Non-tidal South River Watershed

2020 Sediment TMDL Annual Assessment Report

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Prepared For

Anne Arundel County
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List of Acronyms

BayFAST	Chesapeake Bay Facility Assessment Scenario Tool
BIBI	Benthic Index of Biotic Integrity
BMP	Best Management Practices
BSID	Biological Stressor Identification
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
COMAR	Code of Maryland Regulations
DPW	Department of Public Works
EOS	Edge of Stream
EOT	Edge of Tide
EPA	United States Environmental Protection Agency
FIBI	Fish Indices of Biotic Integrity
FY	Fiscal Year
IWPP	Integrated Water Planning Program
LA	Load Allocation
MAST	Maryland Assessment Scenario Tool
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MPHI	Maryland Physical Habitat Index
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometer Turbidity Units
PCB	Polychlorinated Biphenyls
PSU	Primary Sampling Unit
RBP	Rapid Bioassessment Protocol
SPSC	Step Pool Storm Conveyance
STB	Stream Bed and Bank
SW-WLA	Stormwater Wasteload Allocation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WLA	Wasteload Allocation
WM	Watershed Model
BWPR	Bureau of Watershed Protection and Restoration
WQIP	Water Quality Improvement Projects

1 Introduction

1.1 Background

The Anne Arundel County Department of Public Works (DPW) Bureau of Watershed Protection and Restoration (BWPR) is developing and is currently implementing restoration plans to address local water quality impairments for which a Total Maximum Daily Load (TMDL) has been established by the Maryland Department of the Environment (MDE) and approved by the U.S. Environmental Protection Agency (EPA). A TMDL establishes a maximum load of a specific single pollutant or stressor that a waterbody can assimilate and still meet water quality standards for its designated use class.

There are currently three final approved TMDLs within the South River; a total suspended solids (TSS; sediment) TMDL from urban stormwater sources approved in 2017; a TMDL for bacteria for the restricted shellfish harvesting areas in the South River, which includes Duvall Creek, Selby Bay, and Ramsey Lake, approved in 2005; and a PCB TMDL approved in 2016.

The South River watershed lies entirely within Anne Arundel County, therefore the TMDL Stormwater WLA is allocated to Anne Arundel County and the Maryland Department of Transportation State Highway Administration. Anne Arundel County BWPR submitted a TMDL Document of Attainment for the 2017 sediment TMDL to MDE in September 2018 (Anne Arundel County, 2018). Following review and comment from MDE and further modeling analysis, it was found that the South River TMDL has not yet been attained. Development of a South River restoration plan is on hold in anticipation of the release of a tool, under development by MDE, for modeling local TMDL nutrient and sediment loads and reductions. Changes are anticipated to the baseline, permit, and progress loads and load reductions with the new modeling system. The plan, if needed, will specifically address Anne Arundel County's TMDL SW-WLA.

The TMDL loading targets, or allocations, are divided among the pollution source categories, which in this case includes non-point sources (termed load allocation or LA) and point sources (termed waste load allocation or WLA). The WLA consists of loads attributable to regulated process water or wastewater treatment, and regulated stormwater, which is the stormwater wasteload allocation (SW-WLA). For the purposes of the TMDL and consistent with implementation of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit (MS4), stormwater runoff from MS4 areas is considered a point source contribution.

Anne Arundel County's current MS4 permit (11-DP-3316, MD0068306) issued by MDE in February of 2014 requires the development of restoration plans for each SW-WLA approved by EPA prior to the effective date of the permit (permit section IV.E.2.b), and requires an annual TMDL assessment report to document implementation progress, pollutant load reductions, and program costs (permit section IV.E.4). While the restoration plan is on hold until the new MDE modeling tool is complete, this *2020 South River Sediment TMDL Annual Assessment Report* satisfies the progress documentation requirement for fiscal year (FY) 2020.

1.2 Watershed Description

The South River is one of 12 major watersheds in Anne Arundel County, Maryland, and is situated in the central portion of the County (Figure 1). The Severn River watershed is located to the north, the Patuxent River watershed is located to the west, and the Rhode River watershed is located to the south. The South River drains directly to the Chesapeake Bay.

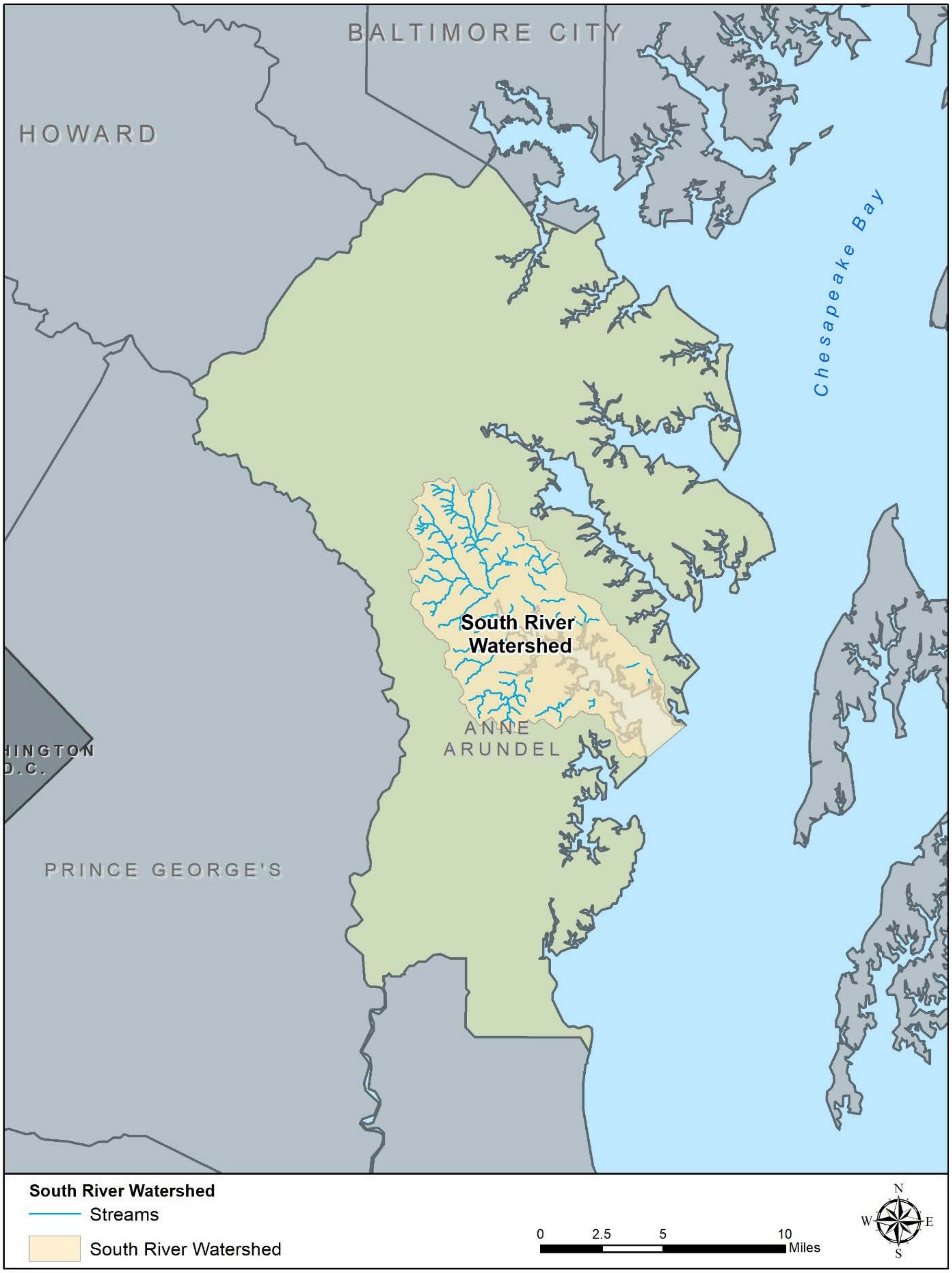

Figure 1: Watershed Location Map

The watershed comprises approximately 36,514 acres and lies entirely within the County. The watershed includes several named streams including Bacon Ridge Branch, Bell Branch, Broad Creek, Church Creek, Duvall Creek, Marriots Branch, North River, and the mainstem of the South River. Communities within the South River watershed include Riva, Edgewater, Selby-on-the-Bay, and Hillsmere Shores.

1.3 TMDL Allocation and Planned Loads Summary

This section describes the derivation of the TMDL reduction targets. The SW-WLA in the sediment TMDL was developed by MDE using the Chesapeake Bay Program Watershed Model Phase 5 (CBP WM P5). Availability of MAST (Maryland Assessment Scenario Tool), which was compatible with BayFAST (Chesapeake Bay Facility Assessment Scenario Tool) and built on Bay Model version P5.3.2, ended in early 2019.

MDE is currently working on a new local TMDL modeling tool that will be available in the future to report progress toward nutrient and sediment load reductions. If completed and available, this new spreadsheet model will be used for FY21 modeling, likely resulting in changes to the baseline, permit, and progress loads and load reductions in this report.

Phase 6 of the Bay Model has been developed and is currently being deployed in the Chesapeake Assessment Scenario Tool (CAST). CAST, created by the Chesapeake Bay Program, is a web-based pollutant load estimation tool that calculates pollutant loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model Phase 6 (CBP WM P6). Section 1.5 contains details on the modeling specifics. Because the TMDL was developed under an older version of the model, the SW-WLA needed to be translated into a CAST-compatible target load. In order to do this, the 2009 baseline sediment load was re-calculated in CAST by modeling baseline BMPs in South River on top of baseline impervious and pervious Anne Arundel County Phase I MS4 acres.

The required percent reduction assigned to the Anne Arundel County Phase I MS4 source (28.0%) in the local TMDL was then applied to the new baseline load to calculate required sediment reduction. The required sediment reduction was then subtracted from the new baseline load to calculate the CAST-compatible target SW-WLA. Sediment loads required for the South River Anne Arundel County Phase I MS4 source are shown in Table 1. The loads modeled using Anne Arundel County's spreadsheet method, which was compatible with Bay Model P5.3.2, were reported in the Document of Attainment (Anne Arundel County, 2018) and are also included in Table 1 for reference. The loads modeled under P6 are used in this year's annual assessment.

Table 1: Sediment Loads Required for the South River Local TMDL

Model	2009 Baseline Load (lbs/yr)	Required Reduction %	Required Reduction (lbs/yr)	TMDL Load Allocation (SW-WLA) (lbs/yr)
County Spreadsheet	3,964,651	28.0%	1,110,102	2,854,549
P6	18,280,219	28.0%	5,118,461	13,161,758

1.4 Planned Reductions

Table 2 provides a concise summary of the loads and reductions at important timeline intervals including the 2009 baseline, 2020 progress, and 2025 final planning intervals. These terms and dates are used throughout the plan and explained in more detail in the following sections. They are presented here to assist the reader in understanding the definition of each, how they were derived, and to provide an overall summary demonstrating the percent reduction required and percent reduction achieved through full implementation of this plan. Sediment loads and wasteload allocations are presented as tons/year in the *Total Maximum Daily Load of Sediment in the Non-Tidal South River Watershed, Anne Arundel County, Maryland,* but will be discussed as lbs/year in this report.

- **2009 Baseline Load**: Baseline level (i.e., land use load with baseline best management practices [BMPs]) from 2009 conditions in the South River watershed. Baseline load was used to calculate the stormwater allocated sediment load, or SW-WLA.
- **2020 Progress Load and Reduction**: Progress load and load reduction achieved from stormwater BMP implementation through 2020.
- **2025 Allocated Load**: Allocated load is calculated from the 2009 baseline level, calibrated to CBP P6 as noted above, using the following calculation: 2025 Allocated Load = 2009 Baseline Load – (2009 Baseline Load x 0.28).
- **2025 Planned Load and Planned Reduction**: Load and reduction that will result from implementation of planned BMPs.

Table 2: South River Local TMDL Allocated and Planned Load

	Sediment (tons/year)	Sediment (lbs/year)
2009 Baseline Load	9,140	18,280,219
2020 Progress Load	7,614	15,228,323
2020 Progress Reduction	1,526	3,051,896
TMDL Allocated Load	6,581	13,161,758
2025 Planned Load*	6,698	13,395,589
2025 Planned Reduction	2,442	4,884,630
Required Percent Reduction	28.0%	28.0%
Planned Percent Reduction	26.7%	26.7%

*It is assumed that stormwater runoff from new development will be treated to the maximum extent practicable to achieve 90% sediment removal and Accounting for Growth policies will address the remaining 10%.

1.5 Modeling Methods

1.5.1 Overview

The baseline, progress, and planned pollutant loads for the South River watershed were determined using CAST, which is a web-based pollutant load estimation tool that calculates nitrogen, phosphorus, and sediment loads and reductions calibrated to the Chesapeake Bay Program Partnership Watershed Model Phase 6 (CBP WM P6). Local TMDL baseline loads were calibrated in CAST by modeling BMPs installed prior to the TMDL baseline year using a 2009 CAST Progress Scenario on top of baseline land use background loads. This ensures that the same set of baseline BMPs are used throughout future progress and planned scenarios. The required sediment load reduction was calculated by multiplying the local

TMDL target reduction percent with the CAST baseline load. This reduction target was then subtracted from the baseline load modeled in CAST to determine the target sediment load (i.e., local SW-WLA).

CAST estimates load reductions for point and nonpoint sources including agriculture, urban, forest, and septic loading. Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. The Chesapeake Bay Program Partnership Watershed Model calculates reductions from all BMPs as a group, much like a treatment train. Reductions are processed in order, with land use change BMPs first, load reduction BMPs next, and BMPs with individual effectiveness values last. The overall the load reduction can vary depending on which BMPs are implemented.

Stormwater retrofits were modeled in CAST by calculating the net treatment (retrofit BMP vs. original BMP) for retrofit BMPs of the same BMP type category (e.g., wet pond) within the same land river segment. The original BMP treatment was removed from the baseline BMPs carried over into progress and planned scenarios and replaced with treatment from the more effective retrofit BMP. This procedure prevents over counting stormwater BMP treatment.

CAST provides analysis and load output at two different scales: Edge-of-Stream (EOS) and Edge-of-Tide (EOT). Edge-of-tide loads incorporate in-stream processes, such as nutrient uptake by algae or other aquatic life and generally result in lower delivered loads from the upstream source to the receiving water body, which in this case is the Chesapeake Bay. The EOT scale is used in Bay TMDL modeling. This TMDL is for impairments in the freshwater tributary streams; therefore, the County's plan focuses on reducing loads delivered from upland and instream tributary sources. As a result, EOS estimates are more appropriate and are used for the modeling analysis.

Pollutant load reductions achieved by stream restoration and annual practices (e.g., street sweeping and inlet cleaning) were calculated outside of CAST following MDE's 2020 accounting guidance (MDE, 2020) and Bay Program methods. Stream restoration projects were credited using project specific load reductions calculated using the Bay Program's Protocol method, when available. Planned stream restoration load reductions were modeled using 248 lbs TSS per linear foot. Sediment reduction credit for vacuum-assisted street sweeping were calculated based on a sweeping frequency of 1 pass every two weeks and the annual number of miles swept averaged over the span of the 5-year permit term. Sediment reductions for inlet cleaning were calculated based on the annual aggregate load collected (assumed sediment was 40% organic and 60% inorganic material) and averaged over the span of the 5-year permit term.

1.5.2 Stream Bed and Bank Disaggregation

The Phase 6 Chesapeake Bay Program Model provides a separate load source for stream bed and bank loads, while the P5.3.2 model included these stream loads implicitly in the upland load sources. The stream bed and bank load includes stream loads from streams located in agriculture, natural, MS4, and non-regulated developed land areas, and therefore was disaggregated for a single source sector to determine the stream load attributed to the County's stormwater sector that should be included under the SW-WLA for this TMDL.

The stream bed and bank load was disaggregated using calculations provided by the Chesapeake Bay Program using the same principals used by CAST to calculate the total stream bed and bank load. The calculation for TSS disaggregation is as follows:

TSS STB load = ((Scenario EOS without STB TSS / CAL EOS without STB TSS) * STB base TSS) + (4/3 * Scenario Impervious TSS)

Where:
EOS = edge-of-stream
STB = stream bed and bank load source
TSS = total sediment
CAL = calibration average

This equation is used to calculate the stream bed and bank load for a given scenario outside of CAST. Load reductions associated with stream restoration practices are applied directly to the stream bed and bank loads in CAST. As a result, stream restoration practices are modeled in a spreadsheet outside of CAST and the calculated load reductions are subtracted from the disaggregated stream bed and bank load to determine the total disaggregated stream bed and bank load for a given scenario (i.e. baseline, progress, planned).

1.5.3 Practice Level

This section briefly describes each practice and includes a summary of the typical sediment reductions achieved with each type.

1.5.3.1 Modeled in CAST

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. Rain gardens may be engineered to perform as a bioretention.
- **Bioswales** —An open channel conveyance that functions similarly to bioretention. Unlike other open channel designs, there is additional treatment through filter media and infiltration into the soil.
- **Dry Detention Ponds** – Depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow. CAST modeling includes hydrodynamic structures in this category. These devices are designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.
- **Dry Extended Detention Ponds** - Depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. They are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, allowing additional wet sedimentation to improve treatment effectiveness.
- **Impervious Surface Reduction** - Reducing impervious surfaces to promote infiltration and percolation of runoff storm water. Disconnection of rooftop and non-rooftop runoff, rainwater harvesting (e.g., rain barrels), and sheetflow to conservation areas are examples of impervious surface reduction.
- **Infiltration** — A depression or trench to form a shallow basin where sediment is trapped and stormwater infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil; they are not constructed on poor

soils, such as C and D soil types. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned. Dry wells, infiltration basins, infiltration trenches, and landscaped infiltration are all examples of this practice type.

- **Outfall Enhancement with Step Pool Storm Conveyance (SPSC)** – The SPSC is designed to stabilize outfalls and provide water quality treatment through pool, subsurface flow, and vegetative uptake. All County SPSCs are completed at the end of outfalls, prior to discharging to a perennial stream. The retrofits promote infiltration and reduce stormwater velocities. This strategy is modeled in CAST as filtering practices. Some SPSC sites qualified for Protocol 5 load reductions. Protocol 5 load reductions were added to modeling results outside of CAST when applicable.
- **Stormwater Retrofits –**Stormwater retrofits may include converting dry ponds, dry extended detention ponds, or wet extended detention ponds into wet pond structures, wetlands, infiltration basins, or decommissioning the pond entirely to install SPSC (step pool storm conveyance). Stormwater retrofits were modeled in CAST by calculating the net treatment (retrofit BMP vs. original BMP) for retrofit BMPs of the same CAST BMP type category (e.g., wet pond) within the same land river segment. If a net calculation was not required (i.e., original CAST BMP type category was different than the retrofit CAST BMP type category), the original BMP treatment was removed from the baseline BMPs carried over into progress and planned scenarios and replaced with treatment from the more effective retrofit BMP. This procedure prevents over counting stormwater BMP treatment.
- **Urban Filtering** - Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.
- **Urban Tree Plantings** - Urban tree planting is planting trees on urban pervious areas at a density that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting
- **Vegetated Open Channels** - Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached pollutants. Until 2002 in Maryland, these practices were generally designed to meet water quantity, not water quality objectives. There is little or no vegetation within the pooled area, nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

The effectiveness for each of these practices are found in Table 3.

Table 3: Typical Sediment Reduction from Stormwater BMPs and Restoration Practices

BMP	Sediment Reduction
Bioretention A/B soils	80%
Bioretention C/D soils	55%

BMP	Sediment Reduction
Bioswales	80%
Dry Detention Ponds	10%
Dry Extended Detention Ponds	60%
Impervious Surface Reduction[1]	-
Infiltration	95%
Outfall Enhancement with SPSC[2]	80%
Stream Restoration[3]	248 lbs/linear ft
Urban Filtering	80%
Urban Tree Plantings[1]	-
Vegetated Open Channels	70%
Wet Ponds or Wetlands	60%
Inlet Cleaning – Organic	400 lbs/ton removed
Inlet Cleaning – Inorganic	1,400 lbs/ton removed
Street Sweeping – 1 pass/2 weeks	11%

Sources: MDE, 2020 and CAST documentation

[1] Calculated as a land use change to a lower loading land use

[2] Outfall enhancement with SPSC modeled as filtering practices in CAST

[3] Stream restoration listed with revised interim rate, now termed the 'planning rate'; some stream restoration projects used Bay Program Protocols to calculate load reductions.

1.5.3.2 Modeled using MDE Guidance

Inlet cleaning, street sweeping, and urban stream restoration load reductions are modeled outside of CAST using MDE's 2020 accounting guidance and Bay Program methods. The methods are compatible with Phase 6 of the Bay Model.

- **Inlet Cleaning -** Storm drain cleanout practice ranks among the oldest practices used by communities for a variety of purposes to provide a clean and healthy environment, and more recently to comply with NPDES stormwater permits. Reduction credit is based on the mass of material collected, at the rate of 400 lbs TSS per ton of organic material and 1,400 lbs TSS per ton of inorganic material (MDE, 2020). Data for the mass removed was reported by the County's Bureau of Highways. The total mass of material collected by the inlet cleaning program each year is distributed proportionately across all of the inlets cleaned and then summed at the watershed scale. The County's inlet cleaning program is now at maturity and while amounts of material collected each year may vary, the current level of effort will be maintained in the foreseeable future.
- **Street sweeping** — Starting Fiscal Year 2015, Anne Arundel County enhanced their street sweeping program (Anne Arundel County DPW, 2015; Figure 2). This enhanced program targets impaired watersheds and curbed streets that contribute trash/litter, sediment, nutrients, and other pollutants. Load reductions for this assessment are calculated using the length/area of street swept and 11% reduction efficiency for TSS for street swept every two weeks using vacuum sweepers (MDE, 2020). Data for the curb miles swept and frequency (1 pass/2 weeks) was reported by the County's Bureau of Highways. The County's street sweeping program is now at maturity and while amounts of material collected each year may vary, the current level of effort will be maintained in the foreseeable future.
- **Urban Stream Restoration** – Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, helping to improve

habitat and water quality conditions in degraded streams. These projects were modeled outside of CAST using load reductions at the rate of 248 lbs TSS per linear foot (MDE, 2020) for older projects that pre-dated full adoption of the Bay Program's protocol methods, and for future projects where a planning rate is appropriate for use before the full design is complete and protocol calculations are developed. Project specific load reductions calculated using the Bay Program's Protocol method were used when available.

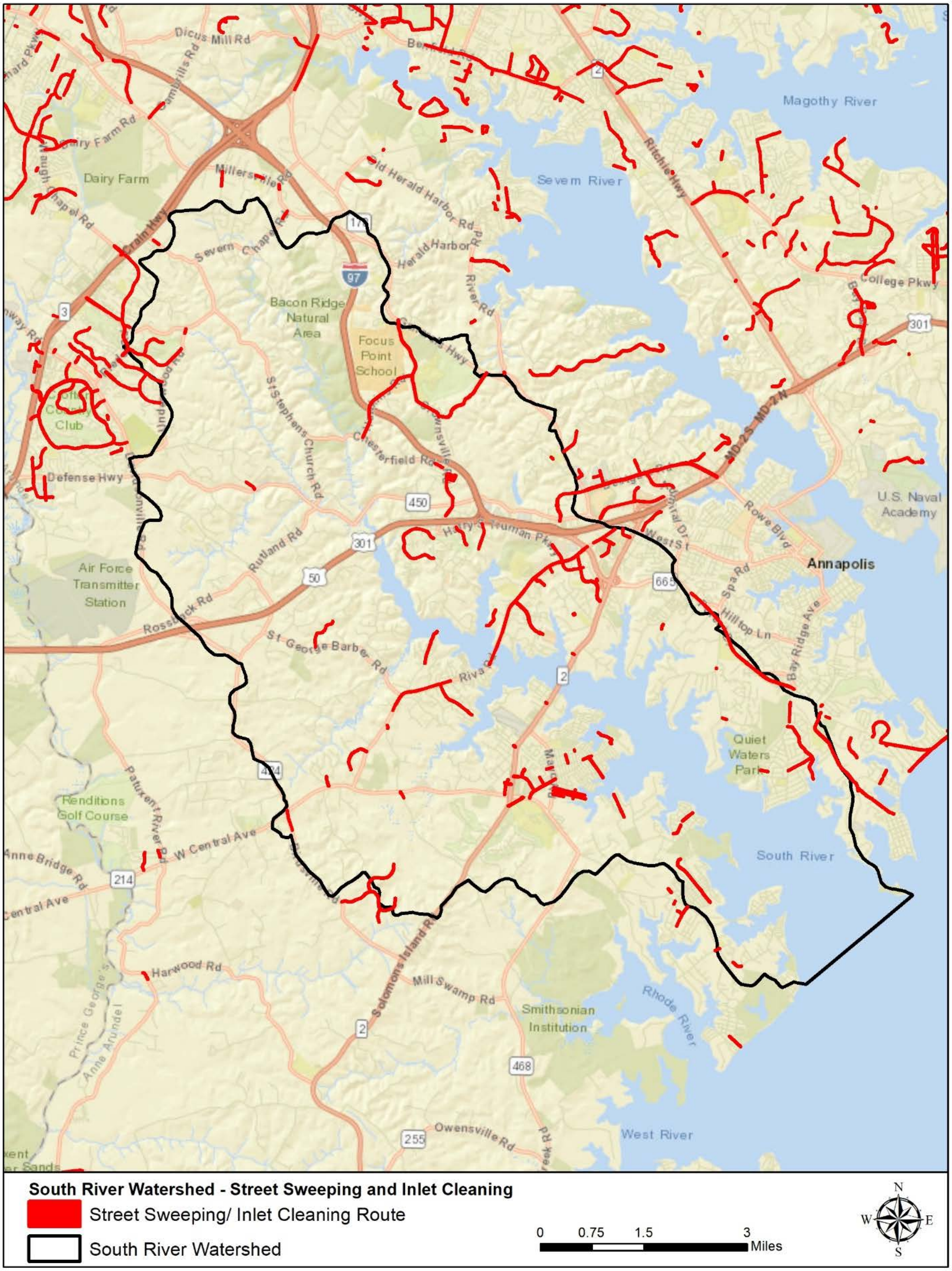

Figure 2: Street Sweeping/ Inlet Cleaning Routes in the South River Watershed, Anne Arundel County, Maryland

2 2020 Progress Summary

The following section summarizes the County's implementation efforts, the resulting load reductions achieved, and the costs of program implementation.

2.1 Implementation Results

Project implementation information extracted from CAST for the 2009 Progress Scenario used to develop Baseline loads is presented in Table 4. Implementation up through the end of FY2020 is detailed in Table 5. Information on completed projects and programs is gleaned primarily from the County's MS4 geodatabase. All 2020 implementation is included in the database. In 2018 the County completed a comprehensive record review of stormwater BMPs. The County's MS4 Geodatabase has been updated to incorporate the results of the review.

Stream Restoration
One stream restoration project was completed in FY2020 (Gravely Community Stream Restoration). This project restored 3,590 linear feet of stream.

Wet Ponds
Two wet pond projects were completed in the watershed in FY2020 (Central Services Garage Pond 4098 Opti Upgrade and South River Colony Pond 4063 Opti Upgrade).

Bioretention
One bioretention facility was completed in FY2020 (Beechnut Kennels). A total of 2.6 acres is treated by this bioretention facility.

Infiltration Trench
One infiltration trench was built in FY2020 (Broad Creek Headwaters Phase II Department of Health Infiltration Trench). A total of 0.8 areas is treated by this infiltration trench.

Shoreline Restoration
One shoreline restoration project was completed in FY2020 (Turnbull Estates Living Shoreline 2). This project stabilized 740 linear feet of shoreline. Shoreline restoration, however, does not receive load reduction credit towards a TMDL at the edge-of-stream (EOS) scale, since these TMDLs are written to address the watershed's tributary streams, rather than the main water body on which the shoreline restoration would occur.

Outfall Stabilization with SPSC
One SPSC project was completed in FY2020 (Broad Creek Headwaters Phase II Department of Health SPSC), treating a drainage area of 6.1 acres.

Inlet Cleaning
A total of 24 inlet cleaning records using storm drain vacuuming were recorded in FY2020. A total of 29.0 tons of material was collected during that period.

Street Sweeping
Building upon on the County's enhanced street sweeping program, 16.4 curb miles were swept in the watershed during FY2020. The average mass of material collected by the street sweeping program was 58.0 tons. Total mass reported for FY2020 is the average of annual mass removed for FY2016 through

FY2020. It is noted that while average mass of material collected is presented here and in the following tables, load reduction calculations were based on curb miles swept and frequency.

The total cost of the practices and programs implemented in FY2020 is $1,423,272.

Table 4: Baseline BMP Implementation

BMP	Unit	2009 Baseline
Structural Permanent Practices		
Runoff Reduction Performance Standard	acre	82.5
Stormwater Treatment Performance Standard	acre	835.1
Bioretention	acre	40.0
Bioswale	acre	12.3
Dry Ponds	acre	840.2
Extended Detention Dry Ponds	acre	662.3
Infiltration	acre	817.7
Filtering Practices	acre	58.4
Permeable Pavement	acre	0.0
Urban Tree Planting	acre	11.7
Wet Ponds or Wetlands	acre	1,251.5
Annual Practices		
Inlet Cleaning	inlets/yr	0.0
Street Sweeping	lbs /yr	0.0

Table 5: Current BMP Implementation through FY2020 for the South River

BMP	Unit	CY2010 – FY2019 Restoration[1]	FY2020 Restoration[1]	FY2020 Progress[2]	FY2020 Restoration Cost[3]
Structural Permanent Practices					
Bioretention	acre	43.3	2.6	45.9	$47,331
Bioswale	acre	0.9	0	0.9	
Dry Ponds	acre	0	0	0	
Extended Detention Dry Ponds	acre	0	0	0	
Filtering Practices	acre	5.7	0	5.7	
Grass Swale	are	0.9	0	0.9	
Impervious Surface Reduction	acre	0.3	0	0.3	
Infiltration	acre	30.1	0.8	30.9	$1,468
Permeable Pavement	acre	0.3	0	0.3	
Shoreline Stabilization[4]	linear ft	4,282	740	5,022	$247,928
Vegetated Open Channels	acre	0	0	0	
Wet Ponds or Wetlands	acre	176.0	171.1	347.1	$279,231
Urban Stream Restoration	linear ft	12,715	3,590	16,305	$378,487
Outfall Enhancement with SPSC	acre	161.2	6.1	167.3	$369,278
Annual Practices					
Inlet Cleaning[5]	inlets/yr	NA	24	24	$67,846
Street Sweeping[6]	lbs /yr	NA	11,593	11,593	$31,703
				Total FY2020 Cost	$1,423,272

Source: BWPR urban BMP, WQIP and MDE MS4 FY20 geodatabase

[1] Restoration completed in each specific period, i.e. CY2010-FY2019, and FY2020.

[2] Total cumulative restoration accounting for the full CY2010-FY2020 period.

[3] Cost of projects and programs for the FY2020 period only. Only costs using County funds are included.

[4] Shoreline restoration projects do not receive load reduction credit towards EOS TMDLs.

[5] Number of inlets refers to the number of inlet cleaning records from the County's MS4 geodatabase.

[6] Value listed here is the lbs of material removed, not specifically the fine TSS sediment; FY2020 is the average of annual reported values for FY2016 through FY2020.

2.2 Load Reduction Results

The implementation summarized in Table 5 above resulted in the load reductions presented here in Table 6.

Table 6: FY2020 Progress Reductions Achieved

Baseline Load and TMDL SW-WLA	TSS-EOS lbs/yr
2009 Baseline Scenario Load	18,280,219
Required Percent Reduction	28.0%
Required Reduction	5,118,461
Local TMDL SW-WLA	13,161,758
2020 Results	**TSS-EOS lbs/yr**
Progress Scenario Load	15,228,323
Progress Reduction Achieved	3,051,896
Percent Reduction Achieved	16.7%

3 Comparison of 2020 Progress and Planned Implementation

This section describes the current progress of both implementation and load reductions in comparison to the planned totals and anticipated progress.

3.1 Implementation

Table 7 compares implementation of completed restoration BMPs through FY2020 (FY2020 Progress) with the planned restoration BMPs through FY2025 based on the County's MS4 geodatabase and the Restoration Project Portfolio.

One stream restoration, two wet pond retrofits, one bioretention, one infiltration trench, one shoreline restoration, and one SPSC project were completed by the end of FY2020, along with annual street sweeping and inlet cleaning. Planned projects include shoreline stabilization, stream restoration, and SPSC. Shoreline restoration does not receive load reduction credit for TMDLs written at the EOS scale. Future inlet cleaning and street sweeping rates are expected to be consistent with current levels of effort.

Table 7: Restoration BMP Implementation - Current FY2020 and Planned FY2025 Implementation Levels

BMP	Units	FY2020 Progress	Total Planned – FY2025[1]
Bioretention	acre	45.9	0
Bioswale	acre	0.9	0
Dry Ponds	acre	0	0
Extended Detention Dry Ponds	acre	0	0
Filtering Practices	acre	5.7	0
Grass Swale	acre	0.9	0
Impervious Surface Reduction	acre	0.3	0

BMP	Units	FY2020 Progress	Total Planned – FY2025[1]
Infiltration	acre	30.9	0
Permeable Pavement	acre	0.3	0
Shoreline Stabilization	linear feet	5,022	4,430
Vegetated Open Channels	acre	0	0
Wet Ponds or Wetlands	acre	347.1	0
Urban Stream Restoration	linear feet	16,305	18,337
Outfall Enhancement with SPSC	acre	167.3	27.2
Annual Practices			
Inlet Cleaning	inlets/yr	24	NA
Street Sweeping	curb-miles	11,593	NA

[1] Planned restoration totals through FY2025 from County's current MS4 geodatabase, plus additional planned projects from Project Portfolio, used in CAST modeling.

3.2 Load Reductions

This section compares the required and planned sediment load reductions against the progress made through FY2020. Values given in Table 8 include the load reductions for each period (generally the milestone years) and the resulting load. Actual reductions are shown for 2020 and planned results are provided for the 2025 period. The planned reductions in this case refer to projects that are in the County's database and are moving forward with implementation, and does not refer to the total planned projects and reductions that were presented in the initial TMDL restoration plan. All values shown (reductions, loads, percent reduction) are the cumulative values, not the year over year changes.

Overall the results indicate that on a TMDL allocated goal of 28.0%, the County has achieved a 16.7% reduction, which translates to 59.6% progress towards the reduction goal.

If the current rate of progress is maintained, it is expected that the TMDL allocated load and load reduction would be met by 2025, the County's initial estimated end date for meeting the TMDL. There are nearly enough planned BMPs in the watershed meet the required reduction. It is noted that the 26.7% reduction planned is based on the assumption that all of the recommended strategies will be completed.

MDE is currently working on a new local TMDL modeling tool that will be available in the future to report progress toward load reductions. It is anticipated that this new spreadsheet model will be used for FY2021 modeling, so additional changes are anticipated to the baseline, permit, and progress loads and load reductions in the FY2021 report.

Table 8: Planning and Target Sediment Load Comparison (lbs/year)

Milestone Year	Actual Load Reduction	Actual Load	Actual % Reduction from Baseline	Planned Load Reduction	Planned Load	Planned % Reduction From Baseline
2009 Baseline	-	18,280,219	-	-	-	-
2020 Progress	3,051,896	15,228,323	16.7%	-	-	-
2025 Allocated	-	-	-	5,118,461	13,161,758	28.0%
2025 Planned	-	-	-	4,884,630	13,395,589	26.7%

4 Monitoring

Official monitoring for Integrated Report assessments and impairment status is the responsibility of the State; however, the County has many on-going monitoring programs that can support the State's efforts. In addition, MDE has stressed specifically for sediment impairments the connection between in-stream biological health and meeting the intent of the sediment TMDL goals.

To determine the specific parameters to be monitored for tracking progress, one must understand the approach used for the initial listing. The Little Patuxent was originally listed for sediments in 1996 as a suspended sediment listing. This was refined in 2008 to a listing for total suspended solids. In 2002, the State began listing biological impairments on the Integrated Report, at the 8-digit scale, based on a percentage of stream miles degraded and whether they differ significantly from a reference condition watershed (<10% stream miles degraded). The biological listing is based on Benthic and Fish Indices of Biotic Integrity (BIBI/FIBI) results from wadeable streams from assessments conducted by the Maryland Department of Natural Resources (MDNR) Maryland Biological Stream Survey (MBSS). The Little Patuxent was listed for biological community impairment in 2006.

MDE then utilized its Biological Stressor Identification (BSID) process to identify the probable or most likely causes of poor biological conditions. For sediment specifically, the BSID identified 'altered hydrology and increased urban runoff have resulted in degradation to streambed morphology, streambed scouring, and subsequent elevated suspended transport through the watershed.' Overall, the results indicated inorganic pollutants (i.e. chlorides, acute ammonia, sulfate), and flow/sediment related stressors as the primary stressors causing impacts to biological communities.

Based on the results of the BSID (MDE, 2014), MDE replaced the biological impairment listing with a listing for total suspended solids (TSS). The 2012 and 2014 integrated reports (MDE, 2012 and MDE, 2014) lists 'Habitat Evaluation' as the indicator, and urban runoff/storm sewers as the source. It is noted that the *Decision Methodology for Solids for the April 2002 Water Quality Inventory (updated in February of 2012)*[1], makes a specific distinction between two different, although related 'sediment' impairment types in free flowing streams:

[1] http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/AM_Solids_2012.pdf

1. **TSS**: The first type is an impact to water clarity with impairment due to TSS using turbidity measured in Nephelometer Turbidity Units (NTUs). Although numeric criteria have not been established in Maryland for TSS, MDE uses a threshold for turbidity, a measurement of water clarity, of a maximum of 150 Nephelometer Turbidity Units (NTU's) and maximum monthly average of 50 NTU as stated in Maryland COMAR regulations (26.08.02.03-3). Turbidity also may not exceed levels detrimental to aquatic life in Use I designated waters.
2. **Sedimentation / siltation**: The second type is an impact related to erosional and depositional impacts in wadeable streams. The measures used are biocriteria and the criteria for Use I streams (the protection of aquatic life and growth and propagation of fish (other than trout) and other aquatic life).

With these two sediment impairments in mind the South River, which is listed as impaired for TSS, would seem to be a water clarity issue; however the methodology used for listing (biological and habitat measures related sediment deposition) seems to point to an in-stream sediment deposition problem. In all likelihood both types of impairment, water clarity and sedimentation, are factors and both should be incorporated into monitoring programs to track changes in the watershed condition over time.

Anne Arundel County's Watershed Bureau of Watershed Protection and Restoration (BWPR) has several on-going monitoring programs that target measures of water clarity and sedimentation. These programs are described here.

4.1 Countywide Biological Monitoring

4.1.1 Background and Goals

Biological monitoring and assessment provide a direct measure of the ecological health of a stream. Stream organisms are continuous monitors of both short- and long-term water quality and other environmental factors and provide direct indicators of the quality of a stream. Advantages of using benthic macroinvertebrates include their generally restricted mobility and often multi-year life cycles, allowing them to integrate the effects of both chemical and physical perturbations over time. When hydrologic regimes of streams are altered, the physical nature of the habitat changes due to accelerated erosion and deposition of channel soils and other materials. This changes the capacity of a stream to support a healthy biota. Changes in the quality of the water resource are reflected as changes in the structural and functional attributes of the macroinvertebrate assemblage. Biological monitoring and assessment results can be used to detect impairment of the biological community and to assess the severity of impacts from both point source (PS) and nonpoint source (NPS) pollution. When coupled with information on chemical and physical stressors, these types of exposure-and effect data can be used to improve water quality assessments. Over the past several decades, biological monitoring and assessment of aquatic communities along with characterization of their chemical and physical habitats have increased with application of these data to watershed management policies and practices.

Historically, many municipalities have been hampered in their ability to recommend and implement pollution control and remediation efforts because the chemical, physical, and biological condition of most of their water resources have not been adequately characterized. To expand its monitoring program, Anne Arundel County developed a stream monitoring program consisting of chemical, physical, and biological assessment techniques to document and track changes in the condition of stream resources County-wide. Problems resulting from chemical contamination and physical habitat alteration are reflected by changes in the aquatic biota. Therefore, inclusion of a biological monitoring component is providing Anne Arundel County with the relevant indicators for assessing the condition of, and managing, its water resources.

In 2004, a Countywide Biological Monitoring and Assessment Program for Anne Arundel County, Maryland was developed to assess the biological condition of the County's streams at multiple scales (i.e., site-specific, primary sampling unit (PSU), and countywide). Under the Countywide Biological Monitoring and Assessment program, biology (i.e., benthic macroinvertebrates) and stream habitat, as well as geomorphological and water quality parameters, are assessed at approximately 240 sites throughout the entire County over a 5-year period using a probabilistic, rotating-basin design.

Round 1 of the County's Biological Monitoring and Assessment Program occurred between 2004 and 2008, and Round 2 took place between 2009 and 2013. During 2017, Round 3 monitoring was initiated and fish sampling and additional water quality parameters were added (Southerland et al., 2016). Field data collection in the South River watershed took place during 2017 and 2019. Annual reports and Round summary reports are available for review at: http://www.aacounty.org/departments/public-works/wprp/ecological-assessment-and-evaluation/biological-monitoring/biological-monitoring-reports/index.html

The primary goals of the program are to assess the current status of biological stream resources, establish a baseline for comparison with current and future assessments, and to relate them to specific programmatic activities. The County currently uses a combination of chemical sampling, geomorphic assessment, storm water sampling, and biological sampling to assist in its environmental management decision-making process. This combination of monitoring greatly assists the County in assessing progress toward achieving Stormwater Wasteload allocations set forth in Sediment TMDLs. The biological monitoring program's stated goals are applicable at three scales; Countywide, Watershed-wide, and Stream-specific, and include the following components.

- Status: describe the overall stream condition
- Trends: how has the overall stream condition changed over time
- Problem identification/prioritization: identify the impaired and most degraded streams
- Stressor-response relationships: identify anthropogenic stressors and their biological response
- Evaluation of environmental management activities: monitor the success of implemented programs and restoration/retrofit projects

4.1.2 Methods

Both field sampling and data analysis methods were developed for the program to be directly comparable to Department of Natural Resources' Maryland Biological Stream Survey (MBSS), and complementary to those in place in Prince George's, Montgomery, and Howard Counties in Maryland (Hill and Stribling, 2004). Primary data collected include site location (latitude and longitude), pH, dissolved oxygen, water temperature and conductivity, benthic macroinvertebrate index of biotic integrity (BIBI), and physical habitat index (PHI) following MBSS methodologies (Kazyak, 2001; DNR, 2007; Stranko et. al, 2015) and EPA's Rapid Bioassessment Protocol (EPA RBP; Barbour et al., 1999). Biological data were analyzed using the revised (2005) version of the MBSS Coastal Plain BIBI (Southerland et al., 2005).

A more detailed description of the sampling and analysis methods can be found in the annual Biological Monitoring and Assessment Program Annual Reports (Crunkleton, et al., 2013; Crunkleton, et al., 2012; Crunkleton, et al., 2011; Crunkleton, et al., 2010; Victoria, et al., 2011). Specific information regarding the sampling and analysis methods, including the standard operating procedures (SOPs), can be found in the Documentation of Method Performance Characteristics for the Anne Arundel County Biological Monitoring Program (Hill et al., 2010) and the Quality Assurance Project Plan for Anne Arundel County Biological Monitoring and Assessment Program (Hill et al., 2011, AA County, 2017).

The South River watershed is made up of two PSUs: Upper North River, and Lower North River. Ten sampling sites were sampled in each of these PSUs in Round 1 and Round 2, while eight sites were sampled in each during Round 3.

Following these procedures, the County is collecting several parameters related to water clarity and sediment deposition at each site.

- Water Quality Measures and Observations
  - Turbidity (measured), observations of general water clarity and color
  - Grab samples analyzed for nutrients, metals, DOC, TOC, and chloride
- Biological Measures
  - Benthic macroinvertebrates (BIBI)
  - Fish (FIBI)
- Habitat Measures
  - General: bar formation and substrate, presence/absence of substrate type
  - PHI: epibenthic substrate, instream habitat
  - RBP: epifaunal substrate / available cover, pool substrate characterization, sediment deposition, channel alteration
- Geomorphic Measures
  - Particle size analysis using modified Wolman pebble counts at 10 transects proportioned by channel bed features

4.1.3 Results

The South River watershed is made up of two PSUs: Upper North River (PSU 11), and Lower North River (PSU 11). Results summarized at the PSU scale with average BIBI and habitat ratings (PHI and RBP) presented in Table 9.

Table 9: Countywide Biological Monitoring Results

PSU Name	Round	PSU Code	Year Sampled	Drainage Area (acres)	BIBI Rating	PHI Rating	RBP Rating
Upper North River	1	11	2005	12,797	F	PD	PS
Upper North River	2	11	2011	12,797	P	PD	S
Upper North River	3	11	2017	12,797	P	PD	PS
Lower North River	1	12	2005	23,681	P	D	PS
Lower North River	2	12	2009	23,681	P	PD	S
Lower North River	3	12	2019	23,681	P	PD	PS

BIBI Ratings: G = Good, F = Fair, P = Poor, VP = Very Poor

PHI Ratings: MD = Minimally Degraded, PD = Partially Degraded, D = Degraded, SD = Severely Degraded

RBP Ratings: C = Comparable, S = Supporting, PS = Partially Supporting, NS = Non-Supporting

4.1.3.1 Biological

During Round 1, biological sampling was completed in 2005 for both the Upper North River and Lower North River sampling units. Benthic macroinvertebrate metric and index scores for sites assessed during the Round 1 sampling effort are presented in Table 10. BIBI narrative condition ratings throughout the South River watershed presented in Figure 3. Overall, 55% of the sites in the watershed were rated as "Fair," 35% rated "Poor," 5% rated "Good," and 5% rated "Very Poor." Upper North River received the second highest average BIBI score of all PSUs during Round 1, with a mean BIBI score of 3.34 ± 0.46 and a corresponding biological condition rating of "Fair." The Lower North River PSU received a "Poor" biological condition rating, with a mean BIBI score of 2.63 ± 0.54.

Table 10: BIBI Data for Round 1 (2005)

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
11-13A	2005	19	6	2.0	1	33.7	1	13.9	3.86	Fair
11-15A	2005	18	3	3.0	1	63.0	0	13.0	3.29	Fair
11-17A	2005	24	4	0.0	0	35.4	1	18.8	3.29	Fair
11-07	2005	23	4	0.0	0	33.0	0	12.6	3.00	Fair
11-05	2005	31	7	1.0	1	48.5	1	8.2	4.14	Good
11-06	2005	17	3	0.0	0	72.6	1	2.8	2.71	Poor
11-04	2005	16	4	0.0	0	61.5	1	8.6	3.00	Fair
11-02	2005	28	6	3.1	1	60.8	0	22.7	3.86	Fair
11-14A	2005	21	1	3.0	1	23.2	4	8.1	3.29	Fair
11-11A	2005	24	6	0.0	0	48.0	0	7.8	3.00	Fair
12-04	2005	22	3	1.0	1	22.9	0	33	3.29	Fair
12-07	2005	18	2	0.0	0	20.8	1	14.1	2.71	Poor
12-06	2005	19	3	0.0	0	8.9	0	10	2.14	Poor
12-05	2005	20	2	0.0	0	53.4	0	6.7	2.43	Poor
12-03	2005	14	3	0.0	0	25.3	2	4.2	2.71	Poor
12-01	2005	27	4	0.0	0	15.5	1	15.5	3.00	Fair
12-08	2005	23	5	0.0	0	48.0	2	7.1	3.57	Fair
12-09	2005	14	3	0.0	0	1.9	1	6.8	2.14	Poor
12-02	2005	17	3	0.0	0	48.5	0	3.9	2.43	Poor
12-10	2005	11	2	0.0	0	1.1	2	0.0	1.86	Very Poor

During Round 2, biological sampling was completed in 2009 (Lower North River) and 2011 (Upper North River). Results of the Round 2 sampling effort are presented in Table 11. Overall, 50% of the sites in the watershed were rated as “Poor,” 30% rated “Fair,” 5% rated “Good,” and 15% rated “Very Poor.” Both Upper North and Lower North PSUs received “Poor” biological condition ratings, with mean BIBI scores of 2.74 ± 0.88 and 2.60 ±0.59, respectively.

Table 11. BIBI Data for Round 2 (2009-2011)

Site ID	Year	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
R2-11-01	2011	32	6	0.9	1	17.9	0	32	3.57	Fair
R2-11-03	2011	17	0	0.0	0	4.6	0	17	1.86	Very Poor
R2-11-05	2011	23	4	0.0	0	12.7	0	23	2.43	Poor
R2-11-06	2011	29	7	2.8	2	10.2	4	29	4.43	Good
R2-11-09	2011	29	5	0.9	1	9.0	1	29	3.57	Fair
R2-11-11A	2011	18	2	0.0	0	5.3	2	18	2.71	Poor
R2-11-13A	2011	14	2	0.0	0	1.8	2	14	2.43	Poor
R2-11-16A	2011	25	0	0.0	0	3.3	3	25	2.71	Poor
R2-11-17A	2011	14	0	0.0	0	5.4	0	14	1.57	Very Poor
R2-11-20A	2011	21	0	0.0	0	1.9	1	21	2.14	Poor
R2-12-01	2009	27	2	0.0	0	11.9	1	27	3.00	Fair
R2-12-02	2009	25	1	0.0	0	4.7	0	25	2.14	Poor
R2-12-03	2009	29	4	0.0	0	34.0	0	29	2.71	Poor
R2-12-04	2009	23	6	0.0	0	27.8	0	23	3.00	Fair
R2-12-06	2009	18	0	0.0	0	9.5	0	18	1.29	Very Poor
R2-12-07	2009	34	4	0.0	0	7.3	0	34	2.14	Poor
R2-12-08	2009	29	6	0.0	0	7.6	0	29	2.71	Poor
R2-12-11A	2009	15	2	0.0	0	52.8	0	15	2.71	Poor
R2-12-12A	2009	28	6	0.0	0	48.0	0	28	3.29	Fair
R2-12-13A	2009	22	3	0.0	0	39.6	0	22	3.00	Fair

In Round 3, the study design was modified and a total of 8 sites were sampled in each PSU. Sampling was performed in the Upper North in 2017 and Lower North in 2019, and site specific results are presented in Table 12. Fifty percent of the sites were rated as "Poor," 31% were rated as "Fair" and the remaining 19% rated as "Very Poor." There were no sites rated "Good" for biological condition in Round 3. The Upper North mean BIBI score was 2.68 ± 0.74, resulting in a narrative rating of "Poor." The Lower North River PSU also received a "Poor" biological condition rating, with a mean BIBI score of 2.39 ± 0.74.

Table 12. BIBI Data for Round 3 (2017-2019)

Site ID	Number of Taxa	Number of EPT Taxa	Percent Ephemeroptera	No. of Ephemeroptera Taxa	Percent Intolerant Urban	Number Scraper Taxa	Percent Climbers	BIBI	Rating
11-L1M-03-17	29	7	1	15.8	0.9	1	17.5	3.86	Fair
11-L1M-04-17	20	4	1	7.5	3.3	0	5.8	2.43	Poor
11-L2M-01-17	20	4	1	10.3	0.9	0	49.5	3.00	Fair
11-L2M-02-17	25	5	0	5.3	0.0	4	43.0	3.29	Fair
11-R3M-02-17	18	2	0	3.3	0.0	0	44.2	2.14	Poor
11-R3M-03-17	32	4	0	6.4	0.0	6	17.4	3.00	Fair
11-R3M-07-17	21	2	0	10.0	0.0	1	0.8	2.14	Poor
11-R3M-08-17	12	0	0	2.5	0.0	0	64.4	1.57	Very Poor
12-L1M-02-19	20	1	0	6.2	0.0	0	15.4	1.86	Very Poor
12-L1M-03-19	12	2	1	0.8	0.8	0	18.6	2.43	Poor
12-L2M-01-19	12	0	0	1.7	0.0	0	0.8	1.00	Very Poor
12-L2M-02-19	22	3	0	27.9	0.0	0	9.6	2.71	Poor
12-R3M-01-19	23	4	1	1.9	0.9	2	13.2	3.57	Fair
12-R3M-03-19	19	3	0	5.5	0.0	1	18.3	2.43	Poor
12-R3M-05-19	26	1	1	5.5	1.1	0	19.8	2.71	Poor
12-R3M-07-19	15	2	0	2.7	0.0	1	17.9	2.43	Poor

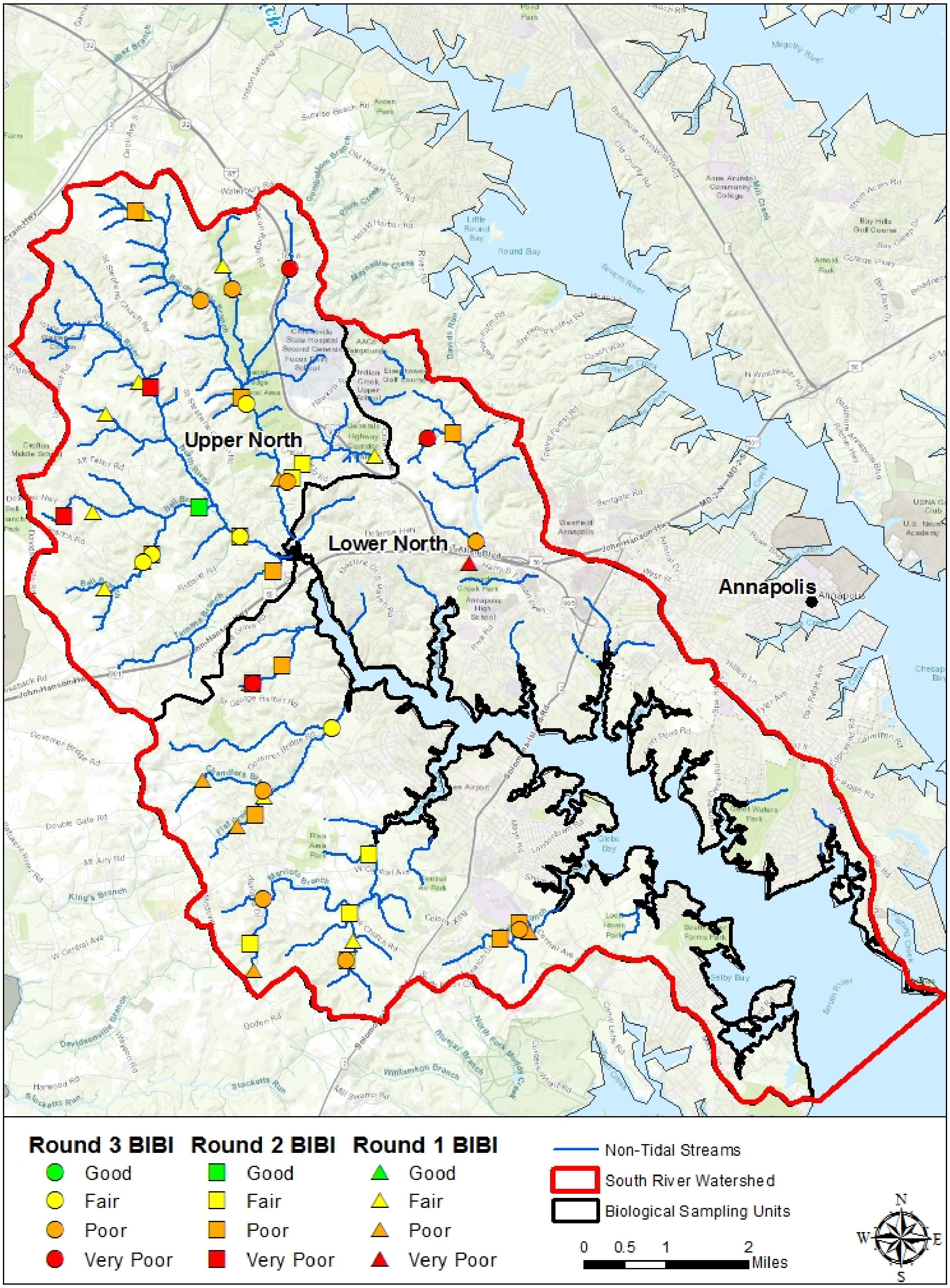

Figure 3: Biological Sampling Results (2005 - 2019).

4.1.3.2 Physical Habitat

During Round 1, all sampling was completed during the spring index period of 2005. Results of the Round 1 habitat assessments are presented in Table 13. MPHI narrative condition ratings across the South River watershed are presented in Figure 4. The MPHI rated 50% of sites "Partially Degraded," 45% as "Degraded," and 5% "Severely Degraded." There were no sites rated "Minimally Degraded" in Round 1. The Upper North River PSU received a narrative habitat condition rating of "Partially Degraded" with a mean MPHI score of 66.75 ± 10.0. The Lower North River PSU received a mean MPHI score of 64.98 ± 8.49, and a corresponding narrative rating of "Degraded."

Table 13: Physical Habitat Index Data from Round 1 (2005).

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
11-13A	2005	100.00	91.34	34.39	52.32	80.13	98.32	76.08	Partially Degraded
11-15A	2005	100.00	73.32	48.39	50.51	60.60	68.92	66.96	Partially Degraded
11-17A	2005	15.79	31.57	46.76	59.05	93.27	94.87	56.89	Degraded
11-07	2005	100.00	58.94	32.56	56.61	100.00	95.75	73.98	Partially Degraded
11-05	2005	71.68	78.67	28.40	37.36	75.63	61.24	58.83	Degraded
11-06	2005	69.36	40.96	24.65	44.54	50.15	50.00	46.61	Severely Degraded
11-04	2005	100.00	91.34	44.88	52.15	80.60	98.75	77.95	Partially Degraded
11-02	2005	65.72	91.34	44.84	74.28	71.66	98.32	74.36	Partially Degraded
11-14A	2005	31.22	78.67	38.56	71.93	80.23	93.10	65.62	Degraded
11-11A	2005	48.32	84.56	40.75	80.93	87.00	79.58	70.19	Partially Degraded
12-04	2005	57.72	91.34	25.99	31.61	54.93	57.01	53.10	Degraded
12-07	2005	31.22	58.94	43.65	50.22	90.30	93.10	61.24	Degraded
12-06	2005	54.78	58.94	59.27	62.06	79.51	80.63	65.86	Degraded
12-05	2005	77.16	84.56	53.49	66.04	80.07	72.46	72.30	Partially Degraded
12-03	2005	48.32	68.32	64.27	42.54	69.75	57.01	58.37	Degraded
12-01	2005	100.00	91.34	57.53	61.29	87.09	87.56	80.80	Partially Degraded
12-08	2005	77.16	84.56	38.92	61.41	74.95	74.16	68.53	Partially Degraded
12-09	2005	3.31	45.47	68.91	66.82	68.22	83.67	56.07	Degraded
12-02	2005	59.13	68.32	30.58	46.33	85.34	81.65	61.89	Degraded
12-10	2005	44.71	68.32	91.93	83.12	44.17	97.47	71.62	Partially Degraded

Round 2 habitat assessments were completed during spring 2009 (Lower North) and spring 2011 (Upper North). Results of the Round 2 assessments are presented in Table 14. The MPHI rated 50% of sites “Partially Degraded,” 35% as “Degraded,” 10% as “Minimally Degraded,” and 5% as “Severely Degraded.” Upper North River received a mean MPHI score of 70.0 ± 10.0 and a corresponding narrative rating of “Partially Degraded.” Lower North River also received a “Partially Degraded” narrative rating, with a mean MPHI score of 66.3 ± 10.8.

Table 14. Physical Habitat Index Data from Round 2 (2009-2011).

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
R2-11-01	2011	64.62	99.94	94.97	97.04	74.36	80.63	85.26	Minimally Degraded
R2-11-03	2011	86.16	99.94	69.77	67.82	67.47	86.61	79.63	Partially Degraded
R2-11-05	2011	75.39	99.94	74.57	75.72	57.36	44.72	71.28	Partially Degraded
R2-11-06	2011	32.31	99.94	52.51	40.70	37.47	94.87	59.63	Degraded
R2-11-09	2011	86.16	99.94	48.02	40.80	64.65	44.72	64.05	Degraded
R2-11-11A	2011	80.78	54.42	90.33	84.20	75.16	77.46	77.06	Partially Degraded
R2-11-13A	2011	100.00	26.57	95.10	90.08	78.05	89.45	79.88	Partially Degraded
R2-11-16A	2011	32.31	91.34	52.05	41.59	59.83	74.16	58.55	Degraded
R2-11-17A	2011	100.00	21.22	71.63	71.10	46.33	94.87	67.52	Partially Degraded
R2-11-20A	2011	10.77	58.94	63.81	69.92	47.54	92.20	57.20	Degraded
R2-12-01	2009	64.62	36.34	16.62	39.08	47.51	83.67	47.97	Severely Degraded
R2-12-02	2009	37.70	100.00	44.62	61.24	80.67	74.16	66.40	Partially Degraded
R2-12-03	2009	21.54	100.00	42.32	96.47	85.56	77.46	70.56	Partially Degraded
R2-12-04	2009	48.47	100.00	56.02	86.66	100.00	63.25	75.73	Partially Degraded
R2-12-06	2009	16.16	100.00	36.12	69.71	99.15	89.45	68.43	Partially Degraded
R2-12-07	2009	70.01	36.34	100.00	100.00	100.00	94.87	83.54	Minimally Degraded
R2-12-08	2009	21.54	99.94	48.48	72.85	87.38	54.77	64.16	Degraded
R2-12-11A	2009	21.54	84.56	48.12	39.00	77.88	59.16	55.04	Degraded
R2-12-12A	2009	26.93	100.00	28.62	54.35	61.22	67.08	56.37	Degraded
R2-12-13A	2009	70.01	99.94	46.68	70.02	90.17	70.71	74.59	Partially Degraded

During Round 3, all habitat assessments were completed during the summer index period sampling visits. Results of the Round 3 habitat assessments are presented in Table 15. During Round 3, the MPHI rated 44% of sites "Partially Degraded," 31% as "Degraded," 13% as "Minimally Degraded," and 13% were unrated. It should be noted that the two unrated stream sites were dry at the time of assessments; therefore, no physical habitat data was collected. The Lower North PSU received a "Partially Degraded" narrative rating, with a mean MPHI score of 69.19 ± 7.05. Upper North received a mean MPHI score of 70.04 ± 7.77 and a corresponding narrative rating of "Partially Degraded."

Table 15. Physical Habitat Index Data from Round 3 (2017-2019).

Station	Year	Remoteness Score	Percent Shading	Epifaunal Substrate	Instream Habitat	#Woody Debris/Rootwads	Bank Stability	PHI	Narrative Rating
11-L1M-03-17	2017	67.81	84.56	57.35	48.31	78.43	45.28	63.62	Degraded
11-L1M-04-17*	2017	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No PHI Rating
11-L2M-01-17	2017	55.23	99.94	68.76	59.08	86.94	65.58	72.59	Partially Degraded
11-L2M-02-17	2017	12.14	68.32	87.05	81.02	74.16	93.63	69.39	Partially Degraded
11-R3M-02-17	2017	80.86	68.32	71.23	62.96	76.44	84.86	74.11	Partially Degraded
11-R3M-03-17	2017	100	58.94	94.95	84.3	57.09	91.65	81.16	Minimally Degraded
11-R3M-07-17*	2017	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No PHI Rating
11-R3M-08-17	2017	31.22	88.49	54.57	39.99	67.15	74.84	59.38	Degraded
12-L1M-02-19	2019	69.95	99.94	51.96	45.02	84.55	92.74	74.02	Partially Degraded
12-L1M-03-19	2019	7.26	78.67	68.74	61	76.8	78.1	61.76	Degraded
12-L2M-01-19	2019	38.17	91.34	43.51	50	81.19	98.83	67.17	Partially Degraded
12-L2M-02-19	2019	68.17	99.94	35.2	42.5	93.38	61.65	66.81	Partially Degraded
12-R3M-01-19	2019	70.53	63.55	100	94	73.73	92.2	82.33	Minimally Degraded
12-R3M-03-19	2019	43.76	84.56	47.42	54.54	91.46	58.31	63.34	Degraded
12-R3M-05-19	2019	61.19	84.56	38.89	44.71	77.85	69.28	62.75	Degraded
12-R3M-07-19	2019	48.66	99.94	54.28	47.07	100	95.4	74.22	Partially Degraded

*Denotes sites that were dry during assessments

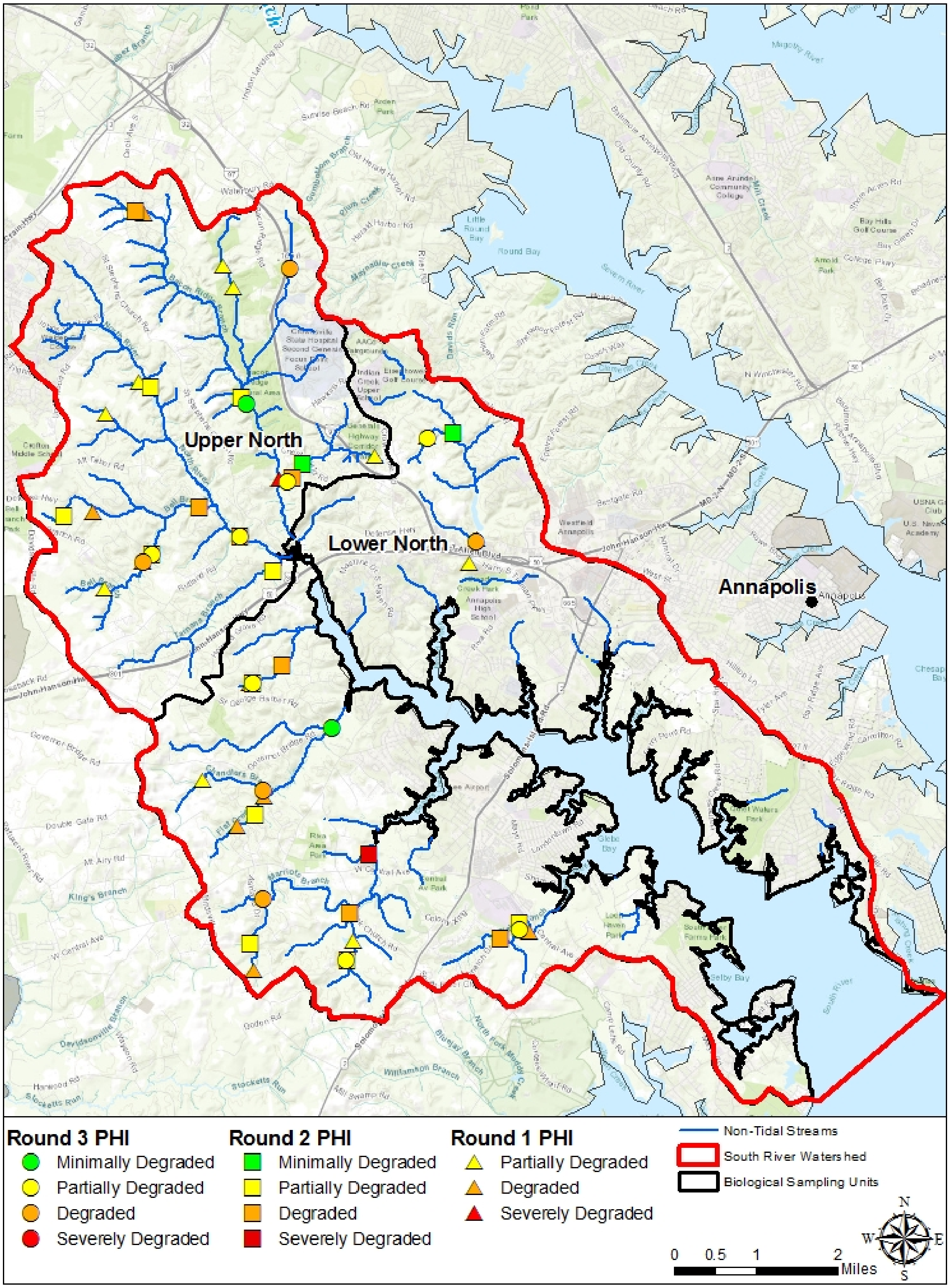

Figure 4: Physical Habitat Assessment Results (2005 - 2019).

4.1.4 Conclusions

At the completion of Round 2, analyses were performed to compare statistical differences between mean index values (i.e., BIBI, PHI) from Round 1 and Round 2 to determine if any changes in PSU scores were statistically significant. The report authors used the method recommended by Schenker and Gentleman (2001), which is the same method used by the MBSS to evaluate changes in condition over time, and is considered a more robust test than the commonly used method, which examines the overlap between the associated confidence intervals around two means (Hill et. al, 2014). Despite a slight decrease in mean BIBI scores in the Upper North River from 3.34 in Round 1 to 2.74 in Round 2, the increase was not statistically significant using a 95% confidence interval. Similarly, there was no statistically significant change observed in the Lower North River between Rounds 1 and 2, given mean BIBI scores of 2.63 and 2.60, respectively. These results suggest there has not been a measurable change in the average BIBI condition across the entire South River watershed from 2005 through 2011.

In 2019, this analysis was performed again to compare statistical differences between mean BIBI values from Round 3 and prior rounds. In the Upper North River PSU, a slight decrease in mean BIBI scores occurred from Round 2 (2.74) to Round 3 (2.68); however, the decrease was not statistically significant using a 95% confidence interval. Conversely, a statistically significant decrease in BIBI scores was observed from Round 1 (3.34) compared to Round 3 (2.68). No statistically significant differences in BIBI scores were observed in the Lower North River PSU between rounds. These results suggest there has not been a measurable change in the average BIBI condition across the broader South River watershed from 2005 to 2019.

4.2 Targeted Biological Monitoring Program

In addition to the Countywide Program, the County implements a targeted biological monitoring program. This program utilizes the same techniques and procedures as use in the Countywide Program, but the sites are not randomly selected. There are two general approaches to site selection in the targeted work. First, the County samples a collection of long term sites every year, the number of which has varied over the years. Currently, there are 34 sites in the program, 18 of which are past or proposed stream restoration sites that the County tracks to see how the stream insect community has changed, or will change, over time while one site is a minimally disturbed stream reach that is used as a reference reach. Most of the sites in this group have only been monitored post-restoration. Another 15 sites are allocated to the Sawmill Creek Project (SCP) with the purpose of tracking changes in the aquatic biological integrity, as well as several abiotic factors, in Sawmill Creek and its tributaries over a period of five years (2017-2021). The goal of this project is to ascertain which factor, or combination of factors, are contributing to the watershed's unexpected biological integrity.

A more detailed description of the Targeted Biomonitoring Program, including the latest published summary report can be found here:
https://www.aacounty.org/departments/public-works/wprp/targeted%20biomonitoring/index.html
and here:
https://www.aacounty.org/departments/public-works/wprp/ecological-assessment-and-evaluation/2016%20Targeted%20Site%20Summary%20Report_Final.pdf

The other group of sites, varying in number from year to year, is established on reaches planned for future restoration work. The intent is to create a baseline of biological conditions to justify project implementation by providing permitting agencies evidence that biological and habitat impairments exist within a reach of interest.

5 Conclusion

This South River TMDL Annual Assessment report documents the progress achieved through the end of FY2020. The assessment includes a report on the project and program implementation completed in the current report year and cumulatively through FY2020. The report summarizes the modeled and calculated pollutant load reductions and loads achieved through the implemented programs.

Anne Arundel County spent $1,473,272 in FY2020 in capital and operational costs in the South River Watershed. With those funds, the County is completing restoration projects and implementing programmatic practices including inlet cleaning and street sweeping. Load reductions are at 16.7% on a total goal of 28.0% and the County is on track to meet the load reduction with currently planned projects before the 2025 target date. Biological stream monitoring data thus far with three rounds completed indicates a watershed that is in fair to poor biological health. While decreases in mean BIBI scores between Round 1 and Round 3 were statistically significant in the Upper North PSU, no significant differences in BIBI scores occurred in the Lower North PSU. This suggests there has not been a measurable change in the average BIBI condition across the broader South River watershed from 2005 to 2019.

MDE is currently working on a new local TMDL modeling tool that will be available in the future to report progress toward load reductions. It is anticipated that this new spreadsheet model will be used for FY2021 modeling, so additional changes are anticipated to the baseline, permit, and progress loads and load reductions in the FY2021 report. After this modeling tool is released, the progress in South River will be reanalyzed and the need for a restoration plan will be determined at that time.

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