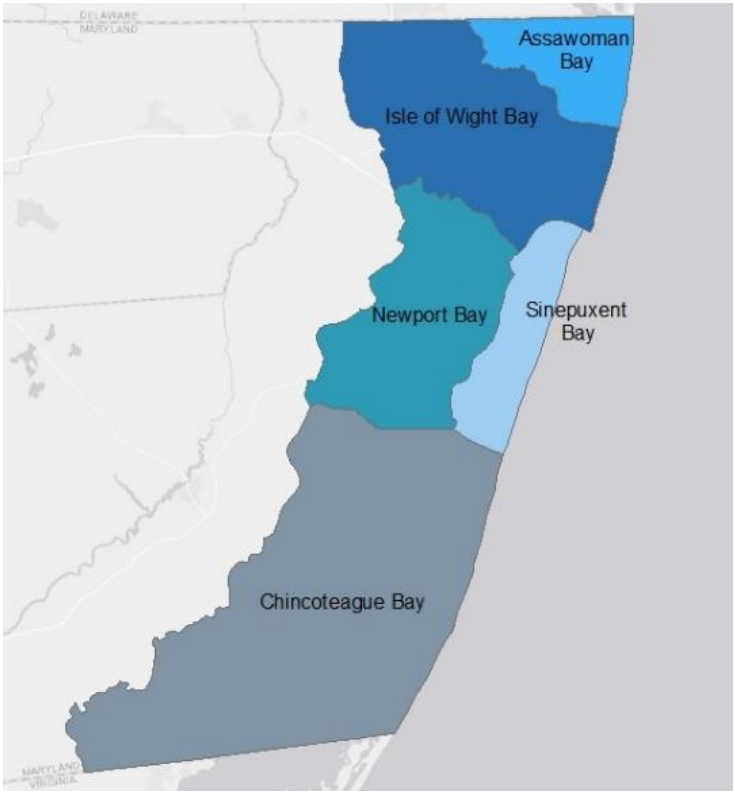
Maryland Coastal Bays Watershed Plan

Including Assawoman Bay "a - i" Subwatershed Plan

September 2019



Prepared by the Center for Watershed Protection
3290 North Ridge Road, Suite 290
Ellicott City, MD 21043

Prepared for Worcester County Maryland Department of Environmental Programs
1 West Market St, Suite 1306
Worcester County Government Center
Snow Hill, MD 21863

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Executive Summary

The Coastal Bays are a shallow coastal lagoon system located on the eastern side of the Delmarva (Delaware-Maryland-Virginia) Peninsula and comprised of five individual waterbodies: Assawoman Bay, Isle of Wight Bay (including the St. Martin's River), Sinepuxent Bay, Newport Bay and Chincoteague Bay. In 2014, the Maryland Department of the Environment (MDE) issued a nitrogen and phosphorus total maximum daily load (TMDL) for Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay and Chincoteague Bay in Worcester County, Maryland. Phosphorus and sediment TMDLs were issued for the Big Mill Pond watershed in Chincoteague Bay in 2002. In total, the approved nutrient and sediment TMDLs address 17 impairments (including the Bays themselves and several tributaries) within the Maryland portion of the Coastal Bays watersheds.

This watershed-based plan is focused on meeting the nonpoint source TMDL load reductions from the Maryland portion of the Coastal Bays watersheds, although additional loads may come from areas outside of Maryland. The primary nonpoint sources of pollution in the Maryland Coastal Bays watersheds include runoff from urban, agricultural and forest/barren land, on-site wastewater disposal systems (also known as septic systems), atmospheric deposition, and shoreline erosion. This plan is structured to follow the nine elements for watershed planning known as the "a-i criteria" that were established by the U.S. Environmental Protection Agency (USEPA) guidance (EPA, 2008) to address non-point source management measures.

The baseline year for the Coastal Bays TMDL is 2004 and the baseline year for the Big Mill Pond TMDL is 2001. Therefore, management measures installed since these baseline years were identified and accounted for in this plan. This includes agricultural BMPs reported by Maryland Department of Agriculture, urban BMPs (e.g., stormwater retrofits, storm drain cleanouts) from a variety of sources, other BMPs such as stream and wetland restoration, shoreline/riparian projects, and septic upgrades and connections. The nutrient (and sediment for Big Mill Pond) load reductions associated with these management measures were calculated, primarily using documented crediting protocols from the Chesapeake Bay Program. Table ES-1and Table ES-2 show the results and indicate the watersheds where existing BMPs have resulted in achievement of the required reductions.

Table ES-1. NPS Reductions Achieved with Existing BMPs: Nitrogen				
Tidal Basin	**TMDL Watershed[1]**	**TN Reduction Required (lbs/yr)**	**TN Reduction Achieved (lbs/yr)**	**TN Reduction Achieved (%)[2]**
Assawoman Bay	Assawoman Bay	10,448	5,061	48%
	Greys Creek	2,508	3,708	148%
Isle of Wight Bay	Isle of Wight Bay	127,858	29,220	23%
	Manklin Creek	6,802	820	12%
	Herring Creek	6,902	1,012	16%
	Turville Creek	12,545	4,989	40%
	St. Martin River	92,859	22,045	24%
	Bishopville Prong	25,439	6,625	26%
	Shingle Landing Prong	56,406	13,236	23%
Newport Bay	Newport Bay	28,409	23,088	81%
	Newport Creek	3,171	3,380	107%
	Marshall Creek	3,445	4,102	119%
	Ayer Creek/Kitts Branch	14,531	10,407	72%
Sinepuxent Bay	Sinepuxent Bay	2,212	8,470	383%
Chincoteague Bay	Chincoteague Bay	47,311	34,971	74%
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	N/A	N/A	N/A

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.
[2] Green shaded cells indicate the load reduction goal has been met.

Table ES-2. NPS Reductions Achieved with Implemented BMPs: Phosphorus				
Tidal Basin	TMDL Watershed[1]	TP Reduction Required (lbs/yr)	TP Reduction Achieved (lbs/yr)	TP Reduction Achieved (%)[2]
Assawoman Bay	Assawoman Bay	0 lbs required	400	0 lbs required
	Greys Creek	0 lbs required	212	0 lbs required
Isle of Wight Bay	Isle of Wight Bay	5,515	1,108	20%
	Manklin Creek	499	14	3%
	Herring Creek	452	33	7%
	Turville Creek	653	48	7%
	St. Martin River	3,370	946	28%
	Bishopville Prong	205	300	146%
	Shingle Landing Prong	2,540	578	23%
Newport Bay	Newport Bay	1,322	874	66%
	Newport Creek	109	106	97%
	Marshall Creek	118	111	94%
	Ayer Creek/Kitts Branch	787	502	64%
Sinepuxent Bay	Sinepuxent Bay	0 lbs required	41.0	0 lbs required
Chincoteague Bay	Chincoteague Bay	1,740	1,043	60%
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	1,642	488	30%

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.
[2] Green shaded cells indicate the load reduction goal has been met.

The estimated pollutant reductions from BMPs implemented since the TMDL baseline are not sufficient to meet the required reductions in many of the TMDL watersheds. A proposed plan to meet the remaining required nitrogen load reduction for Assawoman Bay, is summarized in Table ES-3 and includes a mix of reductions from septic, urban, agricultural, and stream/shoreline erosion sources. Table ES-3 also presents the estimated costs for implementing the management measures proposed in this plan for Assawoman Bay. The suite of proposed BMPs will be refined through discussion with watershed stakeholders and revised as more information is gathered on specific BMP opportunities, such as through the watershed assessment planned for Assawoman Bay in 2019-2020.

Table ES-3. Estimated Cost for BMP Implementation in Assawoman Bay				
BMP	Number of Units	Unit Value	Nitrogen Load Reduction (lbs/yr)	Total Annual Cost
Agricultural BMPs				
Soil Conservation and Water Quality Management Plans	86.5	acres	74	$168
Core Nutrient Management Plans	54.26	acres	193	$898
Other agricultural BMPs * Wetland creation/restoration * Filter strips/grassed waterways * Riparian forest/herbaceous cover * Roof runoff structures * Heavy use protection * Denitrifying ditch bioreactors	10	acres	1,084	$4,199[1]
Urban BMPs				
Stormwater retrofits/redevelopment BMPs * Bioretention/rain gardens * Infiltration practices * Permeable pavement * Bioswales	196	acres	1,535	$844,162[1]
Other BMPs				
Tree planting	20.5	acres	207	$1,735
Riparian buffers	3	acres	30	$276
Stream restoration	9707	feet	728	$738,509
Shoreline restoration	7000	feet	333	$199,150
Septic Systems				
Septic conversions	103	systems	1,203	$54,265
TOTAL				$1,843,360

[1] Composite cost using a variety of BMPs

This plan identifies funding sources and technical needs for Assawoman Bay, and an implementation schedule and milestones. It also includes a description of the information, education and public participation activities as well as monitoring activities to measure water quality improvements. Interim measures of success will include the extent of BMP implementation and estimates of the associated pollutant load reductions, which will be tracked using a spreadsheet tool to be developed by Worcester County and Maryland Coastal Bays Program. The County is committed to restoring its waters and implementing the actions outlined in this plan. Future iterations will identify future proposed BMPs whose associated pollutant load reductions will result in compliance with the TMDL requirements for additional watersheds.

Introduction

This watershed-based plan provides information to address the nutrient and sediment total maximum daily loads (TMDLs) for the five watersheds (Assawoman Bay, Isle of Wight Bay (including the St. Martin's River), Sinepuxent Bay, Newport Bay and Chincoteague Bay) that collectively make up the "Maryland Coastal Bays watersheds" in Worcester County, Maryland. There are 16 waterbodies in total with approved TMDLs for nutrients and/or sediment in the Coastal Bays watersheds. The TMDLs provide a baseline or starting point for the required nutrient and sediment reductions, and also provides a good starting point for the watershed plan. The plan is focused on meeting the portion of the nonpoint source TMDL load reductions from the Maryland portion of the Coastal Bays watersheds, although additional loads may come from areas outside of Maryland.

This watershed plan is structured to follow the nine elements for watershed planning known as the "a-i criteria" that were established by the U.S. Environmental Protection Agency (USEPA) guidance in 2003 to address non-point source management measures. Although this plan primarily focuses on establishing strategies for reducing pollutant loads from nonpoint sources, it also documents reductions achieved (or planned) from point sources,. The elements are identified below, along with a brief description of the information that each element provides. The section headings in this plan represent abbreviated statements of the nine elements and address each element in sequential order. The watershed plan is designed to address all the criteria in order to ensure that future implementation projects are eligible for Section 319(h) Nonpoint Source Program funding from the federal Clean Water Act. While the plan recommendations primarily address nonpoint source pollution, actions planned or already implemented to reduce nutrients from point sources in the watershed have also been documented here.

a) An identification of the causes and sources, or groups of sources, that will need to be controlled to achieve the load reductions estimated in the watershed plan

b) Estimates of pollutant load reductions expected through implementation of proposed nonpoint source (NPS) management measures

c) A description of the NPS management measures that will need to be implemented

d) An estimate of the amount of technical and financial assistance needed to implement the plan

e) An information/education component that will be used to enhance public understanding and encourage participation

f) A schedule for implementing the NPS management measures

g) A description of interim, measurable milestones for the NPS management measures

h) A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards

i) A monitoring component to evaluate effectiveness of the implementation records over time

Section A. Causes and Sources of Impairment

Watershed Location and General Characterization

The Coastal Bays are a shallow coastal lagoon system located on the eastern side of the Delmarva (Delaware-Maryland-Virginia) Peninsula and comprised of five individual waterbodies: Assawoman Bay, Isle of Wight Bay (including the St. Martin's River), Sinepuxent Bay, Newport Bay and Chincoteague Bay. The Coastal Bays span three states, with the majority of the system being located in Worcester County, Maryland along with portions in Sussex County (Delaware), and Accomack County (Virginia). The Worcester County portion includes Ocean City, Assateague Island National Seashore, Ocean Pines and Berlin. Figure 1 shows the location of the Maryland portion of the Coastal Bays and their watersheds.

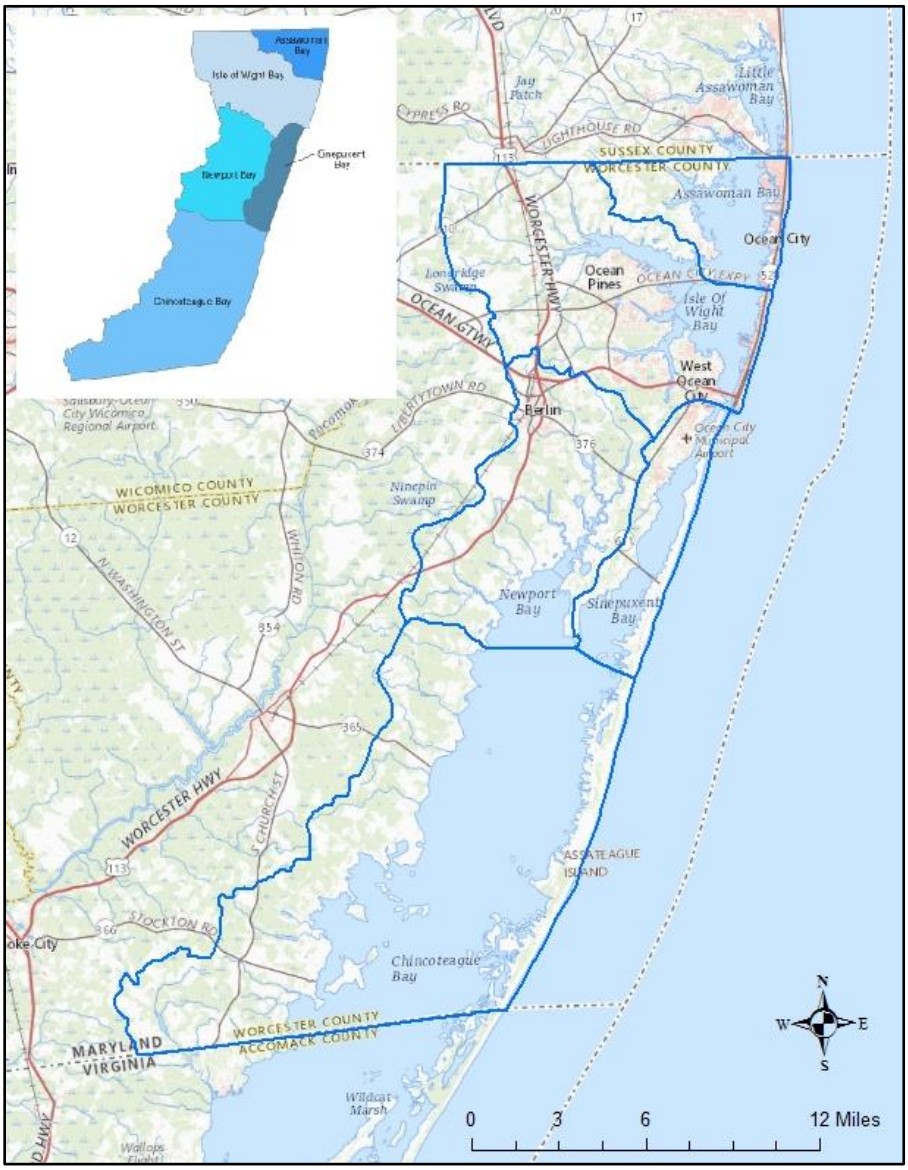

Figure 1. Maryland Coastal Bays Watershed Map

Natural water depths in the Coastal Bays are generally less than eight feet, except for the main navigation channels around the inlets and the tidal range varies by location. The total watershed area (land area only) draining to the Coastal Bays from all three states (Delaware, Virginia, and Maryland is 210,360 acres (851 square kilometers). Upstream watershed areas in Virginia and Delaware are approximately 89,920 acres or about 43% of the total watershed area.

Water Quality Impairments and TMDLs

The designated use for all five Coastal Bays is Use II: *Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting* (COMAR 26.08.02.08, No date). The Maryland Department of the Environment (MDE) has identified the waters of the Maryland Coastal Bays on the *Integrated Report of Surface Water Quality* as impaired by nutrients nitrogen and phosphorus (MDE, 2018). These areas were identified as impaired by nutrients based on high levels of chlorophyll a and low concentrations of dissolved oxygen. In addition to the nutrient impairments, Big Mill Pond, a sub-drainage area of Chincoteague Bay, is impaired by sediment. Table 1 summarizes the Coastal Bays water quality impairments.

Table 1. Water Quality Impairments for the Maryland Coastal Bays (MDE, 2018)

Year listed	Basin	Basin Code	Specific Area	Identified Pollutant
1996	Assawoman Bay	2130102	Open water	Nitrogen
				Phosphorus
			Grey's Creek	Nitrogen
				Phosphorus
1996	Isle of Wight Bay	2130103	Turville Creek	Nitrogen
				Phosphorus
			Manklin Creek	Nitrogen
				Phosphorus
			Herring Creek	Nitrogen
				Phosphorus
			Bishopville Prong	Nitrogen
				Phosphorus
			St. Martin River	Nitrogen
				Phosphorus
			Shingle Landing Prong	Nitrogen
				Phosphorus
			Open Water	Nitrogen
				Phosphorus
1996	Newport Bay	2130105	Newport Creek	Nitrogen
			Marshall Creek	Nitrogen
				Phosphorus
			Kitts Branch	Biochemical Oxygen Demand
			Ayer Creek	Nitrogen
			Newport Bay	Nitrogen

Table 1. Water Quality Impairments for the Maryland Coastal Bays (MDE, 2018)				
Year listed	**Basin**	**Basin Code**	**Specific Area**	**Identified Pollutant**
1996	Sinepuxent Bay	2130104	Sinepuxent Bay	Nitrogen
				Phosphorus
1996	Chincoteague Bay	2130106	Chincoteague Bay	Nitrogen
				Phosphorus
2002	Big Mill Pond	2130106	Chincoteague Bay	Phosphorus
				Sediment

Under Section 303(d)(1)(C) of the Clean Water Act, states must develop a TMDL for each impaired water quality limited segment on the Integrated Report of Surface Water Quality, taking into account seasonal variations and a protective margin of safety to account for uncertainty. A TMDL reflects the total pollutant loading for the pollutant of concern that the waterbody can receive and still meet water quality standards. Water quality standards include a designated use for each waterbody and the water quality criteria (i.e., narrative statements and/or numeric values) designed to protect that use.

Nitrogen and phosphorus TMDLs for areas within Maryland's Northern Coastal Bays were approved by the USEPA in 2002. Nitrogen and Biological Oxygen Demand (BOD) TMDLs for the Newport Bay watershed were approved by the USEPA in 2003. In August of 2014, new TMDLs for nitrogen and phosphorus were approved for the Worcester County, Maryland portion of the Coastal Bays Watersheds that supersede the previous nutrient TMDLs. Phosphorus and sediment TMDLs were approved for Big Mill Pond in Chincoteague Bay in April 2002.

Sources of Impairment

The sources of impairment in the Maryland Coastal Bays watersheds include both nonpoint sources and point sources. Nonpoint source pollution generally results from runoff from various types of precipitation moving across surfaces and then depositing into rivers, lakes, wetlands, coastal waters, and ground water. In general, natural lands like forest and wetlands tend to yield relatively low levels of nitrogen and phosphorus to surface waters, compared to lands that are dedicated to uses such as urban and agricultural land. This plan focuses on the nonpoint sources of pollution in the Maryland Coastal Bays watersheds, which include runoff from urban, agricultural and forest/barren land, on-site wastewater disposal systems (also known as septic systems), atmospheric deposition, and shoreline erosion. A description of point sources of nutrient pollution and point source BMPs implemented in the Coastal Bays watersheds is provided in Appendix A.

Runoff from Urban, Agricultural and Forest/Barren Land

Runoff from urban and agricultural lands contribute significantly to nonpoint source pollution. Urban lands can include residential, commercial, industrial, and institutional areas as well as the road surfaces in those lands. These land uses can contribute pollution from fertilizer, and pet waste, as well as fluids and emissions from vehicles and discharges from on-site sewage disposal systems. Agricultural lands are those used for

growing crops, animal production and can include areas that are used for other purposes such as pasture and nurseries. These lands can contribute pollution from fertilizers, animal waste, and air emissions. Land uses in the Maryland portion of the Coastal Bays watershed are primarily forest and other herbaceous growth (22% of the total watershed area); mixed agriculture (15%); water features (10%); urban land (8%), and barren or beaches (2%). Figure 2 illustrates the overall land use breakdown by category from 2010 (MDP, 2010) while Table 2 presents the acres of each land use (from MDE, 2014 and MDE, 2002).

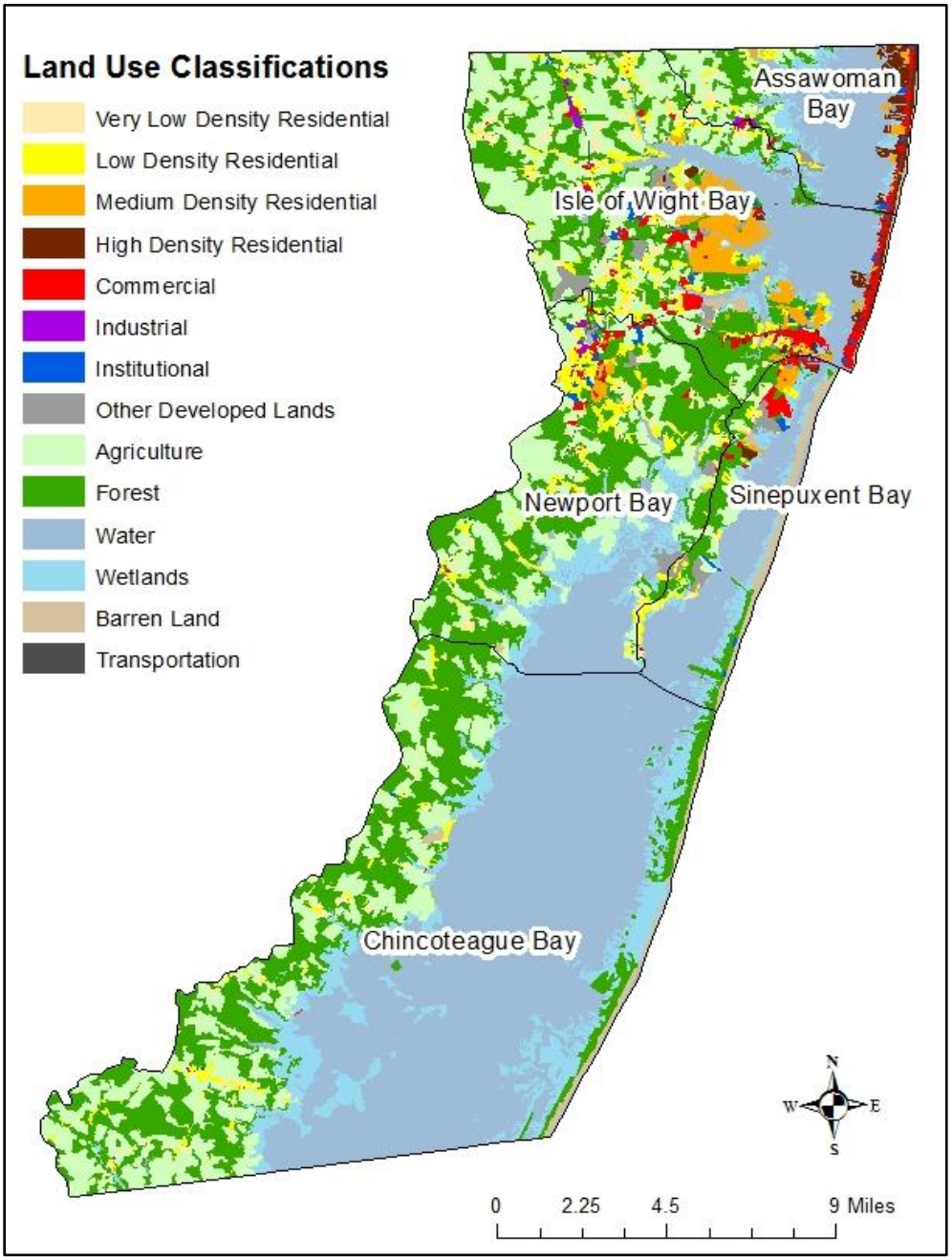

Figure 2. Land Use in the MD Coastal Bays Watershed (Data Sources; MDP, Worcester County, ESRI)

Table 2. Coastal Bays Watershed Drainage Areas and Land Uses							
Tidal Basin	TMDL Watershed[1]	Total Drainage Area (Acres)	Upstream Drainage[2]	Agriculture	Urban	Water/ Wetland	Forest and Barren
Assawoman Bay	Assawoman Bay	31,618	24,909[3]	1,403	1,993	1,477	1,835
	Greys Creek	10,372	6,667	1,365	426	465	1,379
Isle of Wight Bay	Isle of Wight Bay	41,071	6,475	10,321	8,339	2,654	13,282
	Manklin Creek	2,543	0	149	1,158	216	1,020
	Herring Creek	3,433	0	407	762	397	1,867
	Turville Creek	4,373	0	854	1,109	299	2,111
	St. Martin River	28,108	6,475	8,911	3,720	1,087	7,921
	Bishopville Prong	12,529	6,475	2,815	878	158	2,202
	Shingle Landing Prong	12,185	0	5,299	1,785	299	4,803
Newport Bay	Newport Bay	28,488	0	7,684	3,910	4,909	11,986
	Newport Creek	4,151	0	1,280	391	663	1,818
	Marshall Creek	5,735	0	1,678	317	883	2,908
	Ayer Creek/Kitts Branch	11,815	0	2,961	2,446	1,725	4,683
Sinepuxent Bay		7,442	0	499	1,838	1,882	3,224
Chincoteague Bay	Chincoteague Bay	101,473	58,536	12,234	1,446	10,566	18,701
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	5,248	0	1,889	0	53	3,306

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.
[2] Upstream drainage is that portion located outside of Maryland
[3] Maryland Coastal Bays Program asserts that the upstream portion of the Assawoman Bay watershed is around 40% of the total rather than 79%; this is currently under discussion with MDE and EPA

Septic Systems

Conventional septic systems may contribute nitrogen to shallow groundwater and eventually to surface waters. Table 3 shows the number of septic systems in the

Maryland portion of the watershed during the 2001-2004 monitoring period used to develop the TMDL.

Table 3. Septic Systems in the Maryland Coastal Bays Watersheds (MDE, 2014)			
MD Basin	# of septic systems within 1,000 ft of surface water	# of septic systems outside 1,000 ft of surface water	Total # of Maryland septic systems
Assawoman Bay (includes Greys Creek)	214	71	285
Isle of Wight Bay (includes St. Martin's River, Manklin Creek, Herring Creek, and Turville Creek)	1,350	458	1,808
Newport Bay (includes Ayer Creek/Kitts Branch, Newport Creek, and Marshall Creek)	763	288	1,051
Sinepuxent Bay	251	95	346
Chincoteague Bay (includes Big Mill Pond)	443	255	698
Totals	3,021	1,167	4,188

Atmospheric Deposition

Atmospheric deposition of pollutants onto impervious surfaces can also contribute to nonpoint source pollution. This can include emissions from vehicles, industries, power plants, dry cleaners, and gas-powered lawn tools as well as agricultural sources such as animal feeding operations (such as chicken houses) and manure, as well as natural sources (such as "lightning, dust storms, forest fires, plants and trees, erupting volcanoes and wild animals).

Shoreline Erosion

Shoreline erosion also contributes nutrients into coastal waters, typically through sediment movement. This sediment degrades water quality, increases turbidity, impacts aquatic organisms, and releases nitrogen and phosphorus into the water.

Contribution of Nonpoint Sources to Pollutant Loads

The baseline total nitrogen, phosphorus, and sediment loads for the Coastal Bays and percent of the load from each source of pollution are presented in Table 4, Table 5, and Table 6. As shown in Table 4 and Table 5, atmospheric deposition, agricultural runoff and urban runoff are the largest sources of total nitrogen loads to the surface water of the Maryland Coastal Bays, followed by shoreline erosion and septic, for nitrogen only.

Table 4. TMDL Watershed Loads and Sources: Nitrogen (MDE, 2014)										
			Sources of Nitrogen (% of Baseline Load)							
Tidal Basin	TMDL Watershed[1]	Baseline Total Nitrogen Loads (lbs/yr)	Upstream Loads	Atmospheric Deposition	Shoreline Erosion	Agriculture	Urban	Septic	Forest/ Barren Land	Point Source
Assawoman Bay	Assawoman Bay	360,653	70	13	3	5	6	3	0	0
	Greys Creek	124,228	68	4	4	14	4	5	1	0
Isle of Wight Bay	Isle of Wight Bay	425,192	16	12	4	32	33	9	2	3
	Manklin Creek	21,516	0	9	12	9	62	6	2	0
	Herring Creek	21,317	0	5	15	23	40	12	5	0
	Turville Creek	40,515	0	3	10	29	32	23	3	0
	St. Martin River	276,990	25	5	2	40	16	9	2	1
	Bishopville Prong	128,760	53	1	1	27	8	9	1	0
	Shingle Landing Prong	106,055	0	1	1	65	20	8	2	3
Newport Bay	Newport Bay	216,382	0	14	3	42	21	10	3	7
	Newport Creek	25,445	0	4	0	60	18	14	4	0
	Marshall Creek	33,766	0	11	4	59	11	3	4	3
	Ayer Creek/Kitts Branch	94,759	0	5	0	38	30	11	3	13
Sinepuxent Bay		90,037	0	48	10	7	24	8	2	0
Chincoteague Bay	Chincoteague Bay	1,233,856	53	28	4	12	1	1	1	0
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	N/A	N/A							

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch

Table 5. TMDL Watershed Loads and Sources: Phosphorus (MDE, 2014; MDE, 2002)										
			Sources of Phosphorus (% of Baseline Load)							
Tidal Basin	TMDL Watershed[1]	Baseline Total Phosphorus Loads (lbs/yr)	Upstream Loads	Atmospheric Deposition	Shoreline Erosion	Agriculture	Urban	Septic	Forest/ Barren Land	Point Source
Assawoman Bay	Assawoman Bay	23,923	73	9	4	5	9	0	0	0
	Greys Creek	8,379	68	4	7	13	7	0	1	0
Isle of Wight Bay	Isle of Wight Bay	29,523	16	12	7	29	29	0	2	5
	Manklin Creek	1,739	0	6	16	7	68	0	3	0
	Herring Creek	1,598	0	3	22	20	50	0	5	0
	Turville Creek	2,604	0	2	18	30	46	0	4	0
	St. Martin River	18,903	30	4	4	38	21	0	2	1
	Bishopville Prong	9,095	62	1	2	24	10	0	1	0
	Shingle Landing Prong	7,065	0	1	3	62	29	0	3	2
Newport Bay	Newport Bay	14,287	0	11	6	40	31	0	4	8
	Newport Creek	1,566	0	3	0	63	29	0	5	0
	Marshall Creek	2,469	0	7	6	54	14	0	5	14
	Ayer Creek/Kitts Branch	6,043	0	4	0	38	46	0	3	9
Sinepuxent Bay		6,229	0	35	24	6	33	0	2	0
Chincoteague Bay	Chincoteague Bay	84,809	56	20	9	12	2	0	1	0
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	2,552	0	0	0	97	0	0	3	0

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Table 6. TMDL Watershed Loads and Sources: Sediment (MDE, 2002)			
Tidal Basin	TMDL Watershed	Baseline Total Sediment Loads (lbs/yr)	Sources of Sediment (% of Baseline Load)
Chincoteague Bay	Big Mill Pond	1,4228.8 m^3/yr	Agriculture 97% Forest/other herbaceous 3%

Section B. Expected Load Reductions

The objective of the nitrogen and phosphorus TMDLs for the Maryland Coastal Bays is to ensure that DO and Chlorophyll a concentrations meet the water quality criteria applicable to their designated use and control excessive algal growth and increase or maintain DO concentrations. As such, nitrogen and phosphorus loads below which the impaired waters are expected to meet their designated uses were allocated to nonpoint sources (called the Load Allocation or LA) and point sources (called the Wasteload Allocation or WLA for NPDES regulated point sources, as well as CAFOs) in Maryland in the 2014 Coastal Bays TMDL. Similarly, sediment allocations were presented in the Big Mill Pond TMDL.

To calculate the expected pollutant load reductions for this plan, the Maryland Load Allocations were subtracted from the nonpoint source baseline pollutant load in the Maryland portion of each TMDL watershed. The results are presented in Table 7, Table 8, and Table 9.

Table 7. Maryland NPS TMDL Allocations and Required Reductions: Total Nitrogen

Tidal Basin	TMDL Watershed	MD NPS Baseline Loads (lbs/yr)	MD NPS Load Allocation (lbs/yr)	MD NPS Required Reduction (lbs/yr)
Assawoman Bay	Assawoman Bay	105,182	94,734	10,448
	Greys Creek	38,019	35,511	2,508
Isle of Wight Bay	Isle of Wight Bay	325,590	197,733	127,858
	Manklin Creek	21,462	14,660	6,802
	Herring Creek	21,253	14,351	6,902
	Turville Creek	37,889	25,345	12,545
	St. Martin River	190,265	97,406	92,859
	Bishopville Prong	50,971	25,532	25,439
	Shingle Landing Prong	98,139	41,733	56,406
Newport Bay	Newport Bay	192,110	163,701	28,409
	Newport Creek	22,643	19,472	3,171
	Marshall Creek	29,230	25,785	3,445
	Ayer Creek/Kitts Branch	80,123	65,592	14,531
Sinepuxent Bay		88,542	86,331	2,212
Chincoteague Bay	Chincoteague Bay	575,553	528,241	47,311
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	N/A	N/A	N/A

* Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Table 8. Maryland NPS TMDL Allocations and Required Reductions: Total Phosphorus				
Tidal Basin	**TMDL Watershed[1]**	**MD NPS Baseline Loads (lbs/yr)**	**MD NPS Load Allocation (lbs/yr)**	**MD NPS Required Reduction (lbs/yr)[2]**
Assawoman Bay	Assawoman Bay	6,299	6,428	0 lbs required
	Greys Creek	2,196	2,416	0 lbs required
Isle of Wight Bay	Isle of Wight Bay	21,128	15,613	5,515
	Manklin Creek	1,739	1,240	499
	Herring Creek	1,598	1,146	452
	Turville Creek	2,405	1,752	653
	St. Martin River	11,884	8,514	3,370
	Bishopville Prong	2,686	2,481	205
	Shingle Landing Prong	6,527	3,987	2,540
Newport Bay	Newport Bay	12,392	11,070	1,322
	Newport Creek	1,332	1,223	109
	Marshall Creek	1,812	1,694	118
	Ayer Creek/Kitts Branch	5,347	4,560	787
Sinepuxent Bay		6,229	6,370	0 lbs required
Chincoteague Bay	Chincoteague Bay	35,899	34,159	1,740
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	2,522	880	1,642

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.
[2] 0 lbs required indicates that the load allocation was higher than the nonpoint sources baseline load and therefore no reduction was required for nonpoint sources.

Table 9. TMDL Watershed Allocations and Required Reductions: Sediment				
Tidal Basin	**TMDL Watershed**	**Baseline Load (m^3/yr)**	**Total Sediment TMDL Allocation (m^3/yr)**	**Required Reduction (m^3/yr)**
Chincoteague Bay	Big Mill Pond	1,423	931.9 m^3/yr	491

The Load Allocations shown in Tables 7-9 for the Maryland portion of each watershed were taken directly from the TMDLs, with the exception of an adjustment to reflect the official policy of the MDE Water Management Administration for crediting reductions

from septic system conversions, described in Appendix B. The Maryland nonpoint source baseline loads for each watershed were provided by MDE (Jeff White, personal communication, July 31, 2019). Two adjustments were made regarding the loads from agriculture and septic systems. Documentation of the methods for determining Maryland nonpoint source baseline loads is provided in Appendix B.

Section C. Proposed Management Measures

The TMDLs provide a baseline or starting point for the required nutrient and sediment reductions. Although the Coastal Bays TMDL was approved in 2014, the model timeframe was 2000-2005. The TMDL analysis was conducted using 2001-2004 as a baseline, which includes wet, dry and average years. The year 2000 served as the model initiation period and water quality data was available up to August of 2005; therefore, the delivered loads represent an average for the 2001-2004 time periods. As a result, 2005 was identified as the baseline year and the Maryland Department of the Environment (MDE) confirmed that the County could elect to account for all best management practice (BMP) implementation from 2005 through the present toward the required pollutant load reductions (Shanks, 2016). For the Big Mill Pond TMDL, which was approved in 2002 (but based on 2001 data), BMPs installed after 2001 were counted toward the required reductions.

This section describes the types of management measures proposed, the extent of BMPs implemented in each watershed since the TMDL baseline and their associated nutrient and sediment reductions. It also summarizes proposed additional management measures for meeting the required reductions in Assawoman Bay and a general approach to identify additional management measures for the other TMDL watersheds.

Description of Management Measures

Worcester County, the towns of Ocean City and Berlin, the Maryland Coastal Bays Program, the Maryland Department of Agriculture (MDA), and other partners maintain data on nonpoint source management measures implemented to reduce nutrient and sediment loads. A brief description of each management measure by major BMP category is provided below. BMP definitions are taken from MACS, 2013; MDA, 2019a; MDA, 2019b; the Maryland Stormwater Management Design Manual; and the Chesapeake Bay Program (CBP).

Agricultural BMPs

- *Conservation Cover* - A practice which establishes and maintains perennial vegetative cover to protect soil and water resources on agricultural land retired from production or other lands requiring protective cover such as those adjacent to state waters or other sensitive natural source areas.
- *Wetland Creation/Restoration* - An area of vegetated wetland to remove sediment, nutrients, organic matter and other pollutants from surface and ground water associated with agricultural operations.
- *Filter Strips* - A strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forest land), and environmentally sensitive areas that provides protection from erosion and prevents pollution from nutrients, sediment, or agricultural chemicals from reaching the waters of the State from overland flow.
- *Grassed Waterways* - A natural or constructed waterway, shaped or graded and established in suitable vegetation, to safely convey water across areas of concentrated flow.

- *Windbreaks* – Rows of trees or shrubs, also called shelterbelts, planted around the edges of agricultural fields to provide shelter from the wind and protect soil from erosion.
- *Riparian Forest Buffers* - An area of trees, woody shrubs and other vegetation located adjacent to and up-gradient from waters of the state that remove sediment, organic material, nutrients, pesticides and other pollutants in surface runoff and reduce excess nutrients and other chemicals in shallow subsurface flow and reduce pesticide drift in order to prevent or abate pollution.
- *Riparian Herbaceous Cover* - A strip or area of herbaceous vegetation situated in the transitional zone between terrestrial and aquatic habitats that protect and improve water quality, reduce erosion from wind and water and prevent pollution from nutrients, sediment, organic materials or agricultural chemicals from reaching the waters of the State.
- *Field Border* – A border or strip of perennial vegetation established at the outside edge of a field where excessive sheet and rill erosion is occurring.
- *Cover Crops* - In the fall, cold-hardy cereal grains such as wheat, rye and barley are planted as cover crops in newly harvested fields. Once established, cover crops recycle unused plant nutrients remaining in the soil from the previous summer crop and protect fields against wind and water erosion.
- *Water Control Structures* - A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation or measures water. This includes roof runoff structures that collect, control, and dispose of runoff water from roofs.
- *Heavy Use Area Protection* - Stabilization to protect an area on a farm which is being utilized frequently and intensively by livestock or farm equipment in order to prevent or abate pollution.
- *Nutrient Management Plans (NMPs)* – A plan that specifies how much fertilizer, manure or other nutrient sources may be safely applied to crops to achieve yields and prevent excess nutrients from impacting waterways.
- *Soil Conservation and Water Quality Management Plans (SCWQPs)* – A comprehensive plan that addresses natural resource management on agricultural lands and utilizes BMPs that control erosion and sediment loss and manage runoff. SCWQPs includes management practices such as crop rotations and structural practices such as sediment basins and grade stabilization structures.

Urban BMPs

- *Rain Gardens/Bioretention* – Practices that capture and temporarily store runoff before infiltrating it into underlying soils where most pollutants are filtered.
- *Rooftop Disconnection* – Directing flow from downspouts onto vegetated areas where it can soak into or filter over the ground.
- *Rain Barrels* – Practices that capture and temporarily store rooftop runoff.
- *Infiltration* - Includes landscape infiltration and infiltration trenches. Landscape infiltration utilizes on-site vegetative planting areas to capture, store, and treat stormwater runoff. An infiltration trench is an excavated pit filled with gravel or stone that provides temporary storage of runoff within the void space in the stone media.

- *Alternative Surfaces* – Alternatives to impervious surfaces that include permeable pavers, pervious asphalt and pervious concrete.
- *Stormwater Wet Ponds and Wetlands* - A permanent pool of standing water that promotes a better environment for gravitational settling, biological uptake and microbial activity to treat stormwater runoff.
- *Storm Drain Cleanouts* – Removal of solids directly from storm sewer systems (i.e., catch basins, within storm drain pipes or captured at the storm drain outfall).

Other BMPs

- *Tree Planting* – Any tree planting in urban or agricultural areas, except those used to establish riparian forest buffers and those planted as part of a structural BMP (e.g. bioretention).
- *Non-Tidal Wetland Restoration* - The manipulation of the physical, chemical, or biological characteristics of a non-tidal site with the goal of returning natural/historic functions to a former non-tidal wetland.
- *Tidal Wetland Restoration* - The manipulation of the physical, chemical, or biological characteristics of a tidal site with the goal of returning natural/historic functions to a former tidal wetland.
- *Shoreline Restoration* - any tidal shoreline practice (e.g., living shorelines) that prevents and/or reduces tidal sediments to the Bay.
- *Stream Restoration* – The manipulation of the physical, chemical and biological characteristics of a stream with the goal of returning natural/historic functions to a former or degraded aquatic resource.

Septic Systems

- *Septic Pretreatment Upgrades* – Septic system upgrades done after 2005 using Best Available Technology (BAT) and funded either privately or under the Bay Restoration Grant Program (see Figure 3).
- *Septic Conversions to Sewer* – Septic systems taken offline in areas connected to public WWTPs.

BMPs Implemented Since the TMDL Baseline Years

Data from watershed partners was evaluated to determine which management measures were implemented between 2005 and 2019 (2002-2019 for Big Mill Pond), identify their location in the TMDL watersheds and assign pollutant load reductions. Table 10, Table 11, Table 12, and Table 13 summarize the extent of BMPs implemented since the TMDL baseline for agricultural BMPs, urban BMPs, other BMPs and septic systems, respectively.

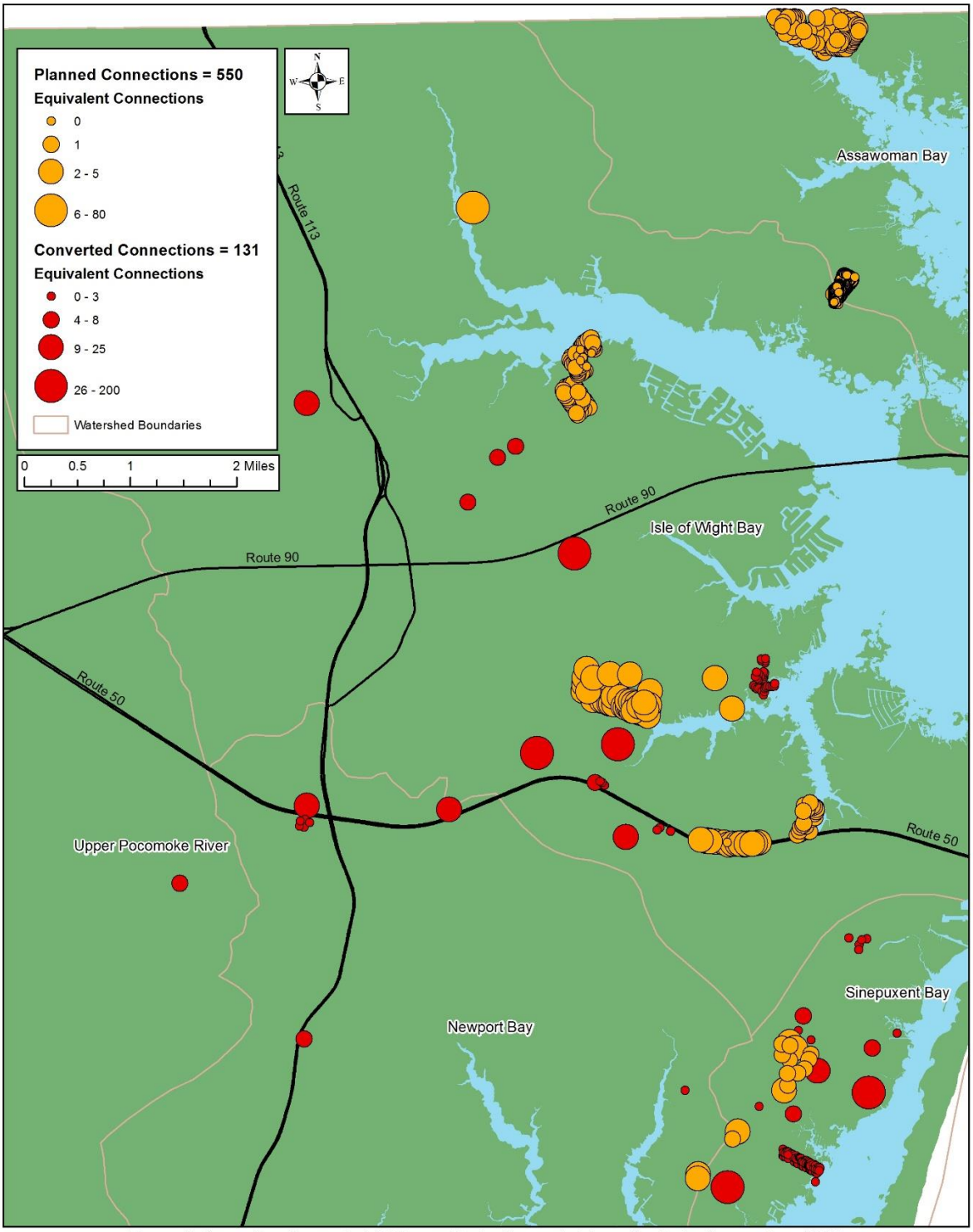

Figure 3. Properties Converted & Planned to be Converted from Septic to Sewer since 2005.
(Data Sources; MDP, Worcester County, ESRI)

Table 10. Agricultural BMPs Implemented Since the TMDL Baseline

Tidal Basin	TMDL Watershed[1]	Units Treated by Agricultural BMPs 2005-2019											
		Conservation Cover (acres)	Wetland Creation/ Restoration (acres)	Filter Strips/ Grassed Waterways (acres)	Windbreak/ Shelterbelt Establishment (ft)	Riparian Forest/ Herbaceous Cover (acres)	Field Borders (ft)	Water Control Structures (no)	Roof Runoff Structure (acres)	Heavy Use Protection (acres)	Cover Crops (acres)	Nutrient Management Plans (acres)	Soil Conservation & Water Quality Management Plans (acres)
Assawoman Bay	Assawoman Bay	0.00	1.00	0.00	2000.00	0.00	0.00	0.00	0.00	5.38	388.97	1075.61	192.75
	Greys Creek	0.00	0.97	0.00	1945.83	0.00	0.00	0.00	0.00	5.23	378.44	1025.79	187.53
Isle of Wight Bay	Isle of Wight Bay	0.00	14.00	0.00	99.98	0.00	0.00	0.00	0.00	7.69	2675.41	5968.29	4021.69
	Manklin Creek	0.00	0.20	0.00	1.44	0.00	0.00	0.00	0.00	0.11	38.63	48.54	58.05
	Herring Creek	0.00	0.55	0.00	3.94	0.00	0.00	0.00	0.00	0.30	105.50	181.64	158.59
	Turville Creek	0.00	1.16	0.00	8.27	0.00	0.00	0.00	0.00	0.64	221.37	302.89	332.78
	St. Martin River	0.00	12.09	0.00	86.33	0.00	0.00	0.00	0.00	6.64	2309.91	5422.64	3472.27
	Bishopville Prong	0.00	3.82	0.00	27.27	0.00	0.00	0.00	0.00	2.10	729.70	1688.85	1096.89
	Shingle Landing Prong	0.00	7.19	0.00	51.34	0.00	0.00	0.00	0.00	3.95	1373.61	3311.56	2064.82
Newport Bay	Newport Bay	0.00	6.01	96.50	970.00	8.80	0.00	0.00	0.00	11.15	3776.27	4262.05	1223.08
	Newport Creek	0.00	1.00	16.07	161.58	1.47	0.00	0.00	0.00	1.86	629.06	776.68	203.74
	Marshall Creek	0.00	1.31	21.07	211.82	1.92	0.00	0.00	0.00	2.43	824.64	888.12	267.09
	Ayer Creek/Kitts Branch	0.00	2.32	37.19	373.79	3.39	0.00	0.00	0.00	4.30	1455.17	1503.19	471.31
Sinepuxent Bay	Sinepuxent Bay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	301.60	80.96

Table 10. Agricultural BMPs Implemented Since the TMDL Baseline

		Units Treated by Agricultural BMPs 2005-2019											
Tidal Basin	TMDL Watershed[1]	Conservation Cover (acres)	Wetland Creation/ Restoration (acres)	Filter Strips/ Grassed Waterways (acres)	Windbreak/ Shelterbelt Establishment (ft)	Riparian Forest/ Herbaceous Cover (acres)	Field Borders (ft)	Water Control Structures (no)	Roof Runoff Structure (acres)	Heavy Use Protection (acres)	Cover Crops (acres)	Nutrient Management Plans (acres)	Soil Conservation & Water Quality Management Plans (acres)
Chincoteague Bay	Chincoteague Bay	9.20	61.40	36.70	1000.00	49.90	2229.00	2.00	1.00	10.12	5928.44	6589.08	1716.65
TOTAL		9.20	82.41	133.20	4069.98	58.70	2229.00	2.00	1.00	34.34	12769.09	18196.63	7235.13
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	1.42	20.53	34.01	154.32	68.56	343.99	0.31	0.15	1.56	914.90	1430.03	264.93

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Table 11. Urban BMPs Implemented Since the TMDL Baseline								
		Units Treated by Urban Stormwater BMPs 2005-2019[1]						
Tidal Basin	TMDL Watershed[2]	Bioretention /Rain Gardens	Wet Ponds/ Wetlands	Infiltration	Alternative Surfaces	Rain Barrels	Rooftop Dis-connection	Storm Drain Cleanout
Assawoman Bay	Assawoman Bay	0.48	0.00	2.58	1.82	0.27	0.97	176.85
	Greys Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Isle of Wight Bay	Isle of Wight Bay	0.03	50.55	4.09	3.15	0.11	0.09	19.65
	Manklin Creek	0.00	50.50	0.00	0.00	0.00	0.00	0.00
	Herring Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Turville Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	St. Martin River	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Bishopville Prong	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Shingle Landing Prong	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Newport Bay	Newport Bay	0.40	2.00	0.00	0.00	0.00	0.00	0.00
	Newport Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Marshall Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ayer Creek/Kitts Branch	0.40	2.00	0.00	0.00	0.00	0.00	0.00
Sinepuxent Bay	Sinepuxent Bay	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chincoteague Bay	Chincoteague Bay	1.60	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL		2.51	52.55	6.67	4.97	0.38	1.05	196.50
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[1] All units shown are acres treated except for catch basin cleanouts which is tons of material removed.
[2] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Table 12. Other BMPs Implemented Since the TMDL Baseline						
		Units Treated by Other BMPs 2005-2019				
Tidal Basin	TMDL Watershed[1]	Tree Planting (acres)	Non-Tidal Wetland Restoration (acres)	Tidal Wetland Restoration (acres)	Shoreline Restoration (ft)	Stream Restoration (ft)
Assawoman Bay	Assawoman Bay	0.00	0.00	4.30	750.00	0.00
	Greys Creek	0.00	0.00	0.00	750.00	0.00
Isle of Wight Bay	Isle of Wight Bay	6.00	20.44	0.00	770.00	600.00
	Manklin Creek	0.00	0.00	0.00	0.00	0.00
	Herring Creek	0.00	0.00	0.00	100.00	0.00
	Turville Creek	0.00	0.00	0.00	110.00	0.00
	St. Martin River	6.00	20.44	0.00	0.00	600.00
	Bishopville Prong	4.50	20.44	0.00	0.00	600.00
	Shingle Landing Prong	0.00	0.00	0.00	0.00	0.00
Newport Bay	Newport Bay	4.40	0.00	0.00	0.00	0.00
	Newport Creek	0.00	0.00	0.00	0.00	0.00
	Marshall Creek	0.00	0.00	0.00	0.00	0.00
	Ayer Creek/Kitts Branch	4.40	0.00	0.00	0.00	0.00
Sinepuxent Bay	Sinepuxent Bay	0.00	0.05	0.45	0.00	0.00
Chincoteague Bay	Chincoteague Bay	0.00	0.00	21.80	0.00	0.00
TOTAL		10.40	20.49	26.55	1520.00	600.00
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	0.00	0.00	0.00	0.00	0.00

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Table 13. Septic Upgrades and Conversions Since the TMDL Baseline					
		Number of Septic Upgrades and Conversions			
		Septic Pretreatment Upgrades		Septic Conversions to Sewer	
Tidal Basin	TMDL Watershed[1]	In Critical Area	Outside Critical Area	In Critical Area	Outside Critical Area
Assawoman Bay	Assawoman Bay	11	4	0	0
	Greys Creek	5	0	0	0
Isle of Wight Bay	Isle of Wight Bay	95	14	277	254
	Manklin Creek	0	0	0	120
	Herring Creek	7	2	0	31
	Turville Creek	8	3	277	54
	St. Martin River	80	9	0	49
	Bishopville Prong	6	4	0	0
	Shingle Landing Prong	31	4	0	49
Newport Bay	Newport Bay	26	14	6	30
	Newport Creek	0	0	0	5
	Marshall Creek	1	0	0	0
	Ayer Creek/Kitts Branch	5	4	6	25
Sinepuxent Bay	Sinepuxent Bay	176	0	487	3
Chincoteague Bay	Chincoteague Bay	34	2	0	0
TOTAL		342	34	770	287
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	0	0	0	0

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Data sources for Tables 10-13 include:

- An agricultural BMP database provided by MDA for the major tidal basin. Note that because the MDA data was not provided in spatial format, exact locations of these BMPs are unknown. Total units installed in each of the tidal basins were distributed to the TMDL watersheds based on the proportional agricultural land use distribution.
- Chesapeake and Atlantic Coastal Bays Trust Fund projects, including stormwater retrofits, tree planting, tidal and non-tidal wetland restoration, shoreline restoration, and stream restoration
- Public Landing stormwater retrofits

- Town of Berlin rain garden retrofits
- Ocean Parkway stormwater pond retrofits
- Ocean City stormwater BMPs installed as retrofits or to meet redevelopment requirements. Note that BMPs installed to comply with stormwater management requirements for new development do not count towards the required load reductions since these practices are designed to help offset the additional pollutant load increase.
- Catch basin cleaning information provided by the Town of Ocean City
- Septic conversions, upgrades and pre-treatment information provided by Worcester County

Assumptions regarding this data are described in Appendix C. Street sweeping data provided by The Town of Ocean City and the Town Berlin were not included in this version of the plan because it is not sufficient to quantify an increase in pollutant load reductions due to street sweeping since the TMDL baseline. Berlin's program appears to have only become formalized after the baseline year but since the sweeping frequency is low and the sweeper technology is broom sweepers, the credit would be negligible based on the CBP and MDE crediting methods available, as described in Appendix C.

Pollutant Reductions Achieved

Nutrient and sediment load reductions were calculated for the BMPs implemented since the TMDL baseline, using the information summarized above for agricultural BMPs, urban BMPs, septic systems and other BMPs. Table 14 presents the nitrogen load reductions achieved by sector and Table 15 presents the phosphorus load reductions by sector. Table 16 presents the total nutrient reductions achieved as well as the percent of the required reductions met in each TMDL watershed. Table 17 presents this information for sediment. Major assumptions regarding pollutant removal credit include:

- Pollutant removal crediting was primarily based on the CBP's protocols.
- For BMPs funded by the Chesapeake and Atlantic Coastal Bays Trust Fund, reductions provided using Field Doc (which is based on the CBP protocols) were used.
- Pollutant removal reductions for nutrient management plans and soil conservation/water quality plans were estimated using data provided by MDA and data reported in the Chesapeake Assessment and Scenario Tool (CAST) for the Chesapeake Bay portion of Worcester County and extrapolated to the Coastal Bays to estimate the acres of land under each type of plan. This is an annual BMP so credit was only given for the estimated increase in acres from the TMDL baseline to the present.
- Pollutant removal reductions for urban BMPs installed in the Town of Ocean City to meet redevelopment requirements were estimated using the CBP protocols for urban stormwater retrofits. A conservative discount factor of 50% was applied because it is unknown what portion of the stormwater treatment provided was for existing impervious cover vs new impervious cover added as part of a redevelopment project.

- Sediment reductions for the Big Mill Pond watershed were calculated following assumptions provided in the TMDL modeling that for every 1% reduction achieved for phosphorus, a 0.5% reduction is achieved for sediment.

More detail on these assumptions and the crediting methodologies used is provided in Appendix C.

Table 14. NPS Nitrogen Load Reductions for BMPs Implemented Since the TMDL Baseline

Tidal Basin	TMDL Watershed[1]	Agricultural BMPs (lbs TN/yr)	Urban BMPs (lbs TN/yr)	Septic BMPs (lbs TN/yr)	Other BMPs (lbs TN/yr)
Assawoman Bay	Assawoman Bay	3,770.0	714.5	146.0	430.5
	Greys Creek	3,614.2	0.0	58.4	35.7
Isle of Wight Bay	Isle of Wight Bay	22,573.0	334.1	5,518.8	794.0
	Manklin Creek	254.8	39.7	525.6	0.0
	Herring Creek	781.2	0.0	226.3	4.8
	Turville Creek	1,405.1	0.0	3,578.5	5.2
	St. Martin River	20,098.7	0.0	1,188.4	757.4
	Bishopville Prong	5,824.1	0.0	87.6	713.1
	Shingle Landing Prong	12,641.5	0.0	594.2	0.0
Newport Bay	Newport Bay	20,048.7	2,344.4	566.5	128.0
	Newport Creek	3,357.5	0.0	21.9	0.0
	Marshall Creek	4,090.5	0.0	11.7	0.0
	Ayer Creek/Kitts Branch	7,679.0	2,344.4	255.5	128.0
Sinepuxent Bay		669.0	0.0	7,757.0	44.1
Chincoteague Bay	Chincoteague Bay	32,550.2	13.4	405.9	2,001.9
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	N/A	N/A	N/A	N/A

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

Table 15. NPS Phosphorus Load Reductions for BMPs Implemented Since the TMDL Baseline					
Tidal Basin	**TMDL Watershed[1]**	**Agricultural BMPs (lbs TP/yr)**	**Urban BMPs (lbs TP/yr)**	**Septic BMPs (lbs TP/yr)[2]**	**Other BMPs (lbs TP/yr)**
Assawoman Bay	Assawoman Bay	196.2	153.7	N/A	49.2
	Greys Creek	186.3	0.0	N/A	25.2
Isle of Wight Bay	Isle of Wight Bay	979.0	51.5	N/A	77.7
	Manklin Creek	8.5	5.7	N/A	0.0
	Herring Creek	29.2	0.0	N/A	3.4
	Turville Creek	44.5	0.0	N/A	3.7
	St. Martin River	894.2	0.0	N/A	51.8
	Bishopville Prong	250.4	0.0	N/A	49.9
	Shingle Landing Prong	577.5	0.0	N/A	0.0
Newport Bay	Newport Bay	568.9	299.8	N/A	5.4
	Newport Creek	105.5	0.0	N/A	0.0
	Marshall Creek	110.6	0.0	N/A	0.0
	Ayer Creek/Kitts Branch	196.9	299.8	N/A	5.4
Sinepuxent Bay		37.3	0.0	N/A	3.7
Chincoteague Bay	Chincoteague Bay	919.5	1.6	N/A	121.8
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	488.0	0.0	N/A	0.0

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.

[2] The septic BMP crediting methodology only provides a load reduction for TN.

Table 16. NPS Nutrient Load Reductions Achieved from BMPs Implemented Since the TMDL Baseline					
		Total NPS Load Reduction from Existing BMPs[2]			
Tidal Basin	TMDL Watershed[1]	TN (lbs/yr)	TP (lbs/yr)	TN (% of Required)	TP (% of Required)
Assawoman Bay	Assawoman Bay	5,061.1	399.1	48.44%	0 lbs required
	Greys Creek	3,708.3	211.5	147.87%	0 lbs required
Isle of Wight Bay	Isle of Wight Bay	29,220.0	1,108.2	22.85%	20.09%
	Manklin Creek	820.2	14.2	12.06%	2.83%
	Herring Creek	1,012.2	32.5	14.67%	7.19%
	Turville Creek	4,988.8	48.2	39.77%	7.38%
	St. Martin River	22,044.6	945.9	23.74%	28.07%
	Bishopville Prong	6,624.8	300.3	26.04%	146.16%
	Shingle Landing Prong	13,235.7	577.5	23.47%	22.74%
Newport Bay	Newport Bay	23,087.7	874.1	81.27%	66.11%
	Newport Creek	3,379.4	105.5	106.59%	97.06%
	Marshall Creek	4,102.1	110.6	119.08%	93.67%
	Ayer Creek/Kitts Branch	10,407.0	502.0	71.62%	63.82%
Sinepuxent Bay	Sinepuxent Bay	8,470.0	41.0	383.00%	0 lbs required
Chincoteague Bay	Chincoteague Bay	34,971.4	1,043.0	73.92%	59.96%
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	N/A	488.0	N/A	29.72%

[1] Values shown for Assawoman Bay include those for Greys Creek; Values shown for Isle of Wight Bay include those for Manklin, Herring and Turville Creek and St. Martin River; Values shown for St. Martin River include those for Bishopville Prong and Shingle Landing Prong; Values shown for Newport Bay include those for Newport Creek, Marshall Creek and Ayer Creek/Kitts Branch.
[2] Green shaded cells indicate the load reduction goal has been met.

Table 17. NPS Sediment Load Reductions Achieved from BMPs Implemented Since the TMDL Baseline			
Tidal Basin	TMDL Watershed	TSS (m^3/yr)[1]	TSS (% of Required)[2]
Chincoteague Bay	Big Mill Pond (Separate TMDL with 2001 baseline year)	137.6 m^3	28.03%

[1] The Big Mill Pond watershed only included agricultural BMPs.
[2] Assumption from the Big Mill TMDL is that for every 1% reduction achieved in TP, a 0.5% reduction will be achieved in TSS.

Proposed Management Measures

The estimated pollutant reductions from BMPs implemented since the TMDL baseline are not sufficient to meet the required reductions in many of the TMDL watersheds. This section presents a strategy for filling the gap with future proposed BMPs for the Assawoman Bay watershed. The County will continue to update this plan to refine a strategy for the remaining watersheds, focusing first on ones that are closest to achieving the required reductions. A general strategy for identifying future proposed BMPs to fill the gaps is described in this section.

Assawoman Bay

Table 18 shows that, with implementation of BMPs from 2005-2019, the required nutrient reductions for Greys Creek have been met and there is a gap of 5,387 lbs/yr to meet the nonpoint source nitrogen required load reduction for Assawoman Bay. Assawoman Bay does not have a nonpoint source phosphorus reduction requirement due to the load allocation being higher than the baseline load.

Table 18. Maryland NPS TMDL Required and Achieved Reductions for Nitrogen

Tidal Basin	TMDL Watershed	Baseline Loads (lbs/yr)	Load Allocation (lbs/yr)	Required Reduction (lbs/yr)	Reduction from Existing BMPs (lbs/yr)	Remaining Required Reduction (lbs/yr)
Assawoman Bay	Assawoman Bay (includes Greys Creek)	105,182	94,734	10,448	5,061	**5,387**
	Greys Creek	38,019	35,511	2,508	3,708	Requirement Met

A proposed plan to meet the remaining required nitrogen load reduction is summarized in Table 19 and includes a mix of reductions from septic, urban, agricultural, and stream/shoreline erosion sources. Assumptions are described following the table and pollutant load reductions were estimated using the methods described in Appendix C. The suite of proposed BMPs in Table 19 will be refined through discussion with watershed stakeholders and revised as more information is gathered on specific BMP opportunities, such as through the watershed assessment planned for Assawoman Bay in 2019-2020.

Table 19. Proposed BMPs to Meet the Remaining NPS Nitrogen Required Reduction

BMP	TN Load Reduction (lbs/yr)	Percent of Gap Filled
Septic Conversions	1,203	22%
Urban BMPs	1,535	29%
Agricultural BMPs	1,351	25%
Stream and shoreline BMPs	1,298	24%
TOTAL	**5,387**	**100%**

Agricultural BMPs

- Increase the number of acres with soil conservation and water quality management plans by 15% (74 lbs/yr)
- Increase the level of compliance for core Nutrient Management Plans to 70% as identified in Worcester County's Phase III Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDL (193 lbs/yr)
- Treat 10 acres with other agricultural BMPs such as filter strips/grass waterways, wetland restoration/creation, roof runoff structures, heavy use protection, riparian forest/herbaceous cover, and denitrifying ditch bioreactors (1,084 lbs, based on average value of 110 total nitrogen lbs reduced per unit from MDA, 2018)

Urban BMPs

- Install stormwater BMPs, such as bioretention/rain gardens, infiltration practices, bioswales, and permeable pavement, to treat 196 acres of land (152 acres of existing impervious cover), either as retrofits or associated with redevelopment in Ocean City (1,535 lbs/yr). Some of these reductions may come from existing BMPs that are not currently accounted for in this plan due to incomplete information (see Appendix C).

Other BMPs

- Plant 20.5 acres with trees (207 lbs/yr)
- Restore 3 acres of non-agricultural riparian forest buffer (30 lbs/yr)
- Restore 9,707 feet of stream (728 lbs/yr)
- Restore 7,000 feet of shoreline (333 lbs/yr)

Septic Systems

- Implement 103 equivalent connection septic conversions at Bayview Estates and Hidden Harbor (1,203 lbs/yr)

Strategy for Remaining Watersheds

The County is committed to restoring its waters and implementing the actions outlined in this plan. Future iterations will identify future proposed BMPs whose associated pollutant load reductions will result in compliance with the TMDL requirements for additional watersheds. Some initial strategies that are being discussed with watershed stakeholders are listed below.

Agricultural BMPs

- No data on planned BMPs was provided by MDA for the Coastal Bays. Explore using WIP III data for the Chesapeake Bay portion of Worcester County and extrapolate to the Coastal Bays based on projected increases in the Chesapeake (see Appendix C).

Urban BMPs

- Graham Ave Submerged Gravel Wetland in Berlin has been identified as a planned BMP. Identify any additional specific projects in the pipeline from partners.

- Use desktop and field assessment to identify additional urban BMP opportunities can be implemented in the future.
- Discuss with Town of Berlin and Town of Ocean City considering upgrades to advanced sweeper technology and measuring the mass of street dirt picked up annually, which will provide the most bang for buck in terms of nutrient removal credit for street sweeping. Need to weigh the cost vs benefit of these upgrades.
- Discuss with Town of Ocean City whether the amount of material removed from the catch basins through recent storm drain cleanouts is a good predictor of what can be removed on an annual basis moving forward, given that they had not been cleaned out in a very long time. Since the credit is annual, the same level must be maintained, or increased to continue receiving it.

Other BMPs

- Swan Gut/Big Mill stream restoration has been identified as a planned BMP.
- Ilea Fehrer living shoreline (in the Ayer Creek/Kitts Branch watershed) has been identified as a planned BMP.
- Use desktop and field assessment to identify additional urban BMP opportunities can be implemented in the future. For example, the Maryland Department of Natural Resources Coastal Atlas can be used to identify lengths of tidal shoreline that exhibit high amounts of erosion and develop a conservative estimate of the length that could potentially be restored.

Septic systems

- Use County information on planned septic conversions and upgrades and determine if any additional septic conversions or pretreatment upgrades can be added.

Some areas in which additional gains can likely be made include:

1. *Improved documentation of installed practices.* Some BMPs that were submitted were not able to be fully credited because they did not include important information needed to calculate the associated pollutant load reduction. An example is the stormwater BMP database provided by the Town of Ocean City that includes a suite of mitigation BMPs with no drainage area or storage volume (note that although mitigiation may not be credited, some projects exceed the credit required for mitigation purposes and that amount could be credited). The County expects that by using a consistent reporting format like the BMP Implementation Tracking Sheet, it will be able to take full credit for all restoration efforts in the future.
2. *More detailed information on the feasibility of and locations for installing BMPs.* Desktop analysis and detailed on-the-ground assessments to identify candidate sites for stormwater retrofits, agricultural BMPs and stream/shoreline BMPs will be conducted by the Maryland Coastal Bays Program this year for the Assawoman, Isle of Wight and St Martins River watersheds. This work will assist in helping to target specific BMP opportunities in these watersheds. The County will continue to pursue grant funding for detailed watershed assessment of BMP opportunities in other priority watersheds.

Section D: Technical and Financial Assistance Needed

Estimated Costs for Assawoman Bay

Table 20 presents the estimated costs for implementing the management measures proposed in this plan for Assawoman Bay.

Table 20. Estimated Cost for BMP Implementation in Assawoman Bay

BMP	Number of Units	Unit Value	Unit Cost/Year	Total Annual Cost
Agricultural BMPs				
Soil Conservation and Water Quality Management Plans	86.5	acres	$1.94	$168
Core Nutrient Management Plans	54.26	acres	$16.55	$898
Other agricultural BMPs * Wetland creation/restoration * Filter strips/grassed waterways * Riparian forest/herbaceous cover * Roof runoff structures * Heavy use protection * Denitrifying ditch bioreactors	10	acres	$419.90[1]	$4,199
Urban BMPs				
Stormwater retrofits/redevelopment BMPs * Bioretention/rain gardens * Infiltration practices * Permeable pavement * Bioswales	196	acres	$4,306.95[1]	$844,162
Other BMPs				
Tree planting	20.5	acres	$84.63	$1,735
Riparian buffers	3	acres	$91.90	$276
Stream restoration	9707	feet	$76.08	$738,509
Shoreline restoration	7000	feet	$28.45	$199,150
Septic Systems				
Septic conversions	103	systems	$526.84	$54,265
TOTAL				$1,843,360

[1] Composite cost using a variety of BMPs

The unit cost data shown in Table 20 is from the Maryland cost profiles that are provided with the Chesapeake Assessment and Scenario Tool (CAST) and include capital, operation and maintenance (O&M), and opportunity costs. Costs are annualized average costs per unit of BMP. Capital and opportunity costs are amortized over the BMP lifespan and added to annual O&M costs for a total annualized cost.

Potential Funding Sources

Given the projected cost to meet the TMDL goals, reliable funding sources for BMP implementation are needed. Worcester County has several sources of funds it can commit to project implementation, including Forest Conservation Act and Critical Area

in-lieu fees as well as CIP funding. The Town of Berlin has a dedicated source of funding through a stormwater utility that generates funds annually for capital projects to help curb flooding, reduce erosion and polluted runoff, and combat property damage. However, grants, loans and other sources of funding will be needed. The Town of Berlin has also been able to secure funding for stormwater projects. The Town received a $165,000 grant from the Federal Emergency Management Agency (FEMA), $800,000 in Community Development Block Grant (CDBG) funds, and a $962,000 grant from the Maryland Department of Natural Resources (DNR) for stormwater improvements in 2014 to address runoff and flooding issues and improve water quality.

Table 21 lists the numerous grant, loan and cost-share programs that can be used for implementation of urban, septic, agricultural and other BMPs.

Table 21. Funding Sources for Coastal Bay BMP Implementation

Program Name	Description
Urban BMP Funding	
319 Nonpoint Source Grant Program	This program is administered by Maryland Department of Environment (MDE) and uses federal funding to provide financial assistance for the implementation of nonpoint source best management practices and program enhancements as a means of controlling the loads of pollutants entering the State's waterways.
National Fish and Wildlife Foundation Five Star and Urban Waters Restoration Grant Program	The program supports projects that address water quality issues in priority watersheds and focuses on the stewardship and restoration of coastal, wetland and riparian ecosystems across the country. The program provides grants, technical support and opportunities for information exchange to enable community-based restoration projects such as streambank erosion, pollution from stormwater runoff, and degraded shorelines caused by development.
Chesapeake Bay Trust Watershed Assistance Grants	The Chesapeake Bay Trust, the Maryland Department of Natural Resources, and the Maryland Department of Environment Watershed Assistance grant program supports design assistance, watershed planning and programmatic development associated with protection and restoration programs and projects that lead to improved water quality in the Maryland Coastal Bays.
Maryland Coastal Bays Program	Grants have been made available to increase public awareness and public involvement in restoring and protecting Maryland's Coastal Bays and its tributaries in accordance with project goals in the Comprehensive Conservation Management Plan for the Coastal Bays. They include improving water quality, restoring and improving fish and wildlife populations and habitat, improving navigation and recreation, and insuring sound development and planning for our community.
Maryland Department of Natural Resources Maryland's Chesapeake & Atlantic Coastal Bays Trust Fund	Funds the most cost-effective, efficient non-point nutrient and sediment reduction project proposals in geographic targeted areas of the State. The Trust Fund encourages multi-year, multi-partner projects that will achieve the greatest reduction per dollar invested.

Table 21. Funding Sources for Coastal Bay BMP Implementation	
Program Name	**Description**
National Fish and Wildlife Foundation Environmental Solutions for Communities	This initiative is supported through a $15 million contribution from Wells Fargo and is designed to support projects that link economic development and community well-being to the stewardship and health of the environment.
Maryland Department of Natural Resources Maryland CoastSmart Communities Grants	CoastSmart Communities Grants (CCG) provides financial assistance to local governments to encourage the incorporation of coastal management issues into local long-term strategic planning. Currently there are two tracks for funding: (Track A - C*oastSmart* Communities) that fund proposals aimed at understanding and planning for coastal hazards; and (Track B – Green Infrastructure Resiliency) for projects to pursue the use of green infrastructure to address localized stormwater flooding resulting from frequent and intense rain events.
Agriculture Funding	
USDA, NRCS, Conservation Program Conservation Reserve Enhancement Program (CREP)	CREP pays farmers paid an annual rental rate to remove environmentally sensitive land from production and implement conservation practices such as planting streamside buffers, creating wetlands and providing wildlife habitat.
Maryland Department of Agriculture Cover Crop Program	Grants are available to help farmers offset seed, labor and equipment costs associated with planting cover crops in the fall.
Maryland Agricultural Water Quality Cost-Share Program (MACS)	MACS provides farmers with grants to cover up to 87.5 percent of the cost to install BMPs on their farms to control soil erosion, manage nutrients, and safeguard water quality in streams, rivers, and the bays. Cover crops planted after the fall harvest to soak up unused fertilizers, streamside buffers of grasses and trees planted to protect waterways from agricultural runoff and sedimentation, and animal waste systems designed to help farmers collect and use manure resources are among 30 BMPs currently eligible for funding.
USDA, NRCS, Conservation Program Environmental Quality Incentives Program (EQIP)	The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land and non-industrial private forestland
USDA, NRCS, Conservation Program Conservation Stewardship Program (CSP)	This program helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns.
USDA, NRCS, Conservation Program Wetland Reserve Enhancement Partnership (WREP)	The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. WREP is a voluntary program through which NRCS signs agreements with partners to leverage resources to carry out high priority wetland protection, restoration and enhancement and to improve wildlife habitat.

Table 21. Funding Sources for Coastal Bay BMP Implementation	
Program Name	**Description**
Septic Funding	
Maryland Department of Environment Water Quality Revolving Loan Fund (WQRLF)	Provides financial assistance and advisory services for a variety of projects to protect or improve the quality of Maryland's rivers, streams, lakes, the Chesapeake Bay and other water resources including low-interest loans to local governments to finance wastewater treatment plant upgrades, nonpoint source projects, and other water quality and public health improvement projects.
Maryland Department of Environment Bay Restoration Fund	The BRF funds upgrades to wastewater treatment plants (WWTP) and onsite disposal systems (OSDS). The *WWTP Fund p*rovides up to 100% in funding to upgrade wastewater treatment plants with enhanced nutrient removal technologies that allow sewage treatment plants to provide a highly advanced level of nutrient removal. The *OSDS Fund* provides up to 100% in grant funding for upgrades of existing systems to best available technology for nitrogen removal or for the marginal cost of using best available technology. Worcester County typically receives about $167,000/year in BRF dollars for septic system enhancement and variable amounts for sewer connections, typically in the neighborhood of $50,000 to $100,000.
Maryland Department of Environment Linked Deposit Program	Provides a source of low-interest financing for certain water quality and drinking water capital projects. Below market interest rates are passed on to borrowers by participating commercial lenders with investment agreements with MDE6.

Technical Assistance

The Coastal Bays Watersheds benefit from being part of the National Estuary Program. This designation has resulted in the development of the Maryland Coastal Bays Program (MCBP). The MCBP is a non-profit collaboration that provides scientific expertise, monitoring capabilities, fundraising skills, public outreach and engagement, and overall watershed planning. The MCBP has developed a comprehensive Conservation Management Plan (CCMP) that acts as a blueprint for restoration of the watershed. Partners include:

- Town of Ocean City
- Town of Berlin
- National Park Service (NPS)
- Worcester County
- U.S. Environmental Protection Agency
- Maryland Department of Natural Resources
- Maryland Department of Agriculture
- Maryland Department of Planning

Worcester County and the partners in the MCBP can act as the primary providers for technical assistance, as the partners provide much of the technical assistance in the State of Maryland.

Section E. Information, Education, and Public Participation

The purpose of this section is to describe an information/education component that enhances public understanding of the project and encourage their participation in selecting, designing, and implementing the NPS management measures that will be implemented. This section of the plan includes the stakeholder outreach strategy including planning for public meetings, listing of identified stakeholders, and education and outreach materials.

Worcester County intends to work closely with Maryland Coastal Bays Program (MCBP) to promote and conduct public outreach regarding the TMDLs and their implementation. Maryland Coastal Bays Program (MCBP) is a U.S. Environmental Protection Agency National Estuary Program (NEP) that exists to protect and conserve the waters and surrounding watershed of Maryland's coastal bays to enhance their ecological values and sustainable use for both present and future generations. As an NEP, MCBP is a part of a non-regulatory program established by Congress that works to improve the waters, habitats and living resources of 28 estuaries across the country. MCBP is charged with using a consensus-building approach by involving community members in the decision-making process that makes it particularly suited to involvement with the education and outreach for the TMDL.

As an NEP, MCBP is guided by Comprehensive Conservation and Management Plan (CCMP, found at http://mdcoastalbays.org/pdf/ccmp.pdf) created and implemented with consensus and assistance from partners and stakeholders, including Worcester County. Other MCBP partners include towns of Ocean City and Berlin, the National Park Service (NPS), the U.S. Environmental Protection Agency (EPA), and the Maryland Departments of Natural Resources, Agriculture and Planning (DNR, MDA, and MDP).

Citizen Outreach and Input

A primary way MCBP's communicates with the public and receives feedback is through various public media and events. MCBP attends meetings, hosts events and participates in citizen forums on many bay related topics. Feedback opportunities are sought through a broad spectrum of major resources groups such as citizens' councils, business, farming, fishing, industry, recreational users and environmental citizens groups.

MCBP used to convene a formal Citizens Advisory Committee to seek comments/ideas on annual work projects, present accomplishments such as mini grant results, and gather input on local issues of concern. The CAC has given way to a less formal but still effective effort to ensure that watershed residents are kept current on relevant issues through more frequent interaction with MCBP.

Identified Stakeholder Groups

In addition to Worcester County, Maryland Coastal Bays Program (MCBP), and the MCBP Citizens Advisory Committee, other civic, environmental, business, university and government stakeholder groups have been identified. These include:

- Town of Ocean City
- Town of Berlin
- Maryland Departments of Environment, Natural Resources, Planning, and Agriculture
- Worcester Soil Conservation District
- National Park Service (Assateague Island National Seashore)
- Assateague Coastal Trust
- Worcester County Farm Bureau
- Assateague Island Alliance
- Lower Shore Land Trust
- Ocean City Surf Club
- Surfrider Ocean City MD Chapter
- Worcester County 4-H
- Master Gardeners (University of Maryland Extension)
- Salisbury Bioenvironmental Science Club
- University of Maryland Eastern Shore
- Choptank Electric
- Delmarva Poultry Industry
- Ocean City Chamber of Commerce
- Ocean City Hotel and Restaurant Association
- Ocean City Green Team
- Ocean Pines Chamber of Commerce
- Homeowners' associations
- Realtor associations

Progress Communication

Each year progress will be reported in MDE's NPS Program Annual Report, which is made available to the public on a website. Other special reports that are generated will be made available to the public.

Communications, Education and Outreach Materials

The following are potential venues for communication, education and outreach regarding TMDL implementation:

- State of the Bays-a comprehensive report published every five years, based upon watershed status and trends, research findings, partner accomplishments and emerging issues of concern. (MCBP)
- Annual Report Card- updates on watershed status and major partner accomplishments. (MCBP)
- Press releases – MCBP and partner's BMP actions, volunteer opportunities, and educational information are promoted via local and regional official representatives, newspapers, television and radio stations, and Chambers of Commerce. Worcester County has a regular column that runs in local newspapers and issues general press releases as well. (MCBP and Worcester County)

- PSAs on local media- MCBP provides educational PSAs through the Town of Ocean City Public Access stations - two television stations and one radio FM station. (MCBP)
- Newsletter- MCBPs monthly digital newsletter is delivered to over 5,800 people and provides educational information and volunteer opportunities including information provided by our partners. (MCBP)
- Publications and brochures:
    - Worcester County has a variety of brochures on topics such as ditch management and maintenance, septic system maintenance, land conservation and restoration, which are displayed in offices, on the website and provided to citizens in various venues (Worcester County)
    - Conservation Choices for Maryland Farmers http://mda.maryland.gov/resource_conservation/counties/ConservationChoices_2012_FINAL%20(1).pdf
    - Maryland Agricultural Water Quality Cost Share Program http://mda.maryland.gov/resource_conservation/Documents/RevisedMACSbochure.pdf
    - Homeowner's Guide to the Coastal Bays- This publication provides information on how individuals impact water quality, including household pollutants, pet waste, septic systems and BMPs. (MCBP)
    - The Scoop on Dog Poop brochure (MCBP)
    - Bay Friendly Program Brochure (MCBP)

Best Management Practices Sites Used for Education

There are several properties in the Coastal Bays watershed that are publicly accessible that contain examples of Best Management Practices, including, in many cases, interpretive signage or other materials. MCBP manages some of these properties and holds educational programs for elementary, middle and high school students and well as university students and researchers on site. In addition, we utilize volunteers at various restoration opportunities that involve education.

- Bishopville Dam Removal and Fish Passage (Bishopville, MD)- This innovative design, the first of its kind in the state, was created to allow the pond to be retained while letting fish move upstream. The new design replaced the Dam with a series of pools, runs and weirs to create a more natural waterway with improved ecosystem functions, including fish passage and nutrient pollution reduction. As a result, this project opened up 7 miles of upstream spawning habitat.

- Lizard Hill Wetlands Restoration (Bishopville, MD)- The 37-acre site, with approximately 450 ft. of shoreline is owned by the Town of Ocean City. It was previously used as a municipal and rubble landfill from 1954 – 1980. The area has since been cleaned of toxic materials and was cleared by MDE in 2007 for public use, which is limited to the designated area. This area has been planted as a shoreline restoration site.

- Ilia Fehrer Nature Preserve (Berlin, MD) - This forested property on Ayres Creek is owned by Worcester County and managed by the MCBP. It was previously managed for timber production and is currently being restored to native woodland. Eventually walking and riding trails will be accessible to the public.

- Grey's Creek Nature Park (Bishopville, MD) - This forested property on Grey's Creek and Assawoman Bay, that also contains extensive tidal marsh, is also being restored to native woodland and will be available to the public for passive access. A portion of shoreline has been converted from bulkhead to a living shoreline. This property is also owned by Worcester County and managed by the MCBP.

- Various boat ramps - Public Landing and Gum Point boat ramp contain examples of BMPs.

Citizen Participation

Volunteers

In FY 2019 (September 2018 – October 2019), approximately 1,000 volunteers completed more than 4,500 hours including plantings, trash cleanups, oyster gardening, and water quality monitoring.

Volunteer opportunities targeting BMPs as well as nutrient and pollutant reduction will continue, especially as relates to CE 3.2.5; MCBP will develop, implement and expand public involvement and education projects or programs based on CCMP priorities, public interest, pollution prevention, resource availability, and other opportunities that arise. Priority goals for MCBP include decreasing nutrient loading throughout the watershed and implementing strategies to meet the TMDL reductions.

MCBP also coordinates Septic 101 presentations through the University of Maryland Extension Office.

Private Landowners

Worcester County will conduct outreach to landowners and/or stakeholders who have a direct stake in the implementation for areas where significant BMPs are anticipated. Input from these individuals will assist in assessing the feasibility of the proposed implementation.

Worcester County and MCBP will work with the Soil Conservation District and Natural Resources Conservation Service to make individual contact with farm owners and operators regarding agricultural BMP implementation as determined appropriate. The Lower Shore Land Trust may also be involved as relevant.

Public Meeting(s)

Worcester County has worked to get organizational stakeholders involved early in the planning stages of the watershed plan. A meeting held December 9th, 2015 involved attendees from the Town of Ocean City, Worcester County, Town of Berlin, and Maryland Coastal Bays Program (MCBP). A planning meeting on March 17, 2016 was

attended by representatives of Worcester County, Center for Watershed Projection, Worcester Soil Conservation District, Town of Ocean City, MCBP, University of Maryland Sea Grant Extension, EA Engineering/Town of Berlin, and the Maryland Departments of Planning (MDP), Agriculture (MDA), Natural Resources (DNR), and Environment (MDE).

The final draft of the plan will be available on the county website and linked from Maryland Coastal Bays Program's website and other websites or outreach media (such as newsletters) as appropriate. Worcester County will hold a public meeting or meetings to provide information about the drafted plan and seek feedback from citizens. The meetings will be advertised via the local news media. Input from the meetings will be considered in finalizing the plan (or individual watershed plans), and the final, adopted plan will also be available on the county's website and other local information sources.

Sources of information use to develop this section include:

EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters
https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/handbook-developing-watershed-plans-restore-and-protect

Worcester County, MD Volunteer Organizations - Environmental
https://www.co.worcester.md.us/departments/hr/volunteer/orgs?title=&field_city_value=&field_impact_area_tid%5B%5D=27

Sections F/G. Schedule and Milestones

Limited information is available on specific candidate locations for the BMPs proposed in this plan for Assawoman Bay. MCBP has obtained grant funding from Maryland DNR to conduct a watershed targeting assessment for the Assawoman Bay and Isle of Wight watersheds to identify, evaluate and prioritize locations for stormwater retrofits, agricultural BMPs and stream/shoreline BMPs. This work will be completed in 2020 and the results will be used to refine the proposed suite of BMPs and develop a more detailed implementation schedule. Implementation efforts will focus primarily on Assawoman Bay, followed by Isle of Wight, Newport, and Chincoteague. The phased approach used for Assawoman Bay will be adopted for the remaining watersheds as well. Table 22 presents a schedule for achieving the measurable goals identified for this phased approach.

Table 22. Measurable Goals for the Maryland Coastal Bays Watershed Plan

Component	Measurable Goals		
	Short Term Phase (2020-2024)	Mid-Term Phase (2025-2029)	Long Term Phase (2030-2040)
Watershed assessment and plan refinement	Assawoman Bay/Isle of Wight Bay assessment completed	Newport Bay and Chincoteague Bay assessments completed	N/A
Project implementation	103 septic conversions; 86.5 acres with SCWQMPs, 54.26 acres with core NMPs; and three demonstration BMPs in Assawoman Bay	Continue work on implementation in Assawoman Bay; begin work on implementation in Isle of Wight Bay	Complete implementation in Assawoman Bay; continue work on implementation in Isle of Wight Bay; begin work on implementation in Newport Bay and Chincoteague Bay
Load reductions	25% of load reductions achieved in Assawoman Bay	75% of load reductions achieved in Assawoman Bay; 25% of load reductions achieved in Isle of Wight Bay	100% of load reductions achieved in Assawoman Bay, Isle of Wight Bay; Newport bay and Chincoteague Bay
Monitoring	Monitoring efforts will begin to show trends toward improvements	Monitoring efforts will show trends toward improvement	
Documentation of results	County/MCBP will develop spreadsheet tool for tracking results	County/MCBP will implement spreadsheet tool for tracking and reporting of results	

One of the most important measurable milestones is evidence of annual increases in BMP implementation, since BMPs decrease nutrient loads. In addition to tracking the numbers of BMPs, the spreadsheet tool for tracking BMP implementation described in Section H will also make it possible to estimate load reductions. The rate of annual increase should be enough to reach compliance with TMDL allocations.

Another key set of measurable milestones includes chemical, physical and biological indicators of progress, including formal water quality standards as well as informal measures. The Maryland Coastal Bays Program conducts monitoring and tracks the progress of implementation of the Comprehensive Conservation and Management Plan. This includes having compliance standards for indicators and using the results of indicator monitoring to alert program participants to the latest trends and emerging environmental problems. Activities to measure chemical, physical and biological indicators of progress are described further in Section I.

In addition to the above milestones, the following ongoing, annual milestones for the activities proposed in this plan have been identified:

- Continue work to meet the Worcester County Water Resources Element goal of an additional 240 septic to sewer connections by 2025.
- Pursue funds from the Bay Restoration Fund for septic upgrades and hook ups to address additional potential septic to sewer connection projects that have already been identified by the County.
- Pursue grant funding for detailed watershed assessment of BMP opportunities in other priority watersheds.
- Coordinate and regularly communicate with MDA to secure funding for agricultural BMPs on an ongoing basis and track farmer installed and non-cost shared BMPs.
- Seek to maintain and increase funding for staff while seeking additional staff and resources using the 319 program and the National Estuary Program status of the Coastal Bays.
- Educate the public to modify their stormwater inducing behaviors, e.g. move downspout outlets from paved areas to grassed areas, in cooperation with the MCBP and jurisdictions in other states.
- Mitigate any future load increases by maximizing the use of Environmental Site Design on all new develop as per the Zoning and Subdivision Control Article.
- Continue and upgrade as necessary water quality monitoring efforts.
- Seek funding from sources such as Chesapeake Bay Trust and the Chesapeake and Atlantic Coastal Bays Trust Fund to implement urban and other BMPs.

While this plan does not address the a-i elements for the portion of the Assawoman Bay watershed in Delaware, there is a TMDL for the Delaware Inland Bays watershed including that portion draining to the Assawoman Bay. There are also pollution control strategies (PCSs) that are in state regulation in Delaware offering reasonable assurance that the milestones developed for the watershed can be identified and significant progress achieved. While the County would not be "tracking" the data for BMPs in Delaware, that information will be coordinated with Delaware and utilized to inform the "plan" in Maryland. This coordination would be explored through the partnership that exists with the Delaware Center for the Inland Bays and Maryland Coastal Bays Programs which are both part of the National Estuary Program.

Delaware watershed data, their programmatic efforts, and an established TMDL and a-i plan for the Little Assawoman watershed in the Inland Bays are in place. Maryland Coastal Bays and Delaware Inland Bays both have compatible Comprehensive

Conservation Management Plans and suites of BMPs that are similar. There will be close coordination when the program develops two-year milestones to take the entire watershed into consideration. Both programs operate under the National Estuary Program umbrella, so it makes sense to coordinate with each other at that level. A recent letter (July 2019) submitted to Maryland MDE from the Delaware Non-Point Source Program indicates that Delaware will place a priority on the development of a management plan for the Little Assawoman Watershed within 12-18 months and will continue to work with MDE and MCBP to integrate relevant data.

Section H. Load Reduction Evaluation Criteria

Overall, success of this watershed plan will be determined by the extent that the Maryland water quality standards for nutrients and sediment are met in previously impaired stream segments of the Maryland Coastal Bays watersheds. Water quality monitoring to document progress towards attaining water quality standards is described in Section I of this plan. Since there is often a lag time between BMP implementation and measurable water quality improvements, interim measures of success will include the extent of BMP implementation and estimates of the associated pollutant load reductions.

The County and MCBP will develop a spreadsheet tool for tracking BMP implementation that uses the pollutant load reduction crediting assumptions in this plan (see Appendix C) to estimate the associated pollutant load reductions. The tool will include two major components: 1) a BMP implementation tracking component for all planned agricultural, urban, septic and other BMPs in the TMDL watersheds, and 2) a pollutant load reduction calculation component that quantifies pollutant load reductions relative to the required reductions.

Tracking the installation of a large group of restoration projects led by numerous partners within a watershed can be a complex enterprise. BMP data collected by different watershed stakeholders is often provided in a variety of formats and may not contain the necessary information to estimate pollutant load reductions. The spreadsheet tool will provide a consistent method of reporting that includes all the necessary data inputs for estimating pollutant load reductions and will be developed with input from watershed stakeholders. Coordinating with key stakeholders such as MDA and the Town of Ocean City will ensure that these partners are engaged in the reporting process and that the spreadsheet tool ties in with existing data collection and reporting procedures so that reporting is not burdensome for these entities. The County and MCBP will also devise a process for housing and collecting data inputs for the spreadsheet tool so that progress can be reported on a regular basis and includes efforts by agencies, non-profits, universities and other groups involved in BMP implementation.

The following process is recommended for determining if the plan needs to be revised:

> After the first 2-5 years, BMP implementation tracking information can be compared with BMP implementation goals to determine when the goal has been achieved. If during this comparison it is shown that interim goals are not being met, a revision of the plan may be necessary. Because of groundwater lag times, and the lag time for riparian buffers to mature, ultimate water quality improvements will not be observed until several years after the control measures are fully implemented. USGS information regarding groundwater lag times should be consulted to estimate the groundwater lag time.
>
> Tidal monitoring will account for ground water lag-times and climatic variability. This information will be compared to the tidal water quality standards.

If a new TMDL with new load limits is established, any changes in the reductions needed would require the Plan to be revised.

Criteria for updating the load reduction analysis include:

If the water quality does not meet standards, field validation of BMP implementation should be undertaken. If this BMP validation process verifies that the BMPs have been fully implemented, then the NPS reduction plan should be revised. This should include additional source assessments to ensure no significant sources of nutrients have been overlooked.

If the Chesapeake Bay Program research results in a change of BMP reduction effectiveness, then the NPS reduction analysis should be updated to reflect those changes.

If new information becomes available that demonstrates the water quality standards need to be revised, then that information should be documented and provided to MDE's Science Services Administration. Several specific criteria are:

If water quality standards change, then the TMDL should be considered for revision.
If a significant error is found in the TMDL analysis, then it should be considered for revision.
If NPS reduction analyses indicate it is infeasible to achieve the water quality standards, and it is infeasible to reduce point sources, then the validity of the TMDL analysis should be assessed. If the analysis is validated, the water quality standards should be revisited.

Section I. Monitoring Component

EPA has broad goals for monitoring to occur at appropriate sites, collecting appropriate parameters, at an appropriate frequency so that real-world implementation progress can be measured over time. For a plan with TMDL goals, monitoring outputs of at least two general types should be included:

1. Tracking and reporting the management measures that are implemented and the estimated pollutant load reductions achieved, and

2. Water quality monitoring for the TMDL parameters in each watershed and/or subwatershed that has a TMDL.

Water quality conditions, species abundance and richness, and habitat quality are routinely monitored in the Maryland Coastal Bays watershed. A deliberate and well-planned monitoring scheme not only provides a compendium of programs and results but also can be mined for changes over time and space (i.e. are we losing or gaining

wetland acres). The Comprehensive Conservation and Management Plan for Maryland's Coastal Bays (CCMP) outlines monitoring actions for the watershed. There are forty-four monitoring action items in the CCMP. Of these forty-four actions, thirty-one of them are currently being addressed. The monitoring actions that have been initiated are presented in Table 23. Monitoring actions that have not started yet but are pending are presented in Table 24.

Table 23. Monitoring Action Items in the CCMP That Have Been Initiated

Action Item	Category	Lead Partner	Outputs (deliverables)	Outcomes (knowledge & behavior)
WQ 3.1.5 DNR will compile the results and determine trends in air pollution inputs from the National Atmospheric Deposition Program monitoring site on Assateague Island. Disseminate information via the "State of the Bay" report every five years.	Research & Ecosystem Assessment	DNR	Air pollution data analysis and trends	Data provides feedback on air pollution reduction policies and programs.
FW 1.1.2 DNR will continue to provide data needed for stock assessments via the Coastal Bays Fisheries Investigation Surveys. Data include finfish, macroalgae, offshore trawl data, seafood dealer port sampling, volunteer angler summer flounder surveys, etc.).	Within Existing Resources	DNR	Annual updates on stock status	Assessment, monitoring and reporting on the status of fishery resources and impacts on them.
FW 1.1.3 DNR will provide annual updates on the stock status of key fish species in relationship to established targets and thresholds.	Research & Ecosystem Assessment	DNR	Annual trends & status reports that relate to thresholds and targets from a designated baseline year(s).	Knowledge to support and predict sustainable harvests.
FW 1.2.1 DNR will annually complete a survey of the shellfish resources within Maryland's Coastal Bays.	Within Existing Resources	DNR	Shellfish surveys	Assessment, monitoring & reporting on Impact
FW 1.4.5 DNR will continue to work with recreational and commercial stakeholders to ensure that services provided to each sector, (such as monitoring stock assessments, harvest monitoring and outreach, etc.,) are recovered from each sector.	Within Existing Resources	DNR	Balanced Fisheries budget	Improved understanding of the function of the Fisheries Service.
FW 1.5.7 DNR will provide information regarding Highly Migratory Marine Species (population estimates, sustainable harvest, economic value of local tournaments, protection efforts).	Within Existing Resources	DNR	Linkages between bay and ocean ecosystems	Public awareness. Tie near-shore and off-shore data together for adaptive management.
FW 3.1.2 DNR will characterize the health of streams within the Coastal Bays watershed.	Within Existing Resources	DNR	Coastal Bays Streams Characterizatio n Report, data	Status of local streams, StreamStat,

Table 23. Monitoring Action Items in the CCMP That Have Been Initiated				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
			for Terrestrial Monitoring Plan	State of the Coastal Bays.
FW 4.1.3 DNR (Coastal & Chesapeake Services) and MARCO, the Mid-Atlantic Regional Council for the Ocean, will characterize critical offshore habitat, migratory pathways, biological populations and ecological processes.	Research & Ecosystem Assessment	DNR	Data posted to the MARCO Portal and a characterizatio n report for managers and the public.	Information for long term ecosystem-based management.
WQ 1.6.6 MCBP STAC will investigate changes to water quality parameters (nutrients, sediment, harmful algal blooms, etc.,) that affect the Coastal Bays through inlet flushing.	Research & Ecosystem Assessment	MCBP	Analysis and reports of water quality exchanges with the ocean	Recommendati ons for monitoring to better understand ecosystem linkages.
FW 1.5.1 DNR and MCBP will protect horseshoe crab populations by promoting the protection of bay beaches and other bottom habitats and promote volunteer monitoring of spawning populations throughout the coastal bays.	Within Existing Resources	MCBP	Annual spawning survey report	Protection of beach habitats, public stewardship & involvement, HSC management plan data.
FW 1.5.3 MCBP will continue terrapin counts and promote the use of cull rings and Turtle Exclusion Devices (TEDs) on all recreational pots. Data will be shared with the Terrapin Work Group.	Research & Ecosystem Assessment	MCBP	Terrapin counts & promotion of excluders for retailers/public	Increased public participation & stewardship, improved population estimates.
FW 1.5.8 MCBP will continue to assist the Marine Mammal Stranding Program, the National Aquarium, DNR and other groups with local educational and volunteer efforts (ex. seal sightings, dolphin counts, Coastal Clean-ups, etc.)	Education & Outreach	MCBP	Data and education & outreach products	Coordination with partner efforts, shared data. Increased public stewardship & volunteer opportunities.
FW 2.1.2 MCBP, DNR, MDE and NPS will ground-truth SAV beds during routine monitoring or other on-the-water efforts.	Within Existing Resources	MCBP	Acres & extent of sea grasses	Resource sharing & coordination.
FW 2.2.2 MCBP will continue to assist DNR with near shore species and habitat monitoring (including colonial nesting birds, horseshoe crabs, terrapins, shorebirds, sea turtles, waterfowl, marsh birds, mosquito ditch restoration, vegetation, etc.)	Within Existing Resources	MCBP	Biometric data	Monitoring assistance.
FW 3.1.1 MCBP will facilitate discussions with USGS and MGS to fully fund the watershed's two stream gauges at Birch Branch and Bassett Creek. The long-	Policy Issue	MCBP	MOU to fully fund stream gauge stations and/or a	Decreased nutrient and bacteria levels to meet TMDL

Table 23. Monitoring Action Items in the CCMP That Have Been Initiated				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
term data sets generated by these gauges are necessary for determining water and nutrient budgets as well as supporting project evaluation and ecosystem changes.			commitment to secure funding	allocations and/or state water quality criteria. Ecosystem response evaluation for watershed changes due to projects and climate.
FW 3.1.6 MCBP will continue annual stream surveys for water quality and rapid assessment of habitat conditions. Special consideration will be given to biometrics and chemistry spectrums in brackish, tannic and freshwater habitats.	Research & Ecosystem Assessment	MCBP	Data for state and local consideration	Stream health monitoring.
FW 3.3.5 MCBP will promote citizen participation in the Audubon Christmas Bird Count, eBird compilations, Backyard Bird Count, Project Feeder Watch and Breeding Bird Surveys.	Within Existing Resources	MCBP	Species counts	Citizen involvement.
FW 3.3.6 MCBP will continue to train volunteers and promote annual herpetology surveys for field data compilation, targeted conservation and community stewardship.	Within Existing Resources	MCBP	Species counts for Herp Atlas	Citizen involvement.
FW 3.3.9 Where appropriate, MCBP will coordinate volunteer efforts to assist with tree planting, non-native species removal, buffer planting and monitoring of projects for long term success evaluation.	Within Existing Resources	MCBP	Citizen involvement	Evaluation of habitat improvement success.
FW 4.1.2 MCBP and partners will collect, manage and share GIS data layers that are publicly available for the watershed.	Within Existing Resources	MCBP	Data layer inventory	Spatially related decision making.
FW 4.2.1 MCBP will compile all CCMP actions that are categorized as Research and Ecosystem Monitoring for STAC review and input. Identify roles and responsibilities for partners and a research schedule.	Within Existing Resources	MCBP	CCMP related STAC Science Agenda	Process for identifying research needs.
FW 4.2.4 MCBP will produce and distribute Report Cards that provide updates on watershed status and major partner accomplishments.	Education & Outreach	MCBP	Report Cards on the health of Coastal Bays	Improve community feedback.
FW 4.2.5 MCBP STAC and partners will publish a comprehensive State of the Bays report every five years. The reports are based upon watershed status and trends, research findings, partner accomplishments and emerging issues of concern.	Within Existing Resources	MCBP	State of the Bays Report	Record and review changes over time.

Table 23. Monitoring Action Items in the CCMP That Have Been Initiated				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
CE 2.2.11 MCBP STAC will track changes in the ecosystem from climate change through monitoring chemical, ecological and spatial trends.	Research & Ecosystem Assessment	MCBP	Indicator species, chemical parameter and range of physical changes in the ecosystem	Data and trends will be useful for predictions and projections of future conditions. Use information for adaptive management.
WQ 2.1.5 NPS-ASIS will continue to pursue saltmarsh restoration and monitoring projects such as ditch plugging and filling, marsh elevation studies, and nekton monitoring to restore natural conditions and document long term changes within salt marshes along Assateague Island.	Within Existing Resources	NPS	Summary of natural salt marsh status and trends, including monitoring of PCBs, PAHs and DDT	Restore saltmarsh hydrology and ecological function, build resiliency, document long-term change.
FW 3.3.2 NPS will continue to monitor barrier island threatened and endangered species including piping plover (*Charadrius melodus*), seabeach amaranth (*Amaranthus pumilus*), sea turtles and tiger beetles (Cicindelinae).	Research & Ecosystem Assessment	NPS	Information and annual reports	Conservation and population trends of threatened and endangered species.
FW 4.2.3 NPS, DNR and MCBP will continue to collaborate and maintain bay water quality monitoring programs to assess nutrient loading and living resource responses.	Research & Ecosystem Assessment	NPS	Spatially related estuarine water quality data	Ecosystem stressors and biotic impacts. Leveraging of limited resources to prevent duplication of effort.
WQ 1.2.3 USGS and NPS will investigate funding resources to continue monitoring nutrient inputs to the Coastal Bays from groundwater. They will study variations in nitrogen concentrations and residence times along surficial groundwater flow paths. This work will provide information on the effects of land use on water quality and provide a basis for planning for conservation areas.	Research & Ecosystem Assessment	USGS	Groundwater monitoring plan. Update the 1955 Mines & Water Resources Bulletin referenced in WC Water Resources Element	Assess flow volumes, groundwater age, and percentage nutrient contribution by land use sector.
WQ 1.1.6 WC and MDE will work cooperatively on incentives or other programs to encourage the use of Best Available Technology for enhanced nitrogen removing septic systems with appropriate monitoring and maintenance schedules.	Education & Outreach	WC	Funding or other incentives that may be leveraged for enhanced nutrient removing septic systems	Funding value leveraged over time, net increase in best available technology systems versus the net decrease in

Table 23. Monitoring Action Items in the CCMP That Have Been Initiated				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
				nutrient pollution.
FW 3.3.1 DNR Wildlife & Heritage Service will characterize the terrestrial areas within the Coastal Bays watershed using existing indicators, monitoring data and game harvest information. Data will include colonial water bird nesting sites, bird migratory stopover areas, presence & abundance of rare & endangered species, location & productivity of terrapin nesting beaches and natural communities.	Research & Ecosystem Assessment	DNR	Data for Coastal Bays Terrestrial Monitoring Plan	Wildlife characterizatio n. Project areas and priorities change over time in sensitive habitats and species.
FW 4.1.1 MCBP STAC will hold workshops to formally adopt the Coastal Bays Terrestrial Monitoring Plan. The plan will consist of a 3-tiered approach: landscape/GIS assessment, rapid site assessment and field surveys. A monitoring frequency schedule, a list of indicators and responsible parties will be produced. Finding will be incorporated into the five-year Coastal Bays Ecosystem Health Assessment Reports.	Research & Ecosystem Assessment	MCBP	Detailed offerings of enhancement techniques	Project areas and priorities.
FW 3.2.2 DNR will use current high-resolution imagery to assess forest and tree cover.	Research & Ecosystem Assessment	DNR	Mapping exercise	Data on change in percent forest cover over time.
CE 3.1.4 DNR will explore the feasibility and potential of expanding precipitation chemistry parameters at the National Atmospheric Deposition site at Assateague State Park to include greenhouse gases. Consider the utility of collecting data for carbon dioxide, ozone, particulates, nitrous oxides, methane, fluorinated gases, etc. Assateague NPS will continue to operate the NADP site which is part of the partnership between NPS, DNR and Worcester County.	Research & Ecosystem Assessment	DNR	Status and trends of atmospheric deposition since 2000. Expanded monitoring parameters to measure change over time.	Reduction in greenhouse gases (25% by 2020 GGRP).

Table 24. Monitoring Action Items in the CCMP That are Pending				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
FW 3.2.1 DNR (ad hoc forest committee) will use the most current GIS layer of Forest Interior Dwelling Species (FIDS) to determine forested parcels that are 50 acres or more in size, with at least 10 acres of FIDs habitat. Calculate canopy	Research & Ecosystem Assessment	DNR	Data for Terrestrial Monitoring Plan, FIDS layer	Multiagency coordination.

Table 24. Monitoring Action Items in the CCMP That are Pending				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
cover, composition and stream widths through field surveys.				
FW 3.3.4 USDOI and DNR will compile information for forest interior songbirds, neotropical migrants, colonial water birds, waterfowl and shorebirds in the watershed from existing databases and produce a status and trends report as well as habitat improvement recommendations.	Research & Ecosystem Assessment	DNR	Status & Trends report for birds	Change in acres designated for habitat services.
WQ 1.6.5 EPA will provide environmental data and analyses collected offshore to inform coastal researchers and local decision-makers about nutrient loading dynamics, particularly from ocean wastewater outfalls.	Within Existing Resources	EPA	Ecosystem data & reports	Integration of off-shore federally collected ecosystem data.
WQ 1.1.4 MCBP and WC will develop a program to ensure regular pump-outs and maintenance of residential septic systems. Septic haulers will provide electronic reporting on pumping activity for tracking and monitoring purposes as well as certifications that septic systems are functioning properly. WC will mail notices to homeowners & use the septic tracking system to monitor the volume of septage treated. MCBP will develop educational materials linking septic nutrients to watershed eutrophication.	Education & Outreach	MCBP	Pump out notices and other educational materials that explain the role of septics in rural areas and their potential for pollution	Increased number of pump outs.
WQ 3.1.2 MCBP will ask EPA (Office of Water) to assist Program efforts by conducting a Recovery Potential Screening for the Coastal Bays. The screening process will be based on ecological, stressor and social indicators, and measured by landscape datasets, impaired water attributes and monitoring data to prioritize restoration projects.	Research & Ecosystem Assessment	MCBP	Recovery Potential Screening Report for the Coastal Bays	Priority planning for conservation or restoration projects.
FW 2.2.8 MCBP will work with EPA, NOAA, ACOE and UMCES to develop "user-friendly" indicators of storm severity (ex. hours/days above predicted high tide, king tide affects).	Within Existing Resources	MCBP	Storm severity indicators	Coastal Resiliency information.
FW 3.1.7 MCBP and MCC-Assateague will participate in Stream Wader collection opportunities as they become available through DNR.	Research & Ecosystem Assessment	MCBP	Data for state and local consideration	Stream health monitoring and volunteer participation.
FW 2.3.6 MDE will review known local wetland gains (mitigation & creation) and net loss (permitting) since 2000. Track tidal and non-tidal impacts & gains and maintain a list of previous and future restoration sites.	Within Existing Resources	MDE	Local tracking of ongoing net loss or gain, compare impact data to MDE	Indicator for the 10,000 acre goal attainment.

Table 24. Monitoring Action Items in the CCMP That are Pending				
Action Item	**Category**	**Lead Partner**	**Outputs (deliverables)**	**Outcomes (knowledge & behavior)**
			authorization records	
FW 2.3.7 MDE will annually monitor and report on the success of wetland mitigation sites and compile the most current wetland inventory for the Coastal Bays. The inventory will include voluntary and mitigated wetland gains and losses over time.	Research & Ecosystem Assessment	MDE	Ecological monitoring, updated wetland inventory	Return on investment for mitigation dollars. BMP cost estimates will be used for project planning.
WQ 1.2.4 NPS will identify baseline groundwater conditions and develop a protocol to monitor and assess changes in the island's ground water resources related to climate variability.	Research & Ecosystem Assessment	NPS	Status and trends of Assateague Island groundwater resources	Ecosystem prediction and response.
WQ 2.1.7 WC will continue to hold hazardous waste disposal programs for farm and residential hazardous materials, including pesticides and fouled gasoline.	Within Existing Resources	WC	Indicator tracking: Volume & types of waste collected	Program evaluation, fish tissue & sediment monitoring for toxins, pharmaceuticals, and household products.

Comments from EPA on the previous version of this plan noted that Table 23 and Table 24 represented partner obligations but lacked specific detail to satisfy the full requirements of the EPA's monitoring criteria for a-i plans (USEPA, 2008). The detail specifically requested is provided by Table 25, which identifies who is conducting the monitoring, what constituents are being monitored and the frequency of monitoring.

Table 25. Water Quality Monitoring Efforts in the Coastal Bays				
Organization	**Analysis**	**Sites**	**Locations**	**Sampling Dates**
Assateague Coastal Trust	Dissolved Oxygen (DO), pH, temp, salinity, water clarity; bacteria - Enterococci	7	Ayers Creek, Isle of Wight Bay, St. Martin River, Turville Creek, Herring Creek,	May - September; Weekly Sample
Assateague Island National Seashore	DO, pH, chlor *a*, turbidity, temp, salinity	3	Chincoteague, Sinepuxent bays	Continuous Monitor, March - November, Every 15 minutes
Assateague Island National Seashore	Temp, water depth, DO, conductivity, pH, secchi depth, wind speed and direction, light attenuation,	18	Sinepuxent, Newport, Chincoteague (MD/VA) bays	Yearlong; Monthly

Table 25. Water Quality Monitoring Efforts in the Coastal Bays				
Organization	**Analysis**	**Sites**	**Locations**	**Sampling Dates**
	nutrients, chlor *a*, *b*, *c*, TSS, pheo *a*			
Department of Natural Resources	DO, water temp, pH, water clarity, salinity,	15	St. Martin River, Assawoman, , Isle of Wight, Sinepuxent, Newport, Chincoteague bays	Yearlong; Monthly
Department of Natural Resources	DO, temp, pH, water clarity, salinity, turbidity, chlor *a*	4	St. Martin River, Chincoteague, Newport, Assawoman bays	Continuous Monitor
Maryland Coastal Bays Program	Nutrients, DO, pH, temp, salinity, chlor *a*	23	St. Martin River, Assawoman, , Isle of Wight, Sinepuxent, Newport, and Chincoteague bays	Yearlong; Monthly
Maryland Coastal Bays Program Spring Sampling	Nutrients, DO, chlor *a*	61	Assawoman, St. Martin, Isle of Wight, Sinepuxent, Newport, Chincoteague bays	Annually, April
NOAA	Water & air temp, wind direction and speed, water level, barometric pressure	1	Sinepuxent Bay	Continuous Monitor
Worcester County	bacteria-Enterococci	5	Sinepuxent Bay, Ocean side of Ocean City and Assateague, Public Landing	May-September; Monday, Tuesday, Wednesday

The water quality monitoring efforts within the Coastal Bays watershed are conducted by six organizations. Additional monitoring efforts include submerged aquatic vegetation (SAV) and brown tide monitoring. Through a partnership with Maryland Coastal Bays Program (MCBP), Virginia Institute of Marine Science (VIMS), and the Department of Natural Resources (DNR), aerial surveys are done annually to determine the presence of SAV. MCBP provides additional field monitoring to verify the accuracy of the data. DNR maintains the database for this information, which is used in the State of the Bays and annual Coastal Bays Report Card. MCBP and DNR, in partnership with Stony Brook University, monitor for brown tides, a type of harmful algal bloom (HAB), within the Coastal Bays.

Additional concerns of EPA in the first draft of this plan inquired as to how the monitoring being done will show trends in water quality so plan implementers can show that they are meeting goals. Since the fall of 2017, Worcester County, MCBP and MD DNR have been engaged in conversations to inform both EPA and MDE that specific monitoring is taking place to demonstrate adequate sampling frequency, constituencies measured, where monitoring is taking place, and that monitoring is taking place at the watershed scale.

MCBP works with partners in the Science Technical Advisory Committee (STAC) chaired by Dr. William Dennison at University of Maryland's Center for Environmental Science, to ensure that monitoring data for both biological and water quality indicators are synthesized into a comprehensive watershed health score for each sub watershed in Maryland's Coastal Bays. This data is available through MD DNR and UMCES web portals and is updated annually.

https://ecoreportcard.org/report-cards/maryland-coastal-bays/health/

The recent 2017 report card for the Coastal Bays has demonstrated trends in water quality in the Assawoman Bay sufficient to provide for a change in the overall composite score for the watershed from 49.7 in 2015, 56.4 in 2016 to 55.3 in 2017. Scores for total phosphorus and chlorophyll-a had improved substantially accounting for the improvement from 2015 to 2016 but increases in total nitrogen and decreases in hard clam density from 2016 to 2017 resulted in a decrease in the total health index for Assawoman Bay (Appendix D).

DNR has recently provided a detailed map of monitoring stations in the Assawoman Bay as well as other Bays at the sub-watershed scale (Appendix E). DNR has also provided a comprehensive spreadsheet of all monitoring data that should prove sufficient documentation to satisfy that the monitoring program in the Assawoman Bay is more than adequate (Appendix F).

MCBP has an EPA approved Quality Management Plan (QMP) (Appendix G) for all operations related to data collection within the program. There is also a Quality Assurance Project Plan (QAPP).

EPA indicated to Worcester County and MCBP in March of 2018 that the data and monitoring points in the "ecoreport" card will be very helpful implementing the plan. MCBP clarified in the plan how those data are collected annually and incorporated into the interactive website.

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