Total Maximum Daily Load of Sediment in the Upper Pocomoke River Watershed, Wicomico and Worcester Counties, Maryland

FINAL

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List of Abbreviations

BIBI	Benthic Index of Biotic Integrity
BIP	Buffer Incentive Program
BMP	Best Management Practices
BSID	Biological Stressor Identification
CBLCD	Chesapeake Bay Land-Cover Dataset
CBP	Chesapeake Bay Program
CBP P4.3	Chesapeake Bay Program Model Phase 4.3
CBP P5.32	Chesapeake Bay Program Model Phase 5.3.2
CCAP	Coastal Change Analysis Program
CFS	Cubic Feet per Second
CV	Coefficient of Variation
CWA	Clean Water Act
DI	Diversity Index
DNR	Maryland Department of Natural Resources
EOF	Edge-of-Field
EOS	Edge-of-Stream
EPA	Environmental Protection Agency
EPT	*Ephemeroptera*, *Plecoptera*, and *Trichoptera*
ESD	Environmental Site Design
FIBI	Fish Index of Biologic Integrity
GIS	Geographic Information System
HBI	Hilsenhoff Biotic Index
IBI	Index of Biotic Integrity
LA	Load Allocation
m	Meter
m^3/yr	Meters cubed per year
MACS	Maryland Agricultural Cost Share Program
MAL	Minimum Allowable IBI Limit
MBSS	Maryland Biological Stream Survey
MD 8-Digit	Maryland 8-digit Watershed

MDE	Maryland Department of the Environment
MDL	Maximum Daily Load
MDP	Maryland Department of Planning
MGD	Millions of Gallons per Day
mg/l	Milligrams per liter
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristics
MS4	Municipal Separate Storm Sewer System
NLCD	National Land-Cover Dataset
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRI	Natural Resources Inventory
PSU	Primary Sampling Unit
SCS	Soil Conservation Service
SDF	Sediment Delivery Factor
SHA	State Highway Administration
TMDL	Total Maximum Daily Load
Ton/acre/yr	Tons per acre per year
Ton/yr	Tons per year
TSD	Technical Support Document
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WIP	Watershed Implementation Plan
WLA	Waste Load Allocation
WQLS	Water Quality Limited Segment

EXECUTIVE SUMMARY

This document, upon approval by the U.S. Environmental Protection Agency (EPA), establishes a Total Maximum Daily Load (TMDL) for sediment in the Maryland 8-Digit (MD 8-Digit) Upper Pocomoke River watershed (basin number 02130203) (2010 *Integrated Report of Surface Water Quality in Maryland* Assessment Unit ID: MD-02130203). Section 303(d) of the federal Clean Water Act (CWA) and the EPA's implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS, the State is required to either establish a TMDL of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met (CFR 2012b).

The Maryland Department of the Environment (MDE) has identified the waters of the MD 8-Digit Upper Pocomoke River watershed in Maryland's Integrated Report as impaired by sediments – total suspended solids (TSS) (1996, Adkins Pond - sedimentation - 1998), nutrients – phosphorus (1996, Adkins Pond - 1998), and impacts to biological communities (2002) (MDE 2010a). All impairment listings are for the non-tidal streams in the watershed, except for the 1998 nutrient and sediment impairment listings for Adkins Pond, a small impoundment within the watershed. The designated use of the MD 8-digit Upper Pocomoke River mainstem and its tributaries is Use I (Water Contact Recreation and Protection of Aquatic Life) (COMAR 2012a,b,c).

The TMDL established herein by MDE will address the 1996 sediments listing, for which a data solicitation was conducted, and all readily available data from the past five years have been considered. Sediment and phosphorus TMDLs for the Adkins Pond impoundment were approved by the EPA in 2002. In the 2012 Integrated Report, the listing for impacts to biological communities will include the results of a stressor identification analysis, and a phosphorus TMDL to address the nutrient impairment listing for the watershed is scheduled to be submitted to the EPA in 2012.

The MD 8-digit Upper Pocomoke River watershed aquatic life assessment scores, consisting of the Benthic Index of Biotic Integrity (BIBI) and Fish Index of Biotic Integrity (FIBI), indicate that the biological metrics for the watershed exhibit a significant negative deviation from reference conditions based on Maryland's biocriteria listing methodology. The biocriteria listing methodology assesses the overall average condition of MD 8-digit watersheds (1st though 4th order streams only) by measuring the percentage of sites, translated into watershed stream miles, that are assessed as having BIBI and/or FIBI scores significantly lower than 3.0 (on a scale of 1 to 5), and then calculating whether the percentage differs significantly from reference conditions (i.e., an unimpaired watershed is one where <10% of stream miles differ from reference conditions) (Roth et al. 2001; MDE 2008). The objective of the TMDL established herein is to ensure that watershed sediment loads are at a level to support the Use I designation for the MD 8-digit Upper Pocomoke River watershed, and more specifically, at a level to support aquatic life.

Currently in Maryland, there are no specific numeric criteria that quantify the impact of sediment on the aquatic life of nontidal stream systems. Therefore, to determine whether aquatic life is impacted by elevated sediment loads, MDE's *Biological Stressor Identification* (BSID) methodology was applied. The BSID identifies the most probable cause(s) for observed biological impairments throughout MD's 8-digit watersheds (1st though 4th order streams only) by ranking the likely stressors affecting a watershed using a suite of physical, chemical, and land-use data. The ranking of stressors was conducted via a risk-based, systematic, weight-of-evidence approach. The risk-based approach estimates the strength of association between various stressors and an impaired biological community. The BSID analysis then identifies individual stressors (pollutants) as probable or unlikely causes of the poor biological conditions within a given MD 8-digit watershed and subsequently concludes whether or not these individual stressors or groups of stressors are contributing to the impairment (MDE 2009).

The BSID analysis for the MD 8-digit Upper Pocomoke River watershed concludes that biological communities are likely impaired due to sediment related stressors/impacts. Individual stressors within the sediment parameter grouping were identified as being probable causes of the biological impairment. Furthermore, the degradation of biological communities in the watershed is strongly associated with agricultural land-use and its concomitant effects (MDE 2012a).

In order to quantify the impact of sediment on the aquatic life of non-tidal stream systems, a reference watershed TMDL approach was used and resulted in the establishment of a *sediment loading threshold* (Currey et al. 2006). This threshold is based on a detailed analysis of sediment loads from watersheds that are identified as supporting aquatic life (i.e., reference watersheds) based on Maryland's biocriteria (Roth et al. 1998,2000; Stribling et al. 1998; MDE 2008). This threshold is then used to determine a watershed specific sediment TMDL.

The computational framework chosen for the MD 8-digit Upper Pocomoke River watershed TMDL was the Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) watershed model target *edge-of-stream* (EOS) land-use sediment loads. The EOS sediment load is calculated per land-use as a product of the land-use area, land-use target edge-of-field (EOF) loading rate, and loss from the EOF to the main channel, expressed as the sediment delivery factor (SDF). The spatial domain of the CBP P5.3.2 watershed model segmentation aggregates to the MD 8-digit watersheds, which is consistent with the impairment listing.

EPA's regulations require TMDLs to take into account seasonality and critical conditions for stream flow, loading, and water quality parameters (CFR 2012b). The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. The biological monitoring data used to determine the reference watersheds reflect the impacts of stressors (i.e., sediment impacts to stream biota) over the course of time (i.e., captures the impacts of all high and low flow events). Thus, critical conditions are inherently addressed. Seasonality is captured in two components. First, it is implicitly included in biological sampling as biological communities reflect the impacts of stressors over time, as described above. Second, the Maryland Biological Stream Survey (MBSS) dataset, which serves as the primary dataset for calculating the biological metrics of the watershed (i.e., BIBI and FIBI scores), included benthic sampling in the spring and fish sampling in the summer.

All TMDLs need to be presented as a sum of waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources generated within the assessment unit, accounting for natural background, tributary, and adjacent segment loads. Furthermore, all TMDLs must include a margin of safety (MOS) to account for any lack of knowledge and uncertainty concerning the relationship between loads and water quality (CFR 2012a,b). It is proposed that the estimated variability around the reference watershed group used in this analysis already accounts for such uncertainty, and therefore the MOS is implicitly included.

The MD 8-Digit Upper Pocomoke River Total Baseline Sediment Load is 2,737.7 tons per year (ton/yr). This baseline load consists of:

- Upstream loads generated outside the assessment unit (i.e., MD 8-digit watershed)
    - A Delaware Upstream Baseline Load (BL_{DE}) of 310.4 ton/yr
- Loads generated within the assessment unit
    - A MD 8-Digit Upper Pocomoke River Watershed Baseline Load Contribution of 2,427.3 ton/yr.

The MD 8-digit Upper Pocomoke River Watershed Baseline Load Contribution is further subdivided into a nonpoint source baseline load (Nonpoint Source BL_{UP}) and two types of point source baseline loads: National Pollutant Discharge Elimination System (NPDES) regulated stormwater (NPDES Stormwater BL_{UP}) and regulated process water (Process Water BL_{UP}) (see Table ES-1).

Table ES-1: MD 8-Digit Upper Pocomoke River Baseline Sediment Loads (ton/yr)

Total Baseline Load (ton/yr)		**Upstream Baseline Load**[1]		**MD 8-Digit Upper Pocomoke River Watershed Baseline Load Contribution**				
	=	**BL_{DE}**	+	**Nonpoint Source BL_{UP}**	+	**NPDES Stormwater BL_{UP}**	+	**Process Water BL_{UP}**
2,737.7	=	310.4	+	2,416.6	+	1.8	+	8.9

Note: [1] Although the Upstream Baseline Load is reported here as a single value, it could include both point and nonpoint sources.

The MD 8-Digit Upper Pocomoke River Average Annual TMDL of Sediment/ TSS is 2,617.8 ton/yr (a 4.4% reduction from the baseline load). This TMDL consists of:

- Allocations attributed to loads generated outside the assessment unit, referred to as Upstream Load Allocations
    - A Delaware Upstream Load Allocation (LA_{DE}) of 310.4 ton/yr
- Allocations attributed to loads generated within the assessment unit
    - A MD 8-Digit Upper Pocomoke River Watershed TMDL Contribution of 2,307.4 ton/yr.

The MD 8-Digit Upper Pocomoke River TMDL Contribution is further subdivided into point and nonpoint source allocations and is comprised of a Load Allocation (LA_{UP}) of 2,296.8 ton/yr, an NPDES Stormwater Waste Load Allocation (NPDES Stormwater WLA_{UP}) of 1.7 ton/yr, and a Process Water Waste Load Allocation (Process Water WLA_{UP}) of 8.9 ton/yr (see Table ES-2).

Table ES-2: MD 8-Digit Upper Pocomoke River Average Annual TMDL of Sediment/Total Suspended Solids (ton/yr)

TMDL (ton/yr)	=	$\mathbf{LA_{DE}}$[1]	+	$\mathbf{LA_{UP}}$	+	**NPDES Stormwater** $\mathbf{WLA_{UP}}$	+	**Process Water** $\mathbf{WLA_{UP}}$	+	**MOS**
2,617.8	=	310.4	+	2,296.8	+	1.7	+	8.9	+	Implicit
		Upstream Load Allocation[2,3]		MD 8-Digit Upper Pocomoke River Watershed TMDL Contribution						

Notes: [1] LA_{DE} is set equivalent to BL_{DE}, as it was determined that reductions to upstream loads from Delaware were not necessary in order to meet Maryland's water quality standards within the MD 8-digit Upper Pocomoke River watershed.
[2] Although for the purposes of this analysis, the upstream load is referred to as an LA, it could include loads from both point and nonpoint sources.
[3] A delivery factor of 1 was used for the Upstream LA.

Table ES-3: MD 8-Digit Upper Pocomoke River Baseline Load, TMDL, and Total Reduction Percentage

Baseline Load (ton/yr)	**TMDL** (ton/yr)	**Total Reduction** (%)
2,737.7	2,617.8	4.4

The Adkins Pond Sediment TMDL of 599 cubic meters per year (m^3/yr), which was developed by MDE to be protective of water quality standards within the impoundment and approved by the EPA in 2002, still applies as the target sediment loading capacity within the pond's drainage area, located in the western portion of the MD 8-Digit Upper Pocomoke River watershed (MDE 2002). The attainment of water quality standards within the MD 8-digit Upper Pocomoke River watershed and Adkins Pond impoundment can only be achieved by meeting the average annual TMDL of sediment/TSS specified for the MD 8-digit watershed within this report as well as the specific TMDL for the Adkins Pond drainage basin established by MDE in 2002. Furthermore, both the baseline sediment loading and TMDL for the impoundment are implicitly included within the MD

8-Digit Upper Pocomoke River watershed NPDES Stormwater BL_{UP}/Nonpoint Source BL_{UP} and NPDES Stormwater WLA_{UP}/LA_{UP}, respectively, due to the spatial resolution of the CBP P5.3.2 watershed model segmentation.

In addition to the TMDL value, a Maximum Daily Load (MDL) is also presented in this document. The calculation of the MDL, which is derived from the TMDL average annual loads, is explained in Appendix B and presented in Table B-1.

This TMDL will ensure that watershed sediment loads are at a level to support the Use I designation for the MD 8-digit Upper Pocomoke River watershed, and more specifically, at a level to support aquatic life. The TMDL, however, will not completely resolve the impairment to biological communities within the watershed. Since the BSID watershed analysis identifies phosphorus, low DO, sulfates, in-stream habitat conditions (most importantly, stream channelization), and the lack of riparian buffer as other possible stressors impacting the biological conditions, this impairment remains to be fully addressed through the Integrated Report listing and TMDL development processes. This impairment to aquatic life will only be fully addressed when all impairing substances identified as impacting biological communities in the watershed are reduced to levels that will meet water quality standards, as established in future TMDLs for those substances (MDE 2009,2012a).

Section 303(d) of the CWA and current EPA regulations require reasonable assurance that the TMDL can and will be implemented. Once the EPA has approved this TMDL and it is known what measures must be taken to reduce pollution levels, implementation of best management practices (BMPs) is expected to take place. The MD 8-Digit Upper Pocomoke River Sediment TMDL is expected to be implemented as part of a staged process recently developed by Maryland. This staged process is designed to achieve both the sediment reductions needed within the MD 8-Digit Upper Pocomoke River watershed and to meet sediment target loads consistent with the Chesapeake Bay TMDL, established by EPA in 2010 (US EPA 2010a) and scheduled for full implementation by 2025. The Bay TMDL requires reductions of nitrogen, phosphorus, and sediment loads throughout the Bay watershed to meet water quality standards that protect the designated uses in the Bay and its tidal tributaries.

MDE expects that the first stage of implementation of the MD 8-Digit Upper Pocomoke River Sediment TMDL will focus on achieving the sediment reductions required within the watershed as per the Chesapeake Bay TMDL, which is expected to be fully implemented in Maryland by 2025, to meet downstream water quality standards. Once the Bay TMDL target sediment loads for the MD 8-Digit Upper Pocomoke River watershed have been met, MDE will reassess the sediment impacts on aquatic life in the MD 8-Digit Upper Pocomoke River watershed, based on any additional monitoring data available. MDE intends for the required reductions to be implemented in an iterative process that first addresses those sources with the largest impact to water quality, with consideration given to cost of implementation.

1.0 INTRODUCTION

This document, upon approval by the U.S. Environmental Protection Agency (EPA), establishes a Total Maximum Daily Load (TMDL) for sediment in the Maryland 8-Digit (MD 8-digit) Upper Pocomoke River watershed (basin number 02130203) (2010 *Integrated Report of Surface Water Quality in Maryland* Assessment Unit ID: MD-02130203). Section 303(d)(1)(C) of the federal Clean Water Act (CWA) and the EPA's implementing regulations direct each state to develop a TMDL for each impaired water quality limited segment (WQLS) on the State's Integrated Report, taking into account seasonal variations, critical conditions, and a protective margin of safety (MOS) to account for uncertainty (CFR 2012b). A TMDL reflects the total pollutant loading of the impairing substance a waterbody can receive and still meet water quality standards.

TMDLs are established to determine the pollutant load reductions needed to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, protection of aquatic life, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The Maryland Department of the Environment (MDE) has identified the waters of the MD 8-Digit Upper Pocomoke River watershed in Maryland's Integrated Report as impaired by sediments – total suspended solids (TSS) (1996, Adkins Pond – sedimentation - 1998), nutrients – phosphorus (1996, Adkins Pond - 1998), and impacts to biological communities (2002) (MDE 2010a). All impairment listings are for the non-tidal streams in the watershed, except for the 1998 nutrient and sediment impairment listings for Adkins Pond, a small impoundment within the watershed. The designated use of the MD 8-digit Upper Pocomoke River mainstem and its tributaries is Use I (Water Contact Recreation and Protection of Aquatic Life) (COMAR 2012a,b,c).

The TMDL established herein by MDE will address the 1996 sediments listing, for which a data solicitation was conducted, and all readily available data from the past five years have been considered. Sediment and phosphorus TMDLs for the Adkins Pond impoundment were approved by the EPA in 2002. In the 2012 Integrated Report, the listing for impacts to biological communities will include the results of a stressor identification analysis, and a phosphorus TMDL to address the nutrient impairment listing for the watershed is scheduled to be submitted to the EPA in 2012.

The objective of the TMDL established herein is to ensure that watershed sediment loads are at a level to support the Use I designation for the MD 8-digit Upper Pocomoke River watershed, and more specifically, at a level to support aquatic life. Currently in Maryland, there are no specific numeric criteria that quantify the impact of sediments on the aquatic life of nontidal stream systems. Therefore, to determine whether aquatic life is impacted by elevated sediment loads, MDE's *Biological Stressor Identification* (BSID) methodology was applied.

The BSID identifies the most probable cause(s) for observed biological impairments throughout MD 8-digit watersheds (1st though 4th order streams only) by ranking the likely stressors affecting a watershed using a suite of physical, chemical, and land-use data. The ranking of stressors was conducted via a risk-based, systematic, weight-of-evidence approach. The risk-based approach estimates the strength of association between various stressors and an impaired biological community. The BSID analysis then identifies individual stressors (pollutants) as probable or unlikely causes of the poor biological conditions within a given MD 8-digit watershed and subsequently concludes whether or not these individual stressors or groups of stressors are contributing to the impairment (MDE 2009).

In order to quantify the impact of sediment on the aquatic life of non-tidal stream systems, a reference watershed TMDL approach was used and resulted in the establishment of a *sediment loading threshold* (Currey et al. 2006). This threshold is based on a detailed analysis of sediment loads from watersheds that are identified as supporting aquatic life (i.e., reference watersheds) based on Maryland's biocriteria (Roth et al. 1998,2000; Stribling et al. 1998; MDE 2008). This threshold is then used to determine a watershed specific sediment TMDL.

2.0 SETTING AND WATER QUALITY DESCRIPTION

2.1 General Setting

Location

The Pocomoke River originates in the Great Cypress Swamp located on the border between Delaware and Wicomico and Worcester Counties, Maryland. From its origin, the river flows approximately sixty miles through Maryland until it outlets to the Pocomoke Sound of the Chesapeake Bay (LESHC 1994). The specific MD 8-Digit Upper Pocomoke River watershed consists of the most upstream portion (i.e., the headwaters) of the Pocomoke River basin within Maryland. The outlet of the MD 8-digit Upper Pocomoke River watershed is located just north of the town of Snow Hill, and the watershed extends all the way to the border between Delaware and Maryland within Wicomico and Worcester Counties. All of the streams within the MD 8-Digit watershed are non-tidal. The watershed drains approximately 19 stream miles and 95,476 acres. The largest towns within the MD 8-Digit Upper Pocomoke River watershed are Willards and Pittsville (see Figure 1).

There is one "high quality," or Tier II, stream segment (Benthic Index of Biotic Integrity (BIBI) and Fish Index of Biotic Integrity (FIBI) aquatic life assessment scores > 4 (scale 1-5)) located within the watershed, Adkins Race, requiring the implementation of Maryland's anti-degradation policy (COMAR 2012d; MDE 2011). Approximately 0.1% percent of the watershed area is covered by water (i.e., streams, ponds, etc). The total population in the MD 8-digit Upper Pocomoke River watershed is approximately 10,097 (US Census Bureau 2010).

Geology/Soils

The MD 8-Digit Upper Pocomoke River watershed lies in the Coastal Plain physiographic province of Maryland. The Coastal Plain province is characterized by deep sedimentary soil complexes that support broad meandering streams, flat/gently rolling topography, and elevations rising from sea level to about 100 feet above sea level (DNR 2012). The Coastal Plain Province is underlain by a wedge of unconsolidated sediments consisting of gravel, sand, silt, and clay (MGS 2012). The predominant soils in the MD 8-Digit Upper Pocomoke River watershed are level to nearly level, poorly drained soils, that are part of the Pocomoke-Fallsington and Othello-Fallsington-Portsmouth Associations (USDA 1970,1973).

The Upper Pocomoke River watershed is located on the Delmarva Peninsula of Maryland/Delaware's Coastal Plain region. The Peninsula contains a series of confined aquifers that are overlain by an extensive surficial (unconfined) aquifer. The typically sandy, unconfined surficial aquifer on the Delmarva Peninsula is vulnerable to contamination from a variety of anthropogenic sources, including septic system discharges and the application of fertilizer, pesticides, lime, and manure (Ator et al. 2005). Groundwater flow paths are generally shorter than a few miles in length, and in areas with a high density of streams or drainage ditches, groundwater flow paths are commonly shorter than a few hundred feet (Hamilton et al. 1993). Hydrologic studies conducted within the non-tidal Pocomoke River watershed indicate that 1) groundwater is a significant hydrologic transport pathway in the watershed, and 2) periods of significant overland flow occur mainly during large storm events (Ator et al. 2005).

Soil type for the MD 8-Digit Upper Pocomoke River watershed is also characterized by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) into four hydrologic soil groups: Group A soils have high infiltration rates and are typically deep well drained/excessively drained sands or gravels; Group B soils have moderate infiltration rates and consist of moderately deep-to-deep and moderately well-to-well drained soils, with moderately fine/coarse textures; Group C soils have slow infiltration rates with a layer that impedes downward water movement, and they primarily have moderately fine-to-fine textures; Group D soils have very slow infiltration rates consisting of clay soils with a permanently high water table that are often shallow over nearly impervious material. The MD 8-Digit Upper Pocomoke River watershed is comprised primarily of Group D (49%) soils with smaller portions of Group B, Group C, and Group C soils (25%, 18%, and 7% respectively) (USDA 2006).

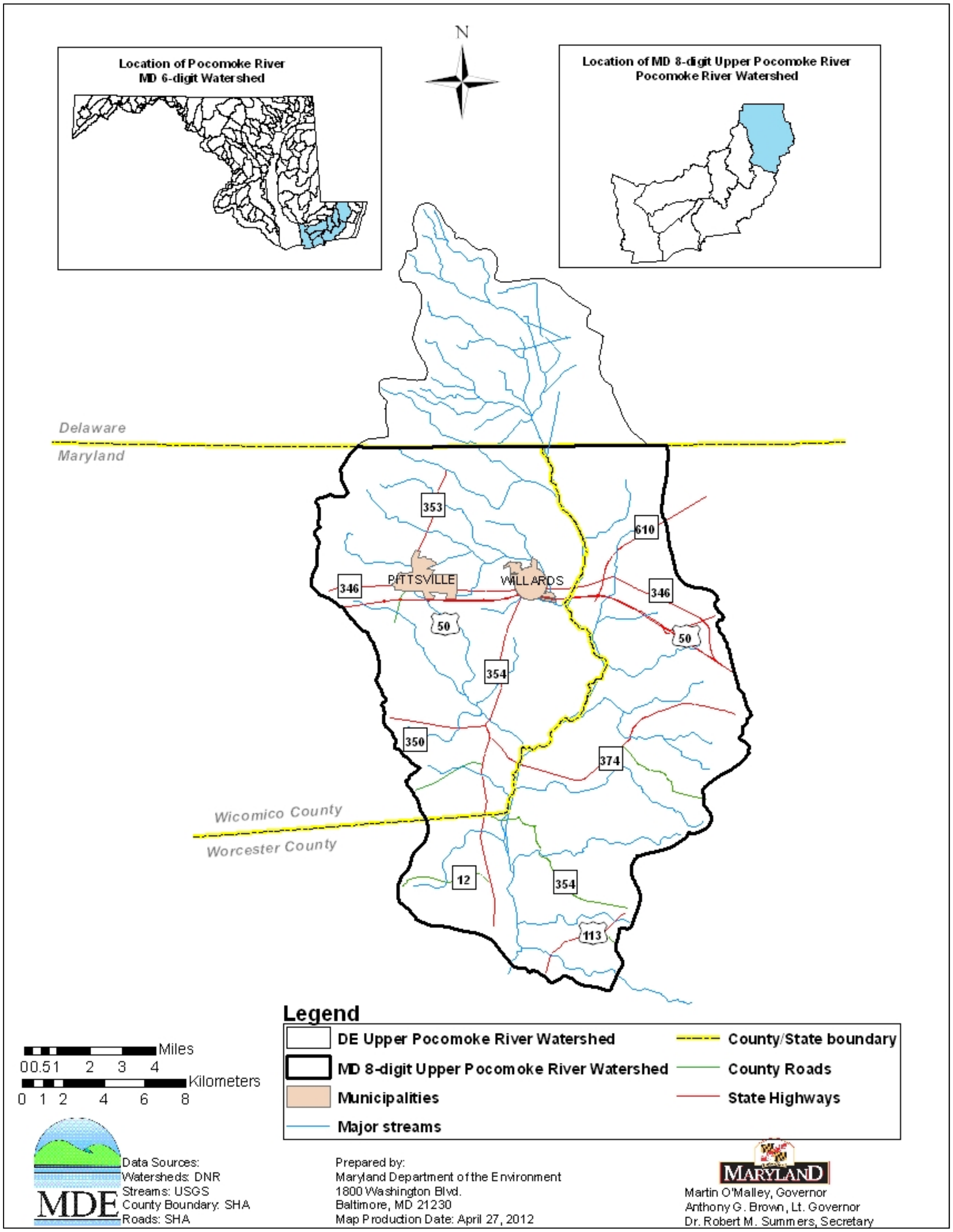

Figure 1: Location Map of the Upper Pocomoke River Watershed in Wicomico and Worcester Counties, Maryland

2.1.1 Land-use

Land-use Methodology

The land-use framework used to develop this TMDL was originally developed for the Chesapeake Bay Program Phase 5.3.2 (CBP P5.3.2) Watershed Model.[1] CBP P5.3.2 land-use was based on two distinct stages of development.

The first stage consists of the development of the Chesapeake Bay Watershed Land-Cover Data (CBLCD) series of Geographic Information System (GIS) datasets. These datasets provide a 30 meter resolution raster representation of land-cover in the Chesapeake Bay watershed, based on sixteen Anderson Level two land-cover classes. The CBLCD basemap, representing 2001 conditions, was primarily derived from the Multi-Resolution Land Characteristics (MRLC) Consortium's National Land-Cover Data (NLCD) and the National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program's (CCAP) Land-Cover Data. By applying Cross Correlation Analysis to Landsat 5 Thematic Mapper and Landsat 7 Enhanced Thematic Mapper satellite imagery, the US Geological Survey's (USGS) contractor, MDA Federal, generated CBLCD datasets for 1984, 1992, and 2006 from the baseline 2001 dataset. The watershed model documentation, *Chesapeake Bay Phase 5.3 Community Watershed Model* (US EPA 2010b), describes the development of the CBLCD series in more detail. USGS and NOAA also developed an impervious cover dataset from Landsat satellite imagery for the CBLCD basemap, which was used to estimate the percent impervious cover associated with CBLCD developed land-cover classifications.

The second stage consists of using ancillary information for: 1) the creation of a modified 2006 CBLCD raster dataset, and 2) the subsequent development of the CBP P5.3.2 land-use framework in tabular format. Estimates of the urban footprint in the 2006 CBLCD were extensively modified using supplemental datasets. NAVTEQ street data (secondary and primary roads) and institutional delineations were overlayed with the 2006 CBLCD land-cover and used to reclassify underlying pixels. Certain areas adjacent to the secondary road network were also reclassified based on assumptions developed by USGS researchers, in order to capture residential development (*i.e*., subdivisions not being picked up by the satellite in the CBLCD). In addition to spatially modifying the 2006 CBLCD, the following datasets were used to supplement the developed land cover data in the final CBP P5.3.2 land-use framework: US Census housing unit data, Maryland Department of Planning (MDP) Property View data, and estimates of impervious coefficients for rural residential properties (determined via a sampling of these properties using aerial photography). This additional information was used to estimate the extent of impervious area in roadways and residential lots. Acres of construction and extractive land-uses were determined independently (Claggett et al. 2012). Finally, in order to develop accurate agricultural land-use acreages, the CBP P5.3.2 incorporated county

[1] The EPA Chesapeake Bay Program developed the first watershed model in 1982. There have been many upgrades since the first phase of this model. The CBP P5.3.2 is the latest version and it was developed to estimate flow, nutrients, and sediment loads to the Bay.

level US Agricultural Census data (USDA 1982, 1987, 1992, 1997, 2002). The watershed model documentation, *Chesapeake Bay Phase 5.3 Community Watershed Model* (US EPA 2010b), describes these modifications in more detail.

The result of these modifications is that CBP P5.3.2 land-use does not exist in a single GIS coverage; instead, it is only available in a tabular format. The CBP P5.3.2 watershed model is comprised of 30 land-uses. Most of these land-uses are differentiated only by their nitrogen and phosphorus loading rates. The land-uses are divided into 13 classes with distinct sediment erosion rates. Table 1 lists the CBP P5.3.2 generalized land-uses, detailed land-uses, which are classified by their sediment erosion rates, and the acres of each land-use in the Upper Pocomoke River watershed.

Upper Pocomoke River Watershed Land-use Distribution

The Upper Pocomoke River watershed land-use was evaluated separately for Maryland and Delaware. The land-use distribution in Maryland consists primarily of forest (63.5%) and crop land (28.9%), with smaller amounts of urban land (5.7%) and pasture (1.9%). In Delaware, the land-use distribution also consists mainly of forest (54.9%) and crop land (40.3%), with smaller amounts of urban land (3.7%), pasture (1.0%), and extractive activities (0.1%). A detailed summary of the watershed land-use areas is presented in Table 1, and a land-use map is provided in Figure 2.

Agriculture dominates the landscape in the Upper Pocomoke River watershed. Ditching on agricultural lands in the Pocomoke River watershed is an extensive practice that has been used to drain wetlands for agriculture. Ditching goes back to the 1840s and much of the land clearing in the Pocomoke River watershed was completed prior to the 1940s (Gellis et al. 2009, Bell and Favero 2000).

Table 1: Land-use Percentage Distribution for the Upper Pocomoke River Watershed

General Land-use	Detailed Land-use	Maryland			Delaware		
		Area (Acres)	**Percent**	**Grouped Percent of Total**	**Area** (Acres)	**Percent**	**Grouped Percent of Total**
Crop	Animal Feeding Operations	19.6	0.0	28.9	5.1	0.0	40.3
	Hay	3,995.8	4.2		356.6	1.6	
	High Till	7,622.2	8.0		2,935.5	13.1	
	Low Till	15,852.9	16.6		5,717.2	25.5	
	Nursery	112.1	0.1		7.1	0.0	
Extractive	Extractive	17.6	0.0	0.0	24.9	0.1	0.1
Forest	Forest	59,980.0	62.8	63.5	12,176.0	54.3	54.9
	Harvested Forest	603.2	0.6		123.0	0.5	
Pasture	Pasture	1,633.4	1.7	1.9	213.6	1.0	1.0
	Trampled Pasture	0.7	0.0		0.0	0.0	
Urban	Barren (Construction)	149.1	0.2	5.7	7.6	0.0	3.7
	Impervious	1,371.1	1.4		299.0	1.3	
	Pervious	4,118.3	4.3		539.0	2.4	
Total		**95,475.9**	**100.0**	**100.0**	**22,404.5**	**100.0**	**100.0**

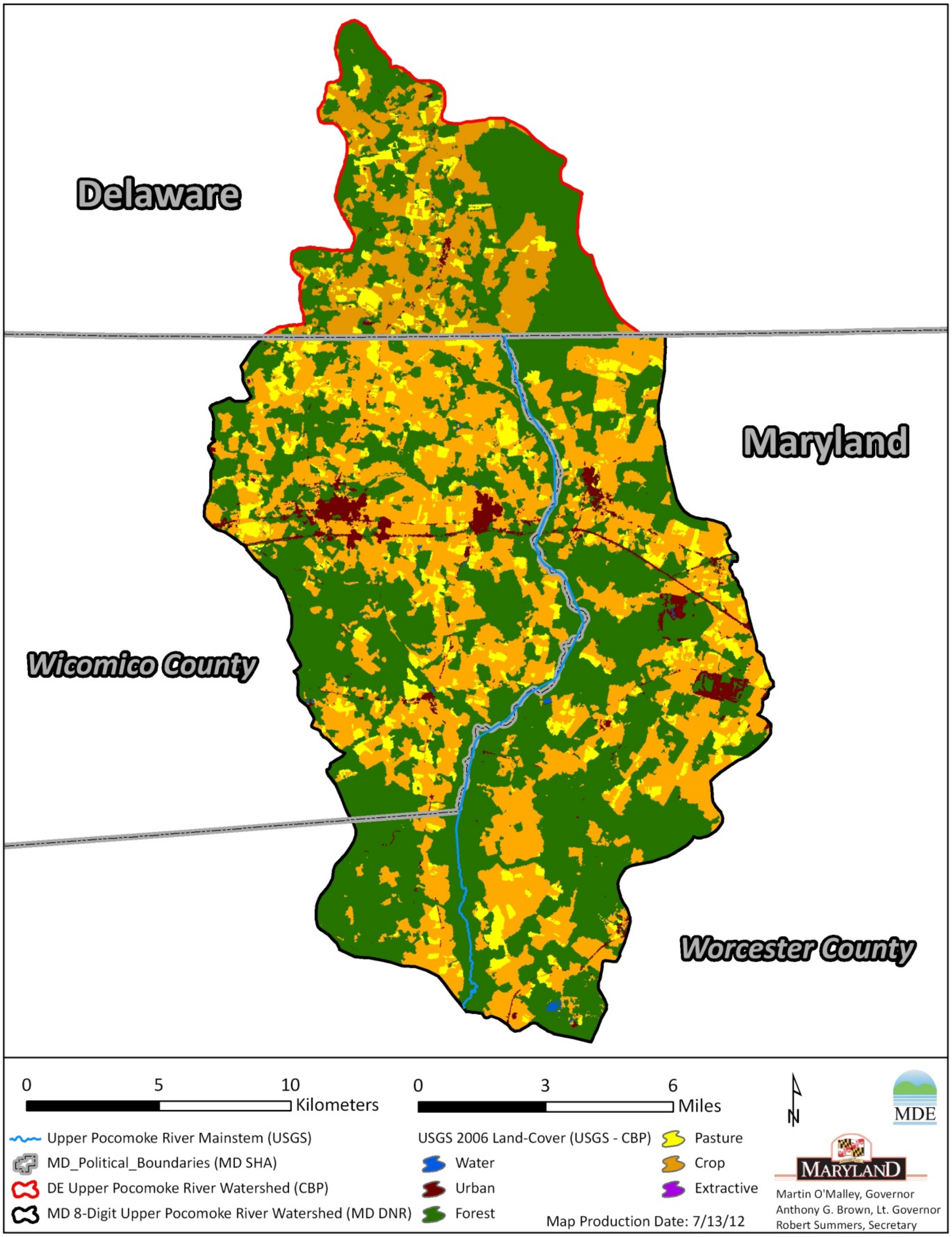

Figure 2: Land-use of the Upper Pocomoke River Watershed

2.2 Source Assessment

The MD 8-Digit Upper Pocomoke River Watershed Total Baseline Sediment Load consists of loads generated outside of the assessment unit, referred to as Upstream Baseline Loads, and loads generated within the assessment unit, referred to as the MD 8-Digit Upper Pocomoke River Watershed Baseline Load Contribution. The MD 8-Digit Upper Pocomoke River Watershed Baseline Load Contribution can be subdivided into nonpoint and point source loads. This section summarizes the methods used to derive each of these distinct source categories.

2.2.1 Nonpoint Source Assessment

In this document, the nonpoint source loads account for all sediment loads not covered under a National Pollutant Discharge Elimination System (NPDES) permit within the MD 8-Digit Upper Pocomoke River watershed. In general, these are rainfall driven land-use based loads from agricultural, forest, and urban lands not covered by an NPDES stormwater permit. This section provides the background and methods for determining the nonpoint source baseline loads generated within the MD 8-Digit Upper Pocomoke River watershed (Nonpoint Source BL_{UP}). This approach was also used to estimate the Delaware Upstream Baseline Load.

General Load Estimation Methodology

Nonpoint source sediment loads generated within the MD 8-Digit Upper Pocomoke River watershed are estimated based on the *edge-of-stream (EOS)* loads from the CBP P5.3.2 watershed model 2010 Progress Scenario. Within the CBP P5.3.2 watershed model, EOS sediment loads are calculated based on the fact that not all of the *edge-of-field* (EOF) sediment load is delivered to the stream or river (some of it is stored on fields down slope, at the foot of hillsides, or in smaller rivers or streams that are not represented in the model). To calculate the actual EOS loads, a *sediment delivery factor (SDF)* (the ratio of sediment reaching a basin outlet compared to the total erosion within the basin) is used. Details of the methods used to calculate sediment load have been summarized in the report entitled *Chesapeake Bay Phase 5 Community Watershed Model* (US EPA 2010b).

Edge-of-Field Target Erosion Rate Methodology

EOF target erosion rates for agricultural land-uses and forested land-use were based on erosion rates determined by the Natural Resource Inventory (NRI). NRI is a statistical survey of land-use and natural resource conditions conducted by the Natural Resources Conservation Service (NRCS) (USDA 2006). Sampling methodology is explained by Nusser and Goebel (1997).

Estimates of average annual erosion rates for pasture and cropland are available on a county basis at five-year intervals, starting in 1982. Erosion rates for forested land-uses are not available on a county basis from NRI; however, for the purpose of the Chesapeake Bay Program Phase 4.3 (CBP P4.3) watershed model, NRI calculated average annual erosion rates for forested land-use on a watershed basis. These rates are still being used as targets in the CBP P5.3.2 model.

The average value of the 1982 and 1987 surveys was used as the basis for EOF target rates for pasture and cropland. Rates for urban pervious, urban impervious, extractive, and barren land were based on a combination of best professional judgment, literature analysis, and regression analysis. The EOF erosion rates do not reflect best management practices (BMPs) or other soil conservation policies introduced in the wake of the effort to restore the Chesapeake Bay. To compensate for this, after the EOS sediment loads have been estimated within the CBP P5.3.2 watershed model, BMPs are applied to the modeled EOS loads in the CBP P5.3.2 2010 Progress Scenario. BMP data, representing current BMPs in place on the ground in 2010, is collected by the Chesapeake Bay Program (CBP), and TSS reduction efficiencies have been estimated by CBP for specific types of BMPs based on peer reviewed studies, data collected by local jurisdictions, and an analysis of available literature values. For further details regarding EOF erosion rates, please see Section 9.2.1 of the community model (US EPA 2010b). Table 2 lists erosion rates specific to the Upper Pocomoke River watershed.

Table 2: Summary of EOF Erosion Rate Calculations

Land-use	**Data Source**	**Wicomico County, Maryland** (ton/acre/yr)[1]	**Worcester County, Maryland** (ton/acre/yr)	**Sussex County, Delaware** (ton/acre/yr)
Forest	Phase 2 NRI	0.13	0.13	0.13
Harvested Forest[1]	Average Phase 2 NRI (x 10)	3.00	3.00	3.00
Nursery[2]	Pasture NRI (1982-1987) (x 9.5)	1.52	2.57	0.29
Pasture[2]	Pasture NRI (1982-1987)	0.16	0.27	0.03
Trampled Pasture[2]	Pasture NRI (1982-1987) (x 9.5)	1.52	2.57	0.29
Animal Feeding Operations[2]	Pasture NRI (1982-1987) (x 9.5)	1.52	2.57	0.29
Hay[2]	Crop NRI (1982-1987) (x 0.32)	0.72	0.8	0.32
High Till[2]	Crop NRI (1982-1987) (x 1.25)	2.8	3.14	1.26
Low Till[2]	Crop NRI (1982-1987) (x 0.75)	1.68	1.89	0.75
Pervious Urban	Intercept Regression Analysis	0.74	0.74	0.74
Extractive	Best Professional Judgment	10.00	10.00	10.00
Barren (Construction)	Literature Survey	20.00	20.00	20.00
Impervious Urban	100% Impervious Regression Analysis	5.18	5.18	5.18

Notes: [1]ton/acre/yr = tons per acre per year
[2]Based on an average of NRI values for the CBP P5.3.2 watershed model segments.
[3]NRI score data adjusted based on land-use.

Edge-of-Stream Loads

Edge-of-stream loads are the loads that enter the river reaches (i.e., the mainstem river of a watershed). Such loads represent not only the erosion from the land but all of the intervening processes of deposition on hillsides and sediment transport through smaller rivers and streams. The formula for the EOS load calculation within the CBP P5.3.2 watershed model is as follows:

$$\sum_{i}^{n} EOS = Acres_i * EOF_i * SDR_i \qquad \text{(Equation 2.1)}$$

where:
- n = number of land-use classifications
- i = land-use classification
- EOS = Edge of stream load, tons per year (ton/yr)
- Acres = acreage for land-use i
- EOF = Edge-of-field erosion rate for land-use i, ton/acre/yr
- SDF = sediment delivery factor for land-use i, per Equation 2.2

Sediment Delivery Factor: In order to account for the changes in sediment loads due to distance traveled to the stream, the CBP P5.3.2 model uses the *sediment delivery factor*. The base formula for calculating *sediment delivery factors* in the CBP P5.3.2 model is the same as the formula used by the NRCS (USDA 1983).

$$SDF = 0.417762 * A^{-0.134958} - 0.127097 \qquad \text{(Equation 2.2)}$$

Where:
- SDF = sediment delivery factor
- A = drainage area in square miles

Land-use specific *sediment delivery factors* were calculated for each river segment using the following procedure:

(1) mean distance of each land-use from the river reach was calculated;

(2) *sediment delivery factors* for each land-use were calculated (drainage area in Equation 2.2 was assumed to be equal to the area of a circle with radius equal to the mean distance between the land-use and the river reach).

For the Coastal Plain physiographic region, where the MD 8-Digit Upper Pocomoke River watershed is located, additional analysis was required because there are very few monitoring stations in the region that are used in the calibration of the CBP P5.3.2 EOS sediment loads. The analysis found that the transport factors on the Coastal Plain were about one-quarter of those from other physiographic regions. It is assumed that this is due to the relatively low gradient of the region. Because of the low gradient, less sediment is delivered to the modeled river reaches in the Coastal Plain region than the higher gradient physiographic regions. On the basis of this analysis, the SDF was multiplied by a reduction factor of 0.25.

2.2.2 Point Source Assessment

A list of five active permitted point sources that contribute to the sediment load in the MD 8-Digit Upper Pocomoke River watershed was compiled using MDE's Permit Database. The types of permits identified include individual municipal, general mineral mining, general industrial stormwater, and the general permit for stormwater discharges from construction sites. The permits can be grouped into two categories, process water and stormwater. The process water category includes those loads generated by continuous discharge sources whose permits have TSS limits. Other permits that do not meet these conditions are considered *de minimis* in terms of the total sediment load. The stormwater category includes all NPDES regulated stormwater discharges. The technical memorandum to this document entitled *Significant Sediment Point Sources in the Upper Pocomoke River Watershed* identifies all the process water permits and NPDES regulated stormwater discharges that contribute to the sediment load in the Upper Pocomoke River watershed.

The baseline sediment loads for the three process water permits (Process Water BL_{UP}) are calculated based on their permitted TSS limits (average monthly or weekly concentration values) and corresponding flow information. The general industrial stormwater permit and the general permit for stormwater discharges from construction sites identified throughout the MD 8-Digit Upper Pocomoke River watershed are regulated based on BMPs and do not include TSS limits. In the absence of TSS limits, the NPDES regulated stormwater baseline load (NPDES Stormwater BL_{UP}) is calculated using the CBP P5.3.2 Progress Scenario urban land-use EOS loads (as per Equation 2.2) associated with these permits. The technical memorandum to this document entitled *Significant Sediment Point Sources in the Upper Pocomoke River Watershed* provides detailed information regarding the calculation of the Upper Pocomoke River Watershed Process Water BL_{UP} and NPDES Stormwater BL_{UP}.

2.2.3 Upstream Loads Assessment

For the purpose of this analysis, only one upstream watershed has been identified: the Delaware portion of the Upper Pocomoke River watershed. Subsequently, sediment baseline loads from this watershed will be presented as a Delaware Upstream Baseline Load (BL_{DE}). The BL_{DE} is estimated based on the same nonpoint source load estimation methodology described in Section 2.2.1.

2.2.4 Summary of Baseline Loads

Table 3 summarizes the MD 8-Digit Upper Pocomoke River Baseline Sediment Load, reported in ton/yr and presented in terms of an Upstream Baseline Load and MD 8-Digit Upper Pocomoke River Watershed Baseline Load Contribution nonpoint and point source loadings. The baseline sediment loading within the Adkins Pond drainage basin (located within the western portion of the MD 8-Digit Upper Pocomoke River watershed), for which a sediment TMDL was developed by MDE and approved by the EPA in 2002 (MDE 2002) is implicitly included within the MD 8-Digit Upper Pocomoke River watershed NPDES Stormwater BL_{UP} and Nonpoint Source BL_{UP} due to the spatial resolution of the CBP P5.3.2 watershed model segmentation. Since the Adkins Pond drainage basin is far smaller than the smallest MD 8-Digit Upper Pocomoke River watershed CBP P5.3.2 model segment, the finest scale at which sediment loading estimates are available, the loading cannot be extracted.

Table 3: MD 8-Digit Upper Pocomoke River Baseline Sediment Loads (ton/yr)

Total Baseline Load (ton/yr)		Upstream Baseline Load[1]		MD 8-Digit Upper Pocomoke River Watershed Baseline Load Contribution				
	=	BL_{DE}	+	Nonpoint Source BL_{UP}	+	NPDES Stormwater BL_{UP}	+	Process Water BL_{UP}
2,737.7	=	310.4	+	2,416.6	+	1.8	+	8.9

Note: [1] Although the Upstream Baseline Load is reported here as a single value, it could include both point and nonpoint sources.

Table 4 presents a breakdown of the MD 8-Digit Upper Pocomoke River Total Baseline Sediment Load, detailing loads per land-use. The largest portion of the sediment load in both Maryland and Delaware is from crop land (71.2% and 59.2% respectively). In Maryland, the remainder of the sediment load is from urban land (15.7%), forest (12%), pasture (0.4%), and extractive (0.3%). In Delaware, the remainder of the sediment load is from urban land (26.3%), forest (12%), pasture (0.1%), and extractive (2.4%).

Table 4: Detailed Baseline Sediment Budget Loads Within the MD 8-DigitUpper Pocomoke River Watershed

General Land-use	Detailed Land-use	Maryland			Delaware		
		Load (ton/yr)	**Percent**	**Grouped Percent of Total**	**Load** (ton/yr)	**Percent**	**Grouped Percent of Total**
Crop	Animal Feeding Operations	1.4	0.1	71.2	0.1	0.0	59.2
	Hay	97.6	4.0		2.6	0.9	
	High Till	745.4	30.7		91.5	29.5	
	Low Till	872.9	36.0		89.4	28.8	
	Nursery	12.3	0.5		0.1	0.0	
Extractive	Extractive	6.4	0.3	0.3	7.5	2.4	2.4
Forest	Forest	256.0	10.5	12.0	33.9	10.9	12.0
	Harvested Forest	35.3	1.5		3.4	1.1	
Pasture	Pasture	9.3	0.4	0.4	0.2	0.1	0.1
	Trampled Pasture	0.0	0.0		0.0	0.0	
Urban[1]	Barren (Construction)	109.0	4.5	15.7	5.4	1.7	26.3
	Impervious	194.3	8.0		63.7	20.5	
	Pervious	78.4	3.2		12.6	4.1	
	Process Water	8.9	0.4	0.4	N/A	N/A	N/A
	Total	**2,427.3**	**100.0**	**100.0**	**310.4**	**100.0**	**100.0**

Note: [1] In Maryland, the entirety of the urban barren land-use sediment load and a portion of the urban pervious and impervious land-use sediment loads represent the permitted stormwater load.

2.3 Water Quality Characterization

The MD 8-Digit Upper Pocomoke River watershed was originally listed on Maryland's 1996 303(d) List as impaired by elevated sediments from nonpoint sources, with supporting evidence cited in Maryland's 1996 305(b) report. The 1996 305(b) report did not directly state that elevated sediments were a concern, and it has been determined that the sediment listing was based on best professional judgment (MDE 2004; DNR 1996).

Currently in Maryland, there are no specific numeric criteria for suspended sediments. Therefore, to determine whether aquatic life is impacted by elevated sediment loads, MDE's BSID methodology was applied. The primary goal of the BSID analysis is to identify the most probable cause(s) for observed biological impairments throughout MD's 8-digit watersheds (MDE 2009).

The BSID analysis applies a case-control, risk-based, weight-of-evidence approach to identify potential causes of biological impairment. The risk-based approach estimates the strength of association between various stressors and an impaired biological community. The BSID analysis then identifies individual stressors as probable or unlikely causes of the poor biological conditions within a given MD 8-digit watershed, and subsequently reviews ecological plausibility. Finally, the analysis concludes whether or not these individual stressors or groups of stressors are contributing to the impairment (MDE 2009).

The primary dataset for BSID analysis is Maryland Department of Natural Resources (DNR) Maryland Biological Stream Survey (MBSS) round two data (collected between 2000-2004) because it provides a broad spectrum of paired data variables, which allow for a more comprehensive stressor analysis. The MBSS is a robust statewide probability-based sampling survey for assessing the biological conditions of 1st through 4th order, non-tidal streams (Klauda et al. 1998; Roth et al. 2005). It uses a fixed length (75 meter (m)) randomly selected stream segment for collecting site level information within a primary sampling unit (PSU), also defined as a watershed. The randomly selected stream segments, from which field data are collected, are selected using either stratified random sampling with proportional allocation, or simple random sampling (Cochran 1977). The random sample design allows for unbiased estimates of overall watershed conditions. Thus, the dataset facilitated case-control analyses because: 1) in-stream biological data are paired with chemical, physical, and land-use data variables that could be identified as possible stressors; and 2) it uses a probabilistic statewide monitoring design.

The BSID analysis combines the individual stressors (physical and chemical variables) into three generalized parameter groups in order to assess how the resulting impacts of these stressors can alter the biological community and structure. The three generalized parameter groups include: sediment, habitat, and water chemistry. Identification of a sediment stressor as contributing to the biological impairment is based on the results of the individual stressor associations within the sediment parameter grouping, which reveal the effects of sediment related impacts on stream biota (MDE 2009).

Since it uses MBSS data, the BSID applies only to 1st through 4th order streams in a MD 8-digit watershed. In larger order mainstem rivers and streams, DNR CORE/TREND program data is used to assess the support of aquatic life. The program collected benthic macroinvertebrate data between 1976 and 2006. These data were used to calculate four benthic community measures: total number of taxa, the Shannon Weiner Diversity Index (DI), the modified Hilsenhoff Biotic Index (HBI), and percent *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT). DNR has extensive benthic macroinvertebrate monitoring data for one station on the mainstem of the MD 8-Digit Upper Pocomoke River through the CORE/TREND program. This station has 30 years of benthic macroinvertebrate data (DNR 2009).

MD 8-Digit Upper Pocomoke River Watershed Monitoring Stations

A total of 24 water quality monitoring stations were used to characterize the MD 8-Digit Upper Pocomoke River watershed. Twenty-three biological/physical habitat monitoring stations from the MBSS program round one and round two data collection were used to describe the MD 8-Digit Upper Pocomoke River watershed in Maryland's 2010 Integrated Report. The BSID analysis used the nine biological/physical habitat monitoring stations from the MBSS program round two data collection. Additionally, one monitoring station from the Maryland CORE/TREND monitoring network was applied within the TMDL analysis. All stations are presented in Figure 3 and listed in Table 5.

Table 5: Monitoring Stations in the MD 8-Digit Upper Pocomoke River Watershed

Site Number	Sponsor	Site Type	Location	Latitude (decimal degrees)	Longitude (decimal degrees)
POK0527	DNR	CORE/TREND	Route 50	38.3889	-75.3250
WI-S-019-208-97	DNR	MBSS Round 1	South Fork Green Run	38.4310	-75.3750
WI-S-037-210-97	DNR	MBSS Round 1	Burnt Mill Bridge	38.3970	-75.3420
WI-S-055-303-97	DNR	MBSS Round 1	Pocomoke River	38.3310	-75.3260
WI-S-057-311-97	DNR	MBSS Round 1	Adkins Race	38.3220	-75.3570
WI-S-057-319-97	DNR	MBSS Round 1	Adkins Race	38.3250	-75.3600
WI-S-059-106-97	DNR	MBSS Round 1	Truitt Bridge	38.3510	-75.3670
WI-S-067-207-97	DNR	MBSS Round 1	Burnt Mill Bridge	38.4020	-75.3700
WI-S-067-219-97	DNR	MBSS Round 1	Burnt Mill Bridge	38.4020	-75.3580
WI-S-074-103-97	DNR	MBSS Round 1	Murray Bridge	38.4020	-75.3500
WO-S-003-306-97	DNR	MBSS Round 1	Pocomoke River	38.4060	-75.3180
WO-S-003-308-97	DNR	MBSS Round 1	Pocomoke River	38.4020	-75.3180
WO-S-005-315-97	DNR	MBSS Round 1	Pocomoke River	38.3730	-75.3240
WO-S-061-205-97	DNR	MBSS Round 1	North Fork Green Run	38.4300	-75.3340
WO-S-061-206-97	DNR	MBSS Round 1	North Fork Green Run	38.4370	-75.3500
UPPC-103-R-2001	DNR	MBSS Round 2	South Fork Green Run	38.4413	-75.3919
UPPC-105-R-2001	DNR	MBSS Round 2	Campbell Ditch	38.3645	-75.4119
UPPC-106-R-2001	DNR	MBSS Round 2	Timmonstown Bridge	38.3459	-75.2554
UPPC-107-R-2001	DNR	MBSS Round 2	Aydylotte Bridge	38.4004	-75.4151
UPPC-113-R-2001	DNR	MBSS Round 2	Campbell Ditch	38.3603	-75.4089
UPPC-115-R-2001	DNR	MBSS Round 2	Campbell Ditch	38.3847	-75.4482
UPPC-204-R-2001	DNR	MBSS Round 2	Libertytown Bridge	38.3223	-75.2932
UPPC-216-R-2001	DNR	MBSS Round 2	Libertytown Bridge	38.3221	-75.2848
UPPC-410-R-2001	DNR	MBSS Round 2	Pocomoke River	38.4220	-75.3278

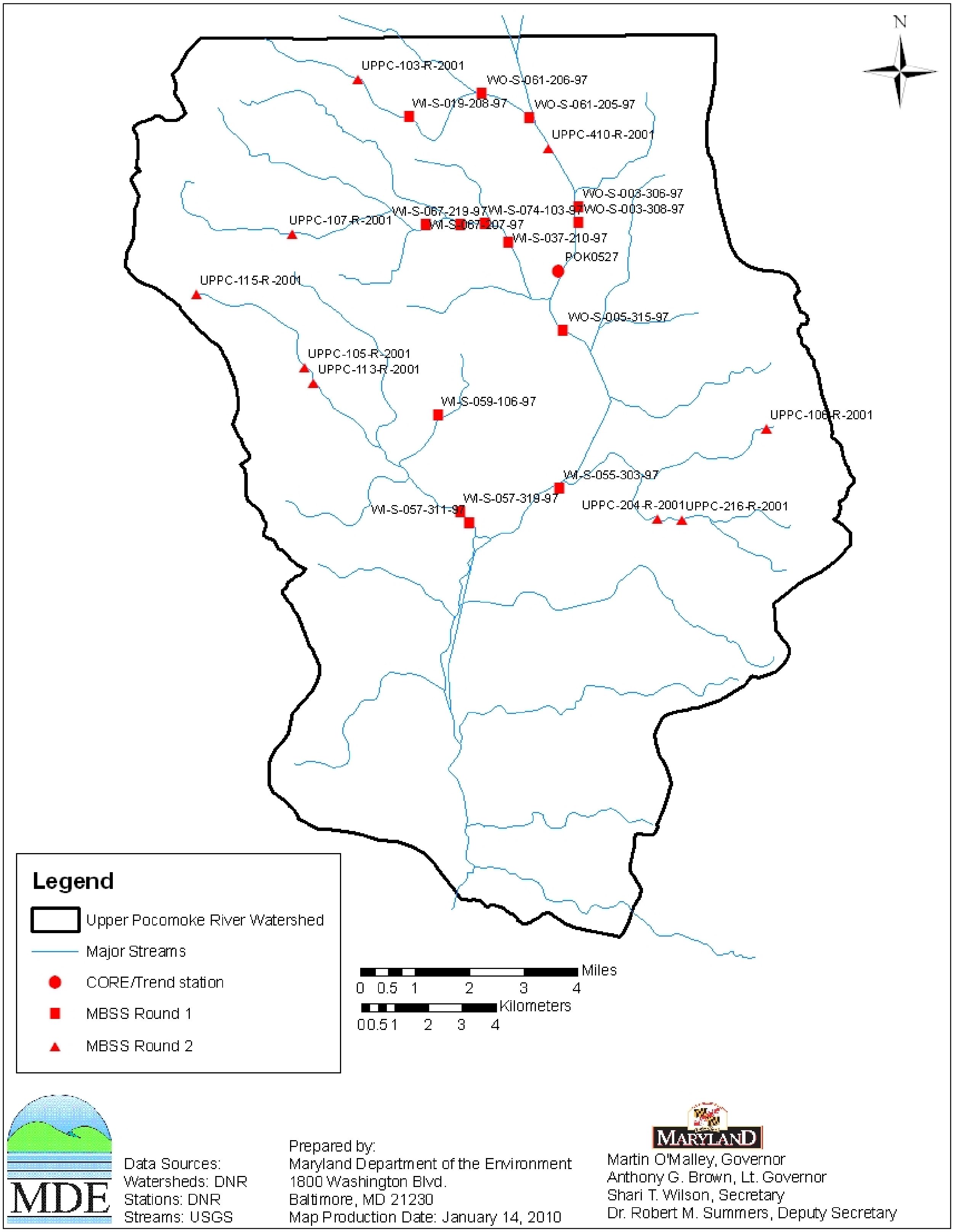

Figure 3: Monitoring Stations in the MD 8-Digit Upper Pocomoke River Watershed

2.4 Water Quality Impairment

The Maryland water quality standards surface water use designation for the MD 8-Digit Upper Pocomoke River mainstem and its tributaries is Use I (Water Contact Recreation, Protection of Aquatic Life) (COMAR 2012a,b,c). The water quality impairment of the MD 8-Digit Upper Pocomoke River watershed addressed by this TMDL is caused by an elevated sediment load beyond a level that the watershed can sustain, thereby causing sediment related impacts that cannot support aquatic life. Assessment of aquatic life is based on benthic and fish Index of Biotic Integrity (IBI) scores, as demonstrated via the BSID analysis for the watershed.

The MD 8-Digit Upper Pocomoke River watershed is listed on Maryland's 2010 Integrated Report as impaired for impacts to biological communities. The biological assessment is based on the combined results of MBSS round one (1995-1997) and round two (2000-2004) data, which includes 23 stations. Eight of the 23 stations, or 35% of the stream miles in the watershed, are assessed as having BIBI and/or FIBI scores significantly lower than 3.0 (on a scale of 1 to 5) (MDE 2010a). As mentioned in Section 2.3, however, only MBSS round two data were used in the BSID analysis. See Figure 3 and Table 5 for station locations and information.

The results of the BSID analysis for the MD 8-Digit Upper Pocomoke River watershed are presented in a report entitled *Watershed Report for Biological Impairment of the Nontidal Upper Pocomoke River Watershed, Wicomico and Worcester Counties, Maryland Biological Stressor Identification Analysis Results and Interpretation*. The report states that the degradation of biological communities in the MD 8-Digit Upper Pocomoke River watershed is strongly associated with agricultural land-use, an altered stream morphology (channelization), lack of riparian buffer, and elevated levels of both sediments and nutrients (MDE 2012a).

The BSID analysis has determined that the biological impairment in the MD 8-Digit Upper Pocomoke River watershed is due in part to sediment-related stressors. Specifically, the analysis confirmed that individual stressors within the sediment parameter grouping were contributing to the biological impairment in the watershed. Overall, stressors within the sediment parameter grouping were identified as having a statistically significant association with impaired biological communities at approximately 84% of the sites with BIBI and/or FIBI scores significantly less than 3.0 throughout the watershed (MDE 2012a). Therefore, since sediment is identified as a stressor to the biological communities in the MD 8-Digit Upper Pocomoke River watershed, the results confirm the 1996 sediment listing, and a TMDL is required.

As discussed in Section 2.3, the BSID applies only to 1st through 4th order streams in a watershed. Therefore, aquatic life in the MD 8-Digit Upper Pocomoke River watershed mainstem is assessed using DNR CORE/TREND program data. As shown in Table 6, the biological monitoring results from one DNR CORE/TREND station data along the MD 8-Digit Upper Pocomoke River watershed mainstem indicate that mainstem water quality can be classified as "GOOD". Statistical analysis of the long term CORE/TREND data indicates that since 1976, the station has shown strong improvement. These results are based on percent EPT, taxa number, biotic index, and diversity index (DNR 2009).

Table 6: MD 8-Digit Upper Pocomoke River Watershed CORE/TREND Data

Site Number	Current Water Quality Status	Trend Since 1970's
POK0527	GOOD	STRONG IMPROVEMENT

3.0 TARGETED WATER QUALITY GOAL

The objective of the sediment TMDL established herein is to reduce sediment loads, and subsequent effects on aquatic life in the 1^{st} through 4^{th} order streams in the MD 8-Digit Upper Pocomoke River watershed, to levels that support the Use I designation for the watershed. Assessment of aquatic life is based on Maryland's biocriteria protocol, which evaluates both the amount and diversity of the benthic and fish community through the use of the IBI (Roth et al. 1998, 2000; Stribling et al. 1998; MDE 2008).

Reductions in sediment loads are expected to result from decreased watershed erosion, which will then lead to improved benthic and fish habitat conditions. Specifically, sediment load reductions are expected to result in an increase in the number of benthic sensitive species present, an increase in the available and suitable habitat for a benthic community, a possible decrease in fine sediment (fines), and improved stream habitat diversity, all of which will result in improved water quality.

The TMDL, however, will not completely resolve the impairment to biological communities within the watershed. Since the BSID watershed analysis identifies phosphorus, low DO, sulfates, in-stream habitat conditions (most importantly, stream channelization), and the lack of riparian buffer as other possible stressors impacting the biological conditions, this impairment remains to be fully addressed through the Integrated Report listing and TMDL development processes. This impairment to aquatic life will only be fully addressed when all impairing substances identified as impacting biological communities in the watershed are reduced to levels that will meet water quality standards, as established in future TMDLs for those substances (MDE 2009,2012a).

Based on the analysis of benthic monitoring results at the CORE/TREND station, it has been determined that the mainstem of the MD 8-Digit Upper Pocomoke River watershed is supportive of aquatic life and is therefore not impaired by sediment. The TMDL will be restricted to the 1^{st} through 4^{th} order tributaries within the MD 8-Digit watershed and will exclude the Upper Pocomoke River mainstem.

4.0 TOTAL MAXIMUM DAILY LOADS AND SOURCE ALLOCATION

4.1 Overview

This section describes how the sediment TMDL and the corresponding allocations were developed for the MD 8-Digit Upper Pocomoke River watershed. Section 4.2 describes the analysis framework for estimating sediment loading rates and the assimilative capacity of the watershed stream system. Section 4.3 summarizes the scenarios that were used in the analysis and presents results. Section 4.4 discusses critical conditions and seasonality. Section 4.5 explains the calculations of TMDL loading caps. Section 4.6 details the load allocations, and Section 4.7 explains the rationale for the MOS. Finally, Section 4.8 summarizes the TMDL.

4.2 Analysis Framework

Since there are no specific numeric criteria in Maryland that quantify the impact of sediment on the aquatic life of nontidal stream systems, a reference watershed approach will be used to establish the TMDL. Furthermore, as the BSID analysis established a link between biological impairment and sediment related stressors, the reference watershed approach will utilize a biological endpoint.

Watershed Model

The watershed model framework chosen for the MD 8-Digit Upper Pocomoke River watershed TMDL was the CBP P5.3.2 watershed model EOS loads. The spatial domain of the CBP P5.3.2 watershed model segmentation aggregates to the MD 8-digit watersheds, which is consistent with the impairment listing. The nonpoint source baseline sediment loads generated within the MD 8-Digit Upper Pocomoke River watershed, as well as the Delaware upstream baseline sediment loads, are based on the EOS loads from the CBP P5.3.2 watershed model 2010 Progress Scenario. CBP P5.3.2 Progress Scenario EOS loads are calculated as the sum of individual land-use EOS loads within the watershed and represent a long-term average loading rate. Individual land-use EOS loads are calculated within the CBP P5.3.2 watershed model as a product of the land-use area, land-use target EOF loading rate, and loss from the EOF to the main channel. BMP data and reduction efficiencies are then subsequently applied to the EOS loads. The loss from the EOF to the main channel is the *sediment delivery factor* and is defined as the ratio of the sediment load reaching a basin outlet to the total erosion within the basin. A *sediment delivery factor* is estimated for each land-use type based on the proximity of the land-use to the main channel. Thus, as the distance to the main channel increases, more sediment is stored within the watershed (i.e., *sediment delivery factor* decreases). Details of the data sources for the unit loading rates can be found in Section 2.2 of this report.

The Upper Pocomoke River watershed was evaluated using two watershed TMDL Segments consisting of five CBP P5.3.2 watershed model segments (See Figure 4). TMDL Segment 1 represents the sediment loads generated in the Delaware portion of the

Upper Pocomoke River watershed. TMDL Segment 2 represents the sediment loads generated in the Maryland portion of the Upper Pocomoke River watershed (i.e., the MD 8-Digit Upper Pocomoke River watershed).

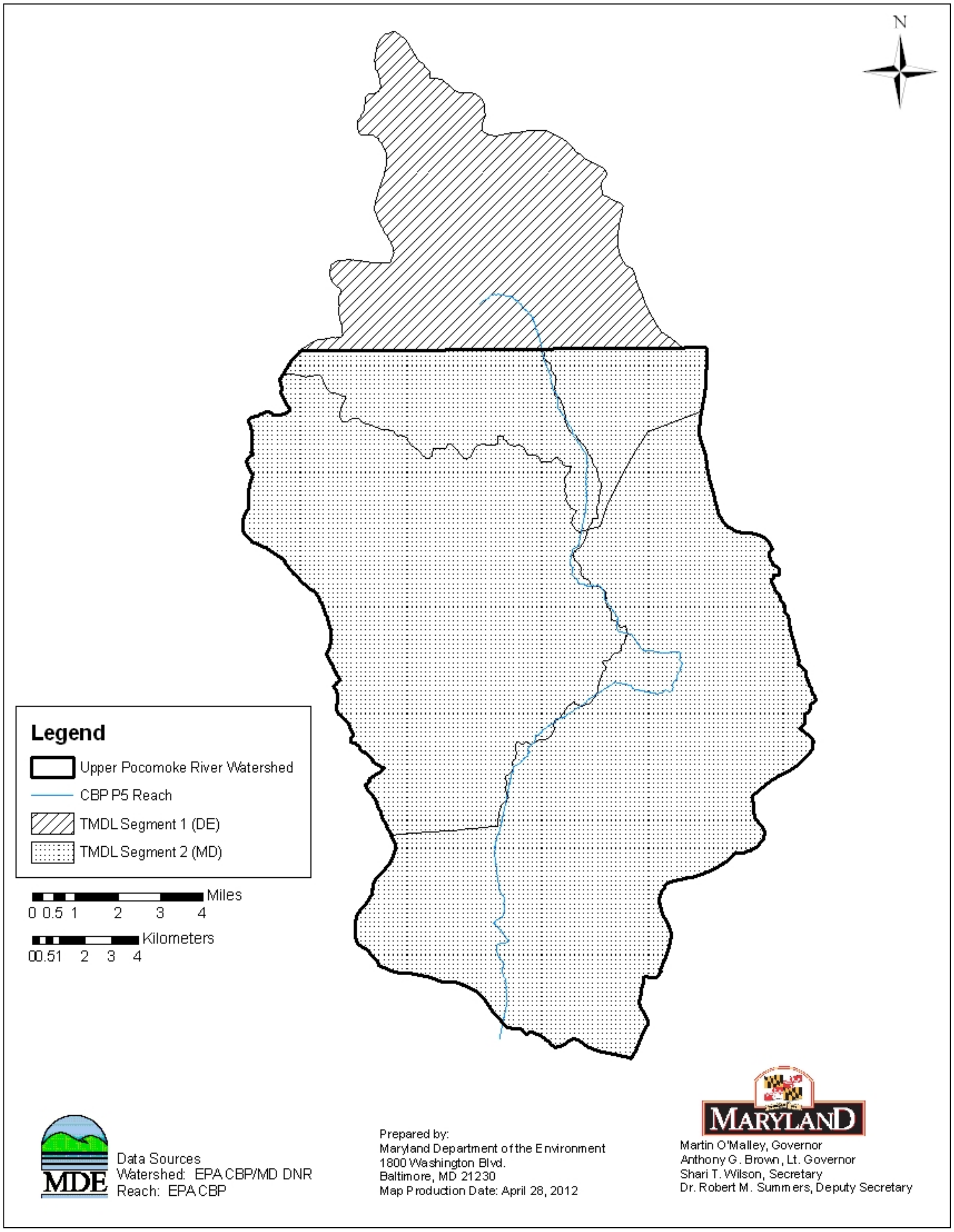

Figure 4: Upper Pocomoke River Watershed TMDL Segmentation

Reference Watershed Approach

Currently in Maryland, there are no specific numeric criteria that quantify the impact of sediment on the aquatic life of nontidal stream systems. Therefore, in order to quantify the impact of sediment on the aquatic life of non-tidal stream systems, a reference watershed TMDL approach was used and resulted in the establishment of a *sediment loading threshold* (Currey et al. 2006). The original methodology was established for watersheds within the Highland and Piedmont physiographic regions but has been adapted to the Coastal Plain physiographic region for this TMDL. Reference watersheds were determined based on Maryland's biocriteria methodology. The biocriteria methodology assesses biological impairment at the MD 8-digit watershed scale based on the percentage of MBSS monitoring stations, translated into watershed stream miles, that have BIBI and/or FIBI scores lower than the Minimum Allowable IBI Limit (MAL). The MAL is calculated based on the average annual allowable IBI value of 3.0 (on a scale of 1 to 5). It accounts for annual variability and helps to avoid classification errors (i.e., false positives) when assessing for biological impairments (Roth et al. 1998,2000; Stribling et al. 1998; MDE 2008).

Comparison of watershed sediment loads to loads from reference watersheds requires that the watersheds be similar in physical and hydrological characteristics. To satisfy this requirement, in the original methodology, Currey et al. (2006) selected reference watersheds only from the Highland and Piedmont physiographic regions. This region is consistent with the non-coastal region that was identified in the 1998 development of FIBI and subsequently used in the development of BIBI (Roth et al. 1998; Stribling et al. 1998). For this analysis, however, the methodology was adapted, and reference watersheds (watersheds identified as supporting aquatic life on Maryland's 2010 Integrated Report) from the Coastal Plains physiographic region only were used (see Appendix A for the list of reference watersheds). The same methodology as described in Currey et al. (2006) for the selection of the Highland and Piedmont reference watersheds was used to select the Coastal Plain reference watersheds. Furthermore, all subsequent methodologies used to establish the TMDL end point, based on these reference watersheds, are exactly the same as those described in Currey et al. (2006).

To further reduce the effect of the variability within the Coastal Plain physiographic region (i.e., soils, slope, etc.), the watershed sediment loads were then normalized by a constant background condition, the all forested watershed condition. This new normalized term, defined as the *forest normalized sediment load* (Y_n), represents how many times greater the current watershed sediment load is than the *all forested sediment load*. A similar approach was used by EPA Region IX for sediment TMDLs in California (e.g., Navarro River or Trinity River TMDLs), where the loading capacity was based on an analysis of the amount of human-caused sediment delivery that can occur in addition to natural sediment delivery, without causing adverse impacts to aquatic life. The *forest normalized sediment load* for this TMDL is calculated as the current watershed sediment load divided by the *all forested sediment load*. The equation for the *forest normalized sediment load* is as follows:

$$Y_n = \frac{y_{ws}}{y_{for}} \qquad \text{(Equation 4.1)}$$

Where:
Y_n = forest normalized sediment load
y_{ws} = current watershed sediment load (ton/yr)
y_{for} = all forested sediment load (ton/yr)

Five reference watersheds were selected from the Coastal Plain physiographic region. Reference watershed *forest normalized sediment loads* were calculated using CBP P5.3.2 watershed model 2010 Progress Scenario EOS loads. The median and 75th percentile of the reference watershed *forest normalized sediment loads* were calculated and found to be 5.6 and 6.0 respectively. The median value of 5.6 was established as the sediment loading threshold as an environmentally conservative approach to develop this TMDL (see Appendix A for more details).

The *forest normalized sediment load* for the Upper Pocomoke River watershed (estimated as 5.9 and 5.0 for the Maryland and Delaware portions of the watershed, respectively) was calculated using CBP P5.3.2 2010 Progress Scenario EOS loads, to best represent current conditions. A comparison of the Upper Pocomoke River watershed *forest normalized sediment loads* to the *forest normalized reference sediment load* (also referred to as the *sediment loading threshold*) demonstrates that the Maryland portion of the watershed exceeds the *sediment loading threshold*, indicating that it is receiving loads above the maximum allowable load that it can sustain and still meet water quality standards. The Delaware portion of the watershed does not exceed the sediment loading threshold. Therefore, a TMDL will be required for the Maryland portion of the watershed only.

4.3 Scenario Descriptions and Results

The following analyses allow a comparison of baseline conditions (under which water quality problems exist) with future conditions, which project the water quality response to various simulated sediment load reductions. The analyses are grouped according to baseline conditions and future conditions associated with TMDLs.

Baseline Conditions

The baseline conditions are intended to provide a point of reference by which to compare the future scenario that simulates conditions of a TMDL. The baseline conditions typically reflect an approximation of nonpoint source loads and upstream loads during the monitoring time frame, as well as estimated point source loads based on discharge data for the same period.

The Upper Pocomoke River watershed baseline sediment loads are estimated using the CBP P5.3.2 2010 Progress Scenario land-use EOS loads. Watershed loading calculations, based on the CBP P5.3.2 watershed model segmentation scheme, are represented by multiple CBP P5.3.2 watershed model segments within a TMDL segment. The sediment loads from these segments are combined to represent the baseline condition. The point source sediment loads are estimated based on the existing permit information. Details of these loading source estimates can be found in Section 2.2 and the technical memorandum to this document entitled *Significant Sediment Point Sources in the Upper Pocomoke River Watershed*.

TMDL Conditions

This scenario represents the future conditions of maximum allowable sediment loads that will be at a level to support aquatic life. In the TMDL calculation, the allowable load for the impaired watershed is calculated as the product of the *sediment loading threshold* (determined from watersheds with a healthy biological community) and the Upper Pocomoke River *all forested sediment load* (see Section 4.2). The resulting load is considered the maximum allowable load the watershed can sustain and support aquatic life.

The TMDL loading and associated reductions are averaged at the watershed scale; however, it is important to recognize that some subwatersheds may require higher reductions than others, depending on the distribution of the land-use.

The formula for estimating the TMDL is as follows:

$$TMDL = \sum_{i=1}^{n} Yn_{ref} \cdot y_{forest_i} \qquad \text{(Equation 4.2)}$$

Where:
TMDL = allowable load for impaired watershed (ton/yr)
Yn_{ref} = sediment loading threshold = forest normalized reference sediment load (5.6)
y_{forest_i} = all forested sediment load for CBP P5.3.2 model segment *i* (ton /yr)
i = CBP P5.3.2 model segment
n = number of CBP P5.3.2 model segments in watershed

The Upper Pocomoke River watershed allowable sediment load is estimated using equation 4.2.

4.4 Critical Condition and Seasonality

EPA's regulations require TMDLs to take into account seasonality and critical conditions for stream flow, loading, and water quality parameters (CFR 2012b). The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. The biological monitoring data used to determine the reference watersheds reflect the impacts of stressors (i.e., sediment impacts to stream biota) over the course of time and therefore depict an average stream condition (i.e., captures all high and low flow events). Since the TMDL endpoint is based on the median of forest normalized loads from watersheds assessed as having good biological conditions (i.e., passing Maryland's biocriteria), by the nature of the biological data described above, it must inherently include the critical conditions of the reference watersheds. Therefore, since the TMDL reduces the watershed sediment load to a level compatible with that of the reference watersheds, critical conditions are inherently addressed.

Seasonality is captured in two components. First, it is implicitly included through the use of the biological monitoring data as biological monitoring data reflect the impacts of stressors over time, as described above. Second, the MBSS dataset included benthic sampling in the spring (March 1 - April 30) and fish sampling in the summer (June 1 - September 30). Benthic sampling in the spring allows for the most accurate assessment of the benthic population, and therefore provides an excellent means of assessing the anthropogenic effects of sediment impacts on the benthic community. Fish sampling is conducted in the summer when low flow conditions significantly limit the physical habitat of the fish community, and it is therefore most reflective of the effects of anthropogenic stressors as well.

4.5 TMDL Loading Caps

This section presents the MD 8-Digit Upper Pocomoke River watershed average annual sediment TMDL. This load is considered the maximum allowable long-term average annual load the watershed can sustain and support aquatic life.

The long-term average annual TMDL was calculated for the MD 8-digit Upper Pocomoke River watershed based on Equation 4.2 and set at a load 5.6 times the all forested condition. In order to attain the TMDL loading cap calculated for the watershed, constant reductions were applied to the predominant controllable sources (i.e., significant contributors of sediment to the stream system), independent of jurisdiction. If only these predominant sources are controlled, the TMDL can be achieved in the most effective, efficient, and equitable manner. Predominant sources typically include urban land, high till crops, low till crops, hay, and pasture, but additional sources could be controlled as well, in order to ensure that the TMDL is attained. High till crops, low till crops, hay, and urban land were identified as the predominant controllable sources in the watershed. Thus, constant reductions were applied to these sources.

In accordance with the conclusions drawn in Sections 2.4, 3.0, and 4.2, it has been determined that sediments are only impairing aquatic life in the 1st through 4th order tributary streams within the MD 8-Digit Upper Pocomoke River watershed. It has been determined that sediment is not impairing the aquatic life in the watershed's mainstem. Since the Delaware portion of the watershed drains to the Upper Pocomoke River mainstem in Maryland, and based on the analysis presented in Section 4.2 of this report, the TMDL is being developed solely for the 1st through 4th order tributaries in the MD 8-Digit watershed, and no reductions are being applied to the Delaware portion of the

Upper Pocomoke River watershed. Therefore, the Delaware portion of the watershed is only provided with an informational allocation equivalent to its baseline load.

The MD 8-Digit Upper Pocomoke River Baseline Load and TMDL are presented in Table 7.

Table 7: MD 8-Digit Upper Pocomoke River Baseline Load and TMDL

Baseline Load (ton/yr)	**TMDL** (ton/yr)	**Reduction** (%)
2,737.7	2,617.8	4.4

4.6 Load Allocations Between Point and Nonpoint Sources

Per EPA regulation, all TMDLs need to be presented as a sum of Wasteload Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source loads generated within the assessment unit, as accounting for natural background, tributary, and adjacent segment loads (CFR 2012a). In the case of the MD 8-Digit Upper Pocomoke River watershed, the TMDL has been developed for the 1st through 4th order streams in the Maryland portion of the watershed draining to the Upper Pocomoke River mainstem only, and not the mainstem itself. Based on this analysis, and the analysis that indicates current sediment loads are not exceeding the sediment loading threshold (see Section 5.2), upstream loads from Delaware are considered in the analysis, but no reductions are applied to them (only an informational allocation, which is equivalent to the baseline load, is assigned), since they empty into the mainstem Upper Pocomoke River within Maryland. Consequently, the MD 8-Digit Upper Pocomoke River watershed sediment TMDL allocations are presented in terms of WLAs (i.e., point source loads identified within the MD 8-Digit watershed) and LAs (i.e., the nonpoint source loads generated within the MD 8-Digit watershed and the upstream loads from Delaware entering the MD 8-Digit watershed). The State reserves the right to allocate the TMDL among different sources in any manner that protects aquatic life from sediment related impacts.

As described in section 4.5, reductions were applied equally to the predominant controllable sources in Maryland, which were identified as high till crops, low till crops, hay and urban land. Forest is the only non-controllable source, as it represents the most natural condition in the watershed, and no reductions were applied to permitted process load sources, since such controls would produce no discernable water quality benefit when nonpoint sources and regulated stormwater sources comprise greater than 99% of the total watershed sediment load.

Table 8 summarizes the TMDL results derived by applying equal percent reductions to the predominant controllable sediment sources in Maryland. The TMDL results in a reduction of 4.9% for the MD 8-Digit Upper Pocomoke River Watershed Contribution, no reduction for Upstream Delaware sources, and an overall reduction of 4.4%. For more detailed information regarding the MD 8-Digit Upper Pocomoke River Watershed TMDL nonpoint source LA, please see the technical memorandum to this document entitled "*Significant Sediment Nonpoint Sources in the Upper Pocomoke River Watershed*".

Table 8: MD 8-Digit Upper Pocomoke River TMDL Reductions by Source Category

<table>
<tr><th></th><th colspan="2">Baseline Load Source Categories</th><th>Baseline Load (ton/yr)</th><th>TMDL Components</th><th>TMDL (ton/yr)</th><th>Reduction (%)</th></tr>
<tr><td rowspan="3">MD 8-digit Upper Pocomoke River Watershed Contribution</td><td colspan="2">Nonpoint Source[1]</td><td>2,416.6</td><td>LA</td><td>2,296.8</td><td>5.0</td></tr>
<tr><td rowspan="2">Point Source</td><td>Urban Stormwater[1]</td><td>1.8</td><td rowspan="2">WLA</td><td>1.7</td><td>5.5</td></tr>
<tr><td>Process Water</td><td>8.9</td><td>8.9</td><td>0.0</td></tr>
<tr><td colspan="3">Subtotal</td><td>2,427.4</td><td></td><td>2,307.4</td><td>4.9</td></tr>
<tr><td>Upstream</td><td colspan="2">Delaware</td><td>310.4</td><td>Upstream LA</td><td>310.4</td><td>0.0</td></tr>
<tr><td colspan="3">Total</td><td>2,737.7</td><td></td><td>2,617.8</td><td>4.4</td></tr>
</table>

Note: [1]The entirety of the urban barren land-use sediment load and a portion of the urban pervious and impervious land-use sediment loads in Maryland are considered point sources/are included in the WLA. The remainder of the urban impervious and pervious land-use sediment loads are considered nonpoint sources/are included in the LA.

The WLA of the MD 8-Digit Upper Pocomoke River watershed is allocated to two permitted source categories, Process Water WLA and Stormwater WLA. The categories are described below.

Process Water WLA

Process Water permits with specific TSS limits and corresponding flow information are assigned to the WLA. In this case, detailed information is available to accurately estimate the WLA. If specific TSS limits are not explicitly stated in the process water permit, then TSS loads are expected to be *de minimis*. If loads are *de minimis*, then they pose little or no risk to the aquatic environment and are not a significant source.

Process Water permits with specific TSS limits include:

- Individual industrial facilities
- Individual municipal facilities
- General mineral mining facilities

There are three process water sources with explicit TSS limits in the MD 8-Digit Upper Pocomoke River watershed that contribute to the watershed sediment load, which include two municipal discharges and one mineral mine discharge. The total estimated TSS load from all of the process water sources is based on current, average permit limits and is equal to 8.9 ton/yr. As mentioned above, no reductions were applied to these sources, since such controls would produce no discernable water quality benefit when nonpoint sources and regulated stormwater sources comprise greater than 99% of the total watershed sediment load. For a detailed list of the three process water permits including information on their permit limits and their allocations, please see the technical memorandum to this document entitled "*Significant Sediment Point Sources in the Upper Pocomoke River Watershed*.

Stormwater WLA

Per EPA requirements, "stormwater discharges that are regulated under Phase I or Phase II of the NPDES stormwater program are point sources that must be included in the WLA portion of a TMDL" (US EPA 2002). Phase I and II permits can include the following types of discharges:

- Small, medium, and large municipal separate storm sewer systems (MS4s) – these can be owned by local jurisdictions, municipalities, and state and federal entities (e.g., departments of transportation, hospitals, military bases),
- Industrial facilities permitted for stormwater discharges, and
- Small and large construction sites.

EPA recognizes that available data and information are usually not detailed enough to determine WLAs for NPDES regulated stormwater discharges on an outfall-specific basis (US EPA 2002). Therefore, NPDES regulated stormwater loads within the MD 8-Digit Upper Pocomoke River watershed TMDL will be expressed as a single NPDES Stormwater WLA. Upon approval of the TMDL, "NPDES-regulated municipal stormwater and small construction storm water discharges effluent limits should be expressed as BMPs or other similar requirements, rather than as numeric effluent limits" (US EPA 2002).

The MD 8-Digit Upper Pocomoke River NPDES Stormwater WLA is based on reductions applied to the sediment load from the portion of the urban land-use in the watershed associated with the applicable NPDES regulated stormwater permits. The WLA may include legacy or other sediment sources. Some of these sources may also be subject to controls from other management programs. The MD 8-Digit Upper Pocomoke River NPDES Stormwater WLA requires an overall reduction of 5.5% (see Table 8).

Neither Wicomico nor Worcester County is an MS4 jurisdiction, and there are no small municipal MS4s located in the watershed. Additionally, Maryland State Highway Administration (SHA) owned roads in the watershed are not covered under SHA's Phase I or II MS4 permit, and the general Phase II MS4 permit for state and federal lands is not applicable within the watershed. Thus, the only applicable NPDES regulated stormwater permits in the watershed are the general permit regulating stormwater discharges for construction sites and one Phase I permit regulating the discharge of stormwater from an industrial facility.

As stormwater assessment and/or other program monitoring efforts result in a more refined source assessment, MDE reserves the right to revise the current NPDES Stormwater WLA provided the revisions protect aquatic life from sediment related impacts.

For more information on the methods used to calculate the NPDES regulated stormwater baseline sediment load, see Section 2.2.2. For a detailed list of all of the NPDES regulated stormwater discharges within the watershed and information regarding the NPDES stormwater WLA distribution amongst these discharges, please see the technical memorandum to this document entitled "*Significant Sediment Point Sources in the Upper Pocomoke River Watershed*".

4.7 Margin of Safety

All TMDLs must include a MOS to account for any lack of knowledge and uncertainty concerning the relationship between loads and water quality (CFR 2012b). The MOS shall also account for any rounding errors generated in the various calculations used in the development of the TMDL. It is proposed that the estimated variability around the reference watershed group used in this analysis already accounts for such uncertainty. Analysis of the reference group *forest normalized sediment loads* indicates that approximately 75% of the reference watersheds have a value of less than 6.0. Also, 50% of the reference watersheds have a value less than 5.6. Based on this analysis the *forest normalized reference sediment load* (also referred to as the *sediment loading threshold*) was set at the median value of 5.6 (Currey et al. 2006). This is considered an environmentally conservative estimate, since 50% of the reference watersheds have a load above this value (5.6), which when compared to the 75% value (6.0), results in an implicit MOS of approximately 18%.

4.8 Summary of Total Maximum Daily Loads

The average annual MD 8-Digit Upper Pocomoke River watershed TMDL is summarized in Table 9. The TMDL is the sum of the LAs, NPDES Stormwater WLA, Process Water WLA, and MOS. Additionally, the Adkins Pond Sediment TMDL of 599 cubic meters per year (m^3/yr), which was developed by MDE to be protective of water quality standards within the impoundment and approved by the EPA in 2002, still applies as the target sediment loading capacity within the pond's drainage area, located in the western portion of the MD 8-Digit Upper Pocomoke River watershed (MDE 2002). The attainment of water quality standards within the MD 8-digit Upper Pocomoke River watershed and Adkins Pond impoundment can only be achieved by meeting the average annual TMDL of sediment/TSS specified for the MD 8-digit watershed within this report as well as the specific TMDL for the Adkins Pond drainage basin established by MDE in

2002. The Maximum Daily Load (MDL) is summarized in Table 10 (See Appendix B for more details).

Table 9: MD 8-Digit Upper Pocomoke River Watershed Average Annual TMDL of Sediment/TSS (ton/yr)

TMDL (ton/yr)	=	**LA**			+	**WLA**			+	**MOS**
		LA_{DE}[1]	+	**LA_{UP}**		**NPDES Stormwater WLA_{UP}**	+	**Process Water WLA_{UP}**		
2,617.8	=	310.4	+	2,296.8	+	1.7	+	8.9	+	Implicit

Upstream Load Allocation[2,3] (310.4); MD 8-Digit Upper Pocomoke River Watershed TMDL Contribution (2,296.8 + 1.7 + 8.9)

Notes: [1] LA_{DE} was set equivalent to its baseline load, since it was determined that reductions from upstream Delaware sources were not necessary to meet Maryland's water quality standards within the MD 8-digit Upper Pocomoke River watershed.
[2] Although for the purposes of this analysis, the upstream load is referred to as an LA, it could include loads from both point and nonpoint sources.
[3] A delivery factor of 1 was used for the Upstream LA**.**

Table 10: MD 8-Digit Upper Pocomoke River Maximum Daily Load of Sediment/TSS (ton/day)

MDL (ton/day)	=	**LA**			+	**WLA**			+	**MOS**
		LA_{DE}[1]	+	**LA_{UP}**		**NPDES Stormwater WLA_{UP}**	+	**Process Water WLA_{UP}**		
7.23	=	0.85	+	6.30	+	0.005	+	0.076	+	Implicit

Upstream Load Allocation[2,3] (0.85); MD 8-digit Upper Pocomoke River Watershed MDL Contribution (6.30 + 0.005 + 0.076)

Notes: [1] LA_{DE} was set equivalent to its baseline load, since it was determined that reductions from upstream Delaware sources were not necessary in to meet Maryland's water quality standards within the MD 8-digit Upper Pocomoke River watershed.
[2] Although for the purposes of this analysis, the upstream load is referred to as an LA, it could include loads from both point and nonpoint sources.
[3] A delivery factor of 1 was used for the Upstream LA**.**

5.0 ASSURANCE OF IMPLEMENTATION

Section 303(d) of the CWA and current EPA regulations require reasonable assurance that the sediment TMDL can and will be implemented (CFR 2012b). This section provides the basis for reasonable assurance that the sediment TMDL in the Upper Pocomoke River watershed will be achieved and maintained.

The MD 8-Digit Upper Pocomoke River Sediment TMDL is expected to be implemented as part of a staged process recently developed by Maryland. This staged process is designed to achieve both the sediment reductions needed within the MD 8-Digit Upper Pocomoke River watershed and to meet sediment target loads consistent with the Chesapeake Bay TMDL, established by EPA in 2010 (US EPA 2010a) and scheduled for full implementation by 2025. The Bay TMDL requires reductions of nitrogen, phosphorus, and sediment loads throughout the Bay watershed to meet water quality standards that protect the designated uses in the Bay and its tidal tributaries. Bay TMDL implementation planning has been primarily focused on nutrient (nitrogen and phosphorus) reductions; however, reductions in sediment loadings and the attainment of the applicable sediment allocations specified within the Bay TMDL are expected to occur as a result of implementation measures to control nutrients. Therefore, even though the Bay TMDL implementation framework has focused on meeting the nutrient allocations, it still ensures the achievement of the required sediment allocations and reductions.

The sediment reductions for the Bay TMDL are independent of those needed to implement any TMDLs developed to address sediment-related impairments in Maryland's non-tidal watersheds, although their reduction goals and strategies do overlap. For example, the implementation planning framework, developed by the Bay watershed jurisdictions in partnership with EPA, provides a staged approach to achieving Bay TMDL sediment reduction goals that is also applicable to the implementation of any sediment TMDLs developed for local non-tidal watersheds. In short, sediment reductions required to meet the Chesapeake Bay TMDL will also support the restoration and protection of local water quality.

Maryland's Phase I Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDL, finalized in December 2010, identifies sediment reduction targets by source sector for the Pocomoke River Tidal Fresh segment-shed, which includes the MD 8-Digit Upper Pocomoke River watershed and a number of other MD 8-Digit watersheds. EPA revised the nutrient and sediment load allocations for the Bay TMDL in August 2011, based on the results of the updated CBP P5.3.2 watershed model. Maryland has been working with key local partners, including county and municipal staff, soil conservation managers, and a variety of stakeholder organizations and business interests, to help them develop local implementation plans at the county scale. These local plans have been incorporated into the basin-scale implementation plans in the Phase II WIP.

Maryland's Phase II WIP and the State's schedule of two-year milestones provide implementation strategies and a time line for achieving sediment reductions across the

State to meet Chesapeake Bay interim target loads by 2017, equivalent to 60% of the final target goals set for 2025 to fully implement the Chesapeake Bay TMDL in Maryland. A Phase III Plan will be developed in 2017 to address the additional reductions needed from 2018 through 2025 to meet the final targets. Prior to Phase III, the TMDL allocations may again be revised to reflect better data, a greater understanding of the natural systems, and to make use of enhanced analytical tools (such as updated watershed and water quality models). This iterative process provides an adaptive approach for achieving the Chesapeake Bay TMDL goals, as well as a framework and time line for the staged implementation of the MD 8-Digit Upper Pocomoke River watershed sediment TMDL.

The proposed approach for achieving the MD 8-Digit Upper Pocomoke River watershed reduction targets will be based on an appropriate selection of the comprehensive implementation strategies described in Maryland's Phase I WIP (MDE 2010b) and Phase II WIP (MDE 2012b), the centerpieces of the State's "reasonable assurance" of implementation for the Bay TMDL. The strategies encompass a host of BMPs, pollution controls and other actions for all source sectors that cumulatively will result in meeting the State's 2017 interim nutrient and sediment reduction targets, as verified by the Chesapeake Bay Water Quality Model.

Accounting, tracking and reporting are an important part of the overall WIP strategy, and progress will be closely monitored for the two-year milestones by tracking both implementation and water quality. The setting of 2017 interim targets and a schedule of two-year milestone commitments will allow for an iterative, adaptive management process with ongoing assessments of implementation progress, as well as periodic reevaluation of sediment impacts on water quality. This staged approach provides further assurance that the implementation of the MD 8-Digit Upper Pocomoke River watershed sediment TMDL will be achieved through increased accountability and verification of water quality improvements over time.

Once the Bay TMDL sediment target loads for the Pocomoke River Tidal Fresh segment-shed have been met, MDE will revisit the status of sediment impacts on aquatic life in the non-tidal waters of the MD 8-Digit Upper Pocomoke River watershed, based on monitoring data that will be collected in the watershed following EPA approval of the TMDL. The primary datatset that will be used to reevaluate the status of sediment impacts on aquatic life will be MBSS biological monitoring data, which is applied within the BSID analysis for the watershed to determine whether or not sediments are impacting aquatic life. The same parameters used to identify sediment related impacts to aquatic life within the BSID will be reassessed. The results of this reassessment will determine whether additional sediment reductions are needed in the watershed, or whether the sediment TMDL goals for the MD 8-Digit Upper Pocomoke River watershed have in fact been met.

Maryland Legislative Actions and Funding Programs to Support TMDL Implementation

In response to the WIP and the increased burden on local governments to achieve nutrient and sediment reduction goals, Maryland has continued to increase funding in the Chesapeake and Atlantic Coastal Bays Trust Fund. For Fiscal Year 2013, in addition to $25 million (pending) for the Trust Fund, $38 million in general obligation bonds were made available to local communities for implementation of stormwater capital improvements. These funds will not only kick start restoration at the local level, but also create and retain green jobs in Maryland's economy. Funding was also increased to support implementation of natural filters on public lands ($9 million), and funding for Soil Conservation Districts from 16 to 39 positions ($2.2 million). In addition, funding for the cover crop program is at $12 million – a record level.

Any new development in the watershed will be subject to Maryland's Stormwater Management Act of 2007 and will be required to use environmental site design (ESD) to the maximum extent practicable.

Additional potential funding sources for implementation include Maryland's Agricultural Cost Share Program (MACS) which provides grants to farmers to help protect natural resources, and the Environmental Quality and Incentives Program, which focuses on implementing conservation practices and BMPs on land involved with livestock and production.

Relative to practices that are expected to reduce sediment loads, for the 2012-2013 milestone period, Maryland is working to require a cover crop following fall applications of organic nutrient sources. For future milestones, best management practices will be required for streams with adjacent livestock (2014).

For more information on Maryland's implementation and funding strategies to achieve nutrient and sediment reductions throughout the State's portion of the Chesapeake Bay watershed, please see Maryland's Phase II Watershed Implementation Plan. Some other examples of programs that can provide funding for local governments and agricultural sources include the Federal Nonpoint Source Management Program (§ 319 of the Clean Water Act), Buffer Incentive Program (BIP), State Water Quality Revolving Loan Fund, Bay Restoration Fund, Chesapeake Bay Trust Fund. Details of these programs and additional funding sources can be found at http://www.dnr.state.md.us/bay/services/summaries.html.

Potential BMPs for reducing sediment loads and resulting impacts can be grouped into two general categories. The first is directed toward agricultural lands, and the second is directed toward urban (developed) lands. In agricultural areas comprehensive soil conservation plans can be developed that meet criteria of the USDA-NRCS Field Office Technical Guide (USDA 1983). Soil conservation plans help control erosion by modifying cultural practices or structural practices. Cultural practices may change from year to year and include changes to crop rotations, tillage practices, or use of cover crops. Structural practices are long-term measures that include, but are not limited to, the installation of grass waterways (in areas with concentrated flow), terraces, diversions, sediment basins, or drop structures. The reduction percentage attributed to cultural practices is determined based on changes in land-use, while structural practices have a reduction percentage of up to 25%. In addition, livestock can be controlled via stream fencing and rotational grazing. Sediment reduction efficiencies of methods applicable to pasture land-use range from 40% to 75% (US EPA 2004). Lastly, riparian buffers can reduce the effect of agricultural sediment sources through trapping and filtering, and reforestation, whether adjacent to part of the watershed stream system or in a watershed's interior, can decrease agricultural sediment sources as well.

Sediment from urban areas can be reduced by stormwater retrofits that address both water quality and flow control. Examples of these retrofits include the modification of existing stormwater structural practices, the construction of new stormwater BMPs in prior development where there is none, a reduction in impervious surfaces, street sweeping, inlet cleaning, increases in the urban tree canopy, stream restoration, and any other management practice that effectively addresses water quality and flow control (i.e., riparian buffers for urban areas and watershed reforestation adjacent to the watershed stream system or within a watershed's interior). Flow controls reduce sheer stress and limit bank erosion to address this portion of the urban sediment load. Impervious surface reduction results in a change in hydrology that could also reduce streambank erosion. In terms of upland urban sediment loads, stormwater retrofit reductions range from as low as 10% for dry detention to approximately 80% for wet ponds, wetlands, infiltration practices, and filtering practices (US EPA 2003).

It has been estimated that the average TSS removal efficiencies for BMPs installed between the years of 1985-2002 and post 2002, which are reflective of the stormwater management regulations in place during these time periods, is 50% and 80%, respectively (Claytor and Schueler 1997; Baldwin et al. 2007; Baish and Caliri 2009). Based on these average TSS reduction efficiencies, BMP specific reduction efficiencies as estimated by CBP, and best professional judgment, MDE estimates that future stormwater retrofits will have approximately a 65% reduction efficiency for TSS. This estimated reduction efficiency is subject to change over time as technology improves and the amount of data gathered from monitoring these retrofits increases.

While a portion of the sediment loads that contribute to the MD 8-Digit Upper Pocomoke River watershed impairment originate in the Delaware portion of the watershed, implementation actions in this area of the watershed are beyond the jurisdictional and regulatory authority of MDE. The Department looks forward to working with Delaware and the EPA to ensure that the Upstream LA presented in this document is achieved to meet Maryland's downstream water quality standards.

In summary, through the use of the aforementioned funding mechanisms and BMPs, there is reasonable assurance that this TMDL can be implemented.

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APPENDIX A – Watershed Characterization Data

Table A-1: Coastal Plain Reference Watersheds

MD 8-Digit Name	MD 8-Digit #	Percent Stream Mile BIBI/FIBI < 3.0 (%)[1,2]	Forest Normalized Sediment Load[3]
Tuckahoe Creek	02130405	19	6.0
Wye River	02130503	15	5.6
Langford Creek	02130506	14	12.2
Corsica River	02130507	8	5.6
Southeast Creek	02130508	0	5.6
Median			**5.6**
75th%			**6.0**

Notes: [1] Based on the percentage of MBSS stations with BIBI and/or FIBI scores significantly lower than 3.0 within the MD 8-digit watershed (MDE 2010a).
[2] The percent stream miles with BIBI and/or FIBI scores significantly lower than 3.0 threshold to determine if an 8-digit watershed is impaired for impacts to biological communities is based on a comparison to reference conditions (MDE 2008).
[3] Forest normalized sediment loads based on Maryland watershed area only (consistent with MBSS random monitoring data).

APPENDIX B – Technical Approach Used to Generate Maximum Daily Loads

Summary

This appendix documents the technical approach used to define MDLs of sediment consistent with the average annual TMDL in the MD 8-Digit Upper Pocomoke River watershed, which is considered the maximum allowable load the watershed can sustain and support aquatic life. The approach builds upon the modeling analysis that was conducted to determine the sediment loadings and can be summarized as follows.

- The approach defines MDLs for each of the source categories.
- The approach builds upon the TMDL modeling analysis that was conducted to ensure that average annual loading targets are at a level that support aquatic life.
- The approach converts daily time-series loadings into TMDL values in a manner that is consistent with available EPA guidance on generating daily loads for TMDLs (US EPA 2007).
- The approach considers a daily load level of a resolution based on the specific data that exists for each source category.

Introduction

This appendix documents the development and application of the approach used to define MDL values. It is divided into sections discussing:

- Basis for approach
- Options considered
- Selected approach
- Results of approach

Basis for approach

The overall approach for the development of daily loads was based upon the following factors:

- **Average Annual TMDL:** The basis of the average annual sediment TMDL is that cumulative high sediment loading rates have negative impacts on the biological community. Thus, the average annual sediment load was calculated so as to ensure the support of aquatic life.
- **CBP P5.3.2 Watershed Model Sediment Loads:** As described in Section 2.2, the nonpoint source sediment loads from the Upper Pocomoke River watershed are based on EOS loads from the CBP P5.3.2 watershed model. The CBP P5.3.2 model river segments were calibrated to daily monitoring information for watersheds with a flow greater that 100 cubic feet per second (cfs), or an approximate area of 100 square miles.

- **Draft EPA guidance document entitled "Developing Daily Loads for Load-based TMDLs":** This guidance document provides options for defining MDLs when using TMDL approaches that generate daily output (US EPA 2007).

The rationale for developing TMDLs expressed as *daily* loads was to accept the existing average annual TMDL, but then develop a method for converting this number to a MDL – in a manner consistent with EPA guidance and available information.

Options considered

The draft EPA guidance document for developing daily loads does not specify a single approach that must be adhered to, but rather it contains a range of acceptable options (US EPA 2007). The selection of a specific method for translating a time-series of allowable loads into the expression of a TMDL requires decisions regarding both the level of resolution (e.g., single daily load for all conditions vs. loads that vary with environmental conditions) and level of probability associated with the TMDL.

This section describes the range of options that were considered when developing methods to calculate MD 8-Digit Upper Pocomoke River Watershed MDLs.

<u>Level of Resolution</u>

The level of resolution pertains to the amount of detail used in specifying the MDL. The draft EPA guidance document on daily loads provides three categories of options for level of resolution, all of which are potentially applicable for the MD 8-Digit Upper Pocomoke River watershed:

1. **Representative daily load:** In this option, a single daily load (or multiple representative daily loads) is specified that covers all time periods and environmental conditions.
2. **Flow-variable daily load:** This option allows the MDL to vary based upon the observed flow condition.
3. **Temporally-variable daily load:** This option allows the MDL to vary based upon seasons or times of varying source or water body behavior (US EPA 2007).

<u>Probability Level</u>

All TMDLs have some probability of being exceeded, with the specific probability being either explicitly specified or implicitly assumed. This level of probability directly or indirectly reflects two separate phenomena:

1. Water quality criteria consist of components describing acceptable magnitude, duration, and frequency. The frequency component addresses how often conditions can allowably surpass the combined magnitude and duration components.
2. Pollutant loads, especially from wet weather sources, typically exhibit a large degree of variability over time. It is rarely practical to specify a "never to be

exceeded value" for a daily load, as essentially any loading value has some finite probability of being exceeded.

The draft daily load guidance document states that the probability component of the MDL should be "based on a representative statistical measure" that is dependent upon the specific TMDL and the best professional judgment of the developers (US EPA 2007). This statistical measure represents how often the MDL is expected/allowed to be exceeded. The primary options for selecting this level of protection would be:

1. **The maximum daily load reflects some central tendency:** In this option, the MDL is based upon the mean or median value of the range of loads expected to occur. The variability in the actual loads is not addressed.
2. **The maximum daily load reflects a level of protection implicitly provided by the selection of some "critical" period**: In this option, the MDL is based upon the allowable load that is predicted to occur during some critical period examined during the analysis. The developer does not explicitly specify the probability of occurrence.
3. **The maximum daily load is a value that will be exceeded with a pre-defined probability:** In this option, a "reasonable" upper bound percentile is selected for the MDL based upon a characterization of the variability of daily loads. For example, selection of the 95^{th} percentile value would result in a MDL that would be exceeded 5% of the time.

Selected Approach

The approach selected for defining a MD 8-Digit Upper Pocomoke River MDL was based upon the specific data that exists for each source category. The approach consists of unique methods for each of the following categories of sources:

- Approach for Nonpoint Sources and Stormwater Point Sources within the MD 8-Digit Upper Pocomoke River watershed
- Approach for Process Water Point Sources within the MD 8-Digit Upper Pocomoke River watershed
- Approach for upstream sources

Approach for Nonpoint Sources and Stormwater Point Sources within the MD 8-Digit Upper Pocomoke River Watershed

The level of resolution selected for the MD 8-Digit Upper Pocomoke River MDL was a representative daily load, expressed as a single daily load for each loading source. This approach was chosen based upon the specific data that exists for nonpoint sources and stormwater point sources within the MD 8-Digit Upper Pocomoke River watershed. Currently, the best available data is the CBP P5.3.2 model daily time series calibrated to long-term average annual loads (per land-use). The CBP reach simulation results are calibrated to daily monitoring information for watershed segments with a flow typically greater that 100 cfs. To be consistent with the average annual TMDL, however, it was concluded that it would not be appropriate to apply the absolute values of the reach simulation model, daily time series results to calculate the MDL. Thus, the annual loads were used instead, and it was assumed that the distribution of the daily values was correct, in order to calculate a normalized statistical parameter to estimate the MDLs.

The MDL was estimated based on three factors: a specified probability level, the average annual sediment TMDL, and the coefficient of variation (CV) of the CBP P5.3.2 MD 8-Digit Upper Pocomoke River reach simulation of daily loads. The probability level (or exceedance frequency) is based upon guidance from EPA (US EPA 1991) where examples suggest that when converting from a long-term average to a daily value, the z-score corresponding to the 99th percentile of the log-normal probability distribution should be used. The average annual sediment TMDL is estimated from the CBP P5.3.2 EOS target loads. The calculation of the CV is described below.

The CBP P5.3.2 MD 8-Digit Upper Pocomoke River reach simulation consisted of a daily time series beginning in 1985 and extending to the year 2005. The CV was estimated by first converting the daily sediment load values to a log distribution and then verifying that the results approximated the normal distribution (see Figure B-1). Next, the CV was calculated using the arithmetic mean and standard deviation results from the log transformation. The log-transformed values were used to reduce the possible influence of outliers. The resulting CV of 0.0003 was calculated using the following equation:

$$CV = \frac{\beta}{\alpha} \qquad \text{(Equation B.1)}$$

Where:

CV = coefficient of variation

$\beta = \alpha\sqrt{e^{\sigma^2} - 1}$

$\alpha = e^{(\mu + 0.5*\sigma^2)}$

α = mean (arithmetic)

β = standard deviation (arithmetic)

μ = mean of logarithms

σ =standard deviation of logarithms

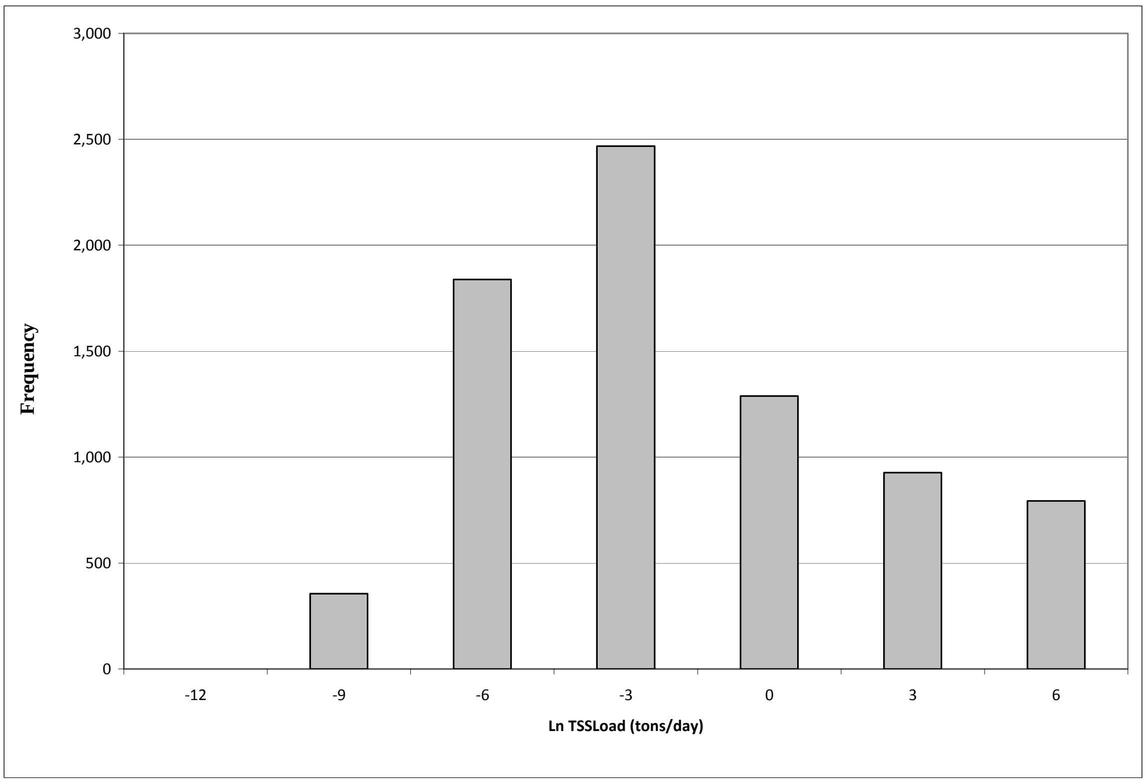

Figure B-1: Histogram of CBP River Segment Daily Simulation Results for the MD 8-Digit Upper Pocomoke River Watershed

The MDL for each contributing source is estimated as the long-term average annual load multiplied by a factor that accounts for expected variability of daily loading values. The equation is as follows:

$$MDL = LTA * e^{(z\sigma - 0.5\sigma^2)} \qquad \text{(Equation B.2)}$$

Where:
MDL = Maximum Daily Load
LTA = Long term average (average annual load)
Z = z-score associated with target probability level
$\sigma^2 = \ln(CV^2+1)$
CV = Coefficient of variation based on arithmetic mean and standard deviation

Using a z-score associated with the 99th percent probability, a CV of 0.0003, and consistent units, the resulting dimensionless conversion factor from long term average annual loads to a MDL is 1.001. The average annual MD 8-Digit Upper Pocomoke River TMDL of sediment/TSS is reported in ton/yr, and the conversion from ton/yr to a MDL in ton/day is 0.0027 (e.g. 1.001/365).

Approach for Process Water Point Sources within the MD 8-Digit Upper Pocomoke River Watershed

The TMDL also considers contributions from other point sources (i.e., sources other than stormwater point sources) in the watershed that have NPDES permits with sediment limits. As these sources are generally minor contributors to the overall sediment load, the TMDL analysis that defined the average annual TMDL did not propose any reductions for these sources and held each of them constant at their existing technology-based NPDES permit monthly (or daily if monthly was not specified) limit for the entire year.

The approach used to determine MDLs for these sources was dependent upon whether a maximum daily limit was specified within the permit. If a maximum daily limit was specified, then the reported average flow was multiplied by the daily maximum limit and a conversion factor of 0.0042 to obtain a MDL in ton/day. If a maximum daily limit was not specified, the MDLs were calculated based on the guidance provided in the Technical Support Document (TSD) for Water Quality-based Toxics Control (US EPA 1991). The long-term average annual TMDL was converted to maximum daily limits using Table 5-2 of the TSD assuming a coefficient of variation of 0.6 and a 99th percentile probability. This results in a dimensionless multiplication factor of 3.11. The average annual MD 8-Digit Upper Pocomoke River TMDL of sediment/TSS is reported in ton/yr, and the conversion from ton/yr to a MDL in ton/day is 0.0085 (e.g. 3.11/365).

Approach for Upstream Source

For the purpose of this analysis, only one upstream watershed has been identified: the Delaware portion of the Upper Pocomoke River watershed. The Delaware MDL was calculated based on the same approach used for nonpoint sources and stormwater point sources within the MD 8-digit Upper Pocomoke River watershed.

Results of approach

This section lists the results of the selected approach to define the MD 8-Digit Upper Pocomoke River MDLs.

- Calculation Approach for Nonpoint Sources and Stormwater Point Sources within the MD 8-Digit Upper Pocomoke River Watershed

LA_{UP} (ton/day) = Average Annual TMDL LA_{UP} (ton/yr) * 0.0027

NPDES Stormwater WLA_{UP} (ton/day) = Average Annual TMDL NPDES Stormwater WLA_{UP} (ton/yr) * 0.0027

- Calculation Approach for Process Water Point Sources within the MD 8-digit Upper Pocomoke River Watershed
    - For permits with a daily maximum limit:

Process Water WLA_{UP} (ton/day) = Permit flow (millions of gallons per day (MGD)) * Daily maximum permit limit (milligrams per liter (mg/l)) * 0.0042, where 0.0042 is a combined factor required to convert units to ton/day

-
    - For permits without a daily maximum limit:

Process Water WLA_{UP} (ton/day) = Average Annual TMDL Process Water WLA_{UP} Other (ton/yr)* 0.0085, where 0.0085 is the factor required to convert units to ton/day

Table B-1: MD 8-Digit Upper Pocomoke River Maximum Daily Loads of Sediment/TSS (ton/day)

MDL (ton/day)	=	**LA**			+	**WLA**			+	**MOS**
		LA_{DE}[1]	+	**LA_{UP}**		**NPDES Stormwater WLA_{UP}**	+	**Process Water WLA_{UP}**		
7.23	=	0.85	+	6.30	+	0.005	+	0.076	+	Implicit

Upstream Load Allocation[2,3]

MD 8-digit Upper Pocomoke River Watershed MDL Contribution

Notes: [1] LA_{DE} was set equivalent to its baseline load, since it was determined that reductions from upstream Delaware sources were not necessary in to meet Maryland's water quality standards within the MD 8-digit Upper Pocomoke River watershed.

[2] Although for the purposes of this analysis, the upstream load is referred to as an LA, it could include loads from both point and nonpoint sources.

[3] A delivery factor of 1 was used for the Upstream LA.