemental clean-ups occur as needed or upon public request when possible.

- Contracted Crew Clean-ups – In addition to maintenance crew clean-ups, SHA's Office of Maintenance (OOM) also issues trash removal contracts for supplemental clean-ups along the ROW. Contractors include private companies and inmate cleaning crews. Contracts are awarded for designated roadway segments and contractors are required to pick up on a regular schedule.

- Adopt-A-Highway – SHA's Adopt-A-Highway Program utilizes volunteer groups that pick up litter along one to three mile stretches of non-interstate roadways. The groups are encouraged to perform this community service a minimum of four times per year for a two-year period.

- Sponsor-A-Highway – The Sponsor-A-Highway Program allows corporate sponsors to fund contracted clean-ups for one-mile sections of Maryland roadways. The sponsor has an agreement with a maintenance provider to remove litter from the sponsored highway segment. Segments are typically interstate roadways.

Illicit Discharge Detection and Elimination

SHA also has an Environmental Compliance Division (ECD) that manages SHA's Illicit Discharge Detection and Elimination (IDDE) program. Illicit discharges are defined as a storm drain that has measurable flow during dry weather containing pollutants or pathogens, and they have potential to contain harmful bacteria or other pollutants. SHA's IDDE program conducts regular inspections and testing for any suspected illicit discharge. Sampling does not directly test for bacteria and PCBs, but the testing does detect indicators of sewage, including phenol and detergents. If an illicit discharge is confirmed, the ECD works with local jurisdictions to disconnect the discharge from SHA's drainage system.

Geese/Waterfowl Prevention at Ponds

Waterfowl have been known to establish colonies at pond sites, particularly in large stormwater ponds with a permanent pool adjacent to grassy areas, or areas with attractive waterfowl habitat. As these colonies increase in size, overcrowding can result. In general, an overcrowded bird population in a pond creates high nutrient and bacteria loads from fecal material. Waterfowl are also known to carry pathogens that can be dangerous to humans. These pathogens include *Escherichia coli* (*E. coli*), *Salmonella*, *Protozoan Cryptosporidium*, *Streptococcus*, and *Staphylococcus*. Two birds per acre of pond is a manageable number that will not result in significant property damage or water quality impairments (Clemson Cooperative Extension, 2015). Once the number of waterfowl exceed this ratio, control measures may be considered.

Generally, SHA ponds are not attractive to waterfowl because 'shore areas' are not maintained in a lawn condition. SHA inspects SWM control structures on a 3-year cycle and evidence of waterfowl infestation is taken into consideration. If a colony is identified, measures are undertaken to eradicate the colony in cooperation with the Maryland Department of Natural Resources (DNR).

Cattle Fencing and Pasture Stream Buffers

Cows and other pasture animals with open access to streams contribute to poor water quality, stream bank degradation, and erosion. As the animals walk through the water, they pollute the stream with manure, urine, and pathogens such as bacteria. Cattle can also consume and trample the vegetation on stream banks as they enter and exit the channel. The decrease in stream bank vegetation and associated root systems leads to an increased amount of sediment, pesticides, nutrients, and phosphorus entering into the water (Pennsylvania Association of Conservation Districts [PACD], 2009).

Installing fences or vegetative buffers limits the animal's access to stream banks and establishes a protective riparian buffer along the stream. The fencing helps to protect banks, allowing a natural riparian buffer to thrive. When there is space, additional vegetation can be planted to help establish a healthy riparian buffer. A riparian buffer is a vegetated area running parallel to a stream that helps limit runoff and protects the stream from farm animals. The riparian buffer traps sediment, pesticides, and nutrients before they enter the water while also helping to maintain a stable streambank. See **Figure 1-21** for examples of streams with and without cattle fencing.

Figure 1-21: Example of Stream Edge Treatments with and without Cattle Fencing

SHA does not own farmland or pasture land; however, SHA may use these strategies on stream restoration projects in rural areas if there is potential for the presence of cattle or horses. Farmers who implement cattle fencing and create riparian buffers on their property must do so on their own accord. Once implemented, farmers may utilize nutrient credit trading as discussed above in **Section E.7**.

Pet Waste Disposal Stations

A component of bacteria pollution can be attributed to pet waste. Dog feces have been found to contain *E. coli*, Giardia, *Salmonella*, and other microscopic pathogens (Vaughn, 2012). Dog feces are also very rich in nutrients. Some pet owners may not pick up after their pets. When the waste is left on a lawn or impervious surface, it washes into storm drains and nearby streams. Domestic pet waste accounts for 24% of the bacteria that pollute Maryland's urban and suburban waterways (Lazarick, 2013).

SHA has pet waste stations at highway rest areas and is collaborating with local jurisdictions to identify additional opportunities to install them in other locations. See **Figure 1-22** for an example of a pet waste disposal station.

Figure 1-22: Pet Waste Disposal Station at the I-70 Eastbound Rest Area and Welcome Center

Targeted Drainage System and Waterway Clean-ups

Trash, litter, dumping and other forms of debris are collected and removed from stream valleys and riparian areas. Participants can be composed of state worker, volunteers or contracted crew.