

# State of Delaware Ambient Surface Water Quality Monitoring Program FY 2020 (July 1, 2019-June 30, 2020)

---



**Department of Natural Resources and Environmental Control**

**Division of Watershed Stewardship**

**Watershed Assessment and Management Section**

**June 17, 2019**

## Table of Contents

Executive Summary .....	3
Ambient Surface Water Quality Monitoring Program - FY 2020 .....	5
The General Assessment Monitoring Network (GAMN) .....	9
Chesapeake Bay Non-tidal Monitoring .....	12
Continuous Water Quality Monitoring.....	13
Biological Assessment Monitoring .....	15
Toxics in Biota Monitoring .....	15
Toxics in Sediment Monitoring.....	15
Monitoring under the Watershed Approach to Toxics Assessment and Restoration (WATAR) Plan.....	15
Field and Laboratory Procedures .....	18
Quality Assurance, Documentation, Data Usage and Reporting.....	18

## List of Tables

Table 1 - Station Locations, Descriptions, Parameters, and Sampling Frequency .....	19
Table 2 - Water Quality Parameters to be monitored at all stations - FY 2020.....	25
Table 3 - Metal Parameters.....	26
Table 4 - Additional parameters needed for freshwater stations with Biotic Ligand Model Sampling for Copper (BLM Parameters) .....	27

## List of Figures

Figure 1 – State of Delaware Watersheds and Basins .....	7
Figure 2 - Delaware's Surface Water Quality Monitoring Sites .....	10
Figure 3 - Delaware's Rotating Priority Monitoring Basins .....	11
Figure 4 - Delaware's Non-tidal Monitoring Sites.....	12
Figure 5 - Delaware's Continuous Monitoring Sites.....	14
Figure 6 - WATAR Sampling sites.....	17

## Executive Summary

Delaware's Surface Water Quality Monitoring Program for Fiscal Year 2020 as conducted by Delaware Department of Natural Resources and Environmental Control (DNREC) is described in this report. Elements of Delaware's monitoring program include: General Assessment Monitoring, Chesapeake Non-tidal Monitoring, Continuous Water Quality Monitoring, Biological Assessment Monitoring, Toxics in Biota Monitoring, Toxics in Sediment Monitoring, and Monitoring under the Watershed Approach to Toxics Assessment and Restoration (WATAR) Plan. Each element of the monitoring program is briefly described below:

- Delaware maintains a General Assessment Monitoring Network (GAMN). GAMN stations are considered long term stations whose data is used to perform long term status and trend assessments of water quality conditions of the State's surface waters and support compilation of Watershed Assessment Reports as mandated by the Clean Water Act under section 305(b). In addition, the data is used to calculate annual nutrients and other pollutants loads and to track progress toward achieving the targets established by the Total Maximum Daily Loads (TMDLs) for many of the watersheds of the State. Furthermore, the data will be used to identify effect of land use on N and P concentrations. The State's GAMN currently has a total of 139 stations. 23 of the monitoring stations are considered category 1 stations (C1) and are monitored monthly. These stations are co-located with a United States Geological Survey (USGS) stream gaging station or are located at the mouth of a tidal river. The remaining 116 monitoring stations are Category 2 (C2) stations and are monitored monthly for 2 years and bi-monthly for 3 years according to a 5-year rotating basin schedule. 4 storm samples (one per season) are collected annually at 12 C1 and C2 sites statewide shown at the end of Table One. During FY 2020, Piedmont and Chesapeake Bay Drainage Basins are the priority basins and all stations in these two basins are monitored every month. Monitoring frequency at stations in the other 3 basins (Inland Bays, Upper Delaware Bay, and Lower Delaware Bay) will be bi-monthly.
- Delaware DNREC is participating in the Chesapeake Bay Program's Non-tidal Monitoring Program and collects samples from two of the non-tidal sites located in Delaware. These two sites are Nanticoke River near Bridgeville and Marshyhope Creek at Fishers Bridge Rd. Samples at these two sites are collected according to sample collection protocol developed by the Chesapeake Bay Program Non-tidal Monitoring Workgroup. Monthly samples and 8 storm samples per year (2 storm samples per season) are collected at these two sites. The data collected at these two sites are provided to the Chesapeake Bay Program and are used for calibrating the Chesapeake Bay Watershed Model. The data are also used to monitor water quality status and to perform trend analysis.
- Delaware DNREC, in cooperation with the Delaware Geological Survey (DGS) and the United States Geological Survey (USGS), is maintaining 6 continuous water quality monitoring sites in the State. Monitoring of water temperature, dissolved oxygen (DO), pH, and specific conductance at these sites are conducted

at fifteen minute intervals by using multi-parameter water-quality sondes (YSI sondes).

- During FY 2020, Delaware DNREC will not conduct any new habitat/biological survey. Instead, it will review the results of surveys conducted during the past several years to evaluate the condition of habitat/biota and to identify any areas where data gap exist and where additional monitoring is needed. Future habitat/biological monitoring will be based on the findings of this data review and analysis.
- During FY2020 DNREC's WATAR Team plans to continue to focus its ongoing efforts to characterize watersheds that flow from Delaware to the Chesapeake Bay. This focus started in FY2018. During the past two reporting periods, water, sediment and fish samples were collected from 18 locations within 15 watersheds, including the Elk Creek watershed, Perch Creek watershed, C&D Canal West watershed, Bohemia Creek watershed, Sassafra River watershed, Chester River watershed, Choptank River watershed, Marshyhope Creek watershed, Nanticoke River watershed, Gum Branch watershed, Gravely Branch watershed, Deep Creek watershed, Broad Creek watershed, Pocomoke River watershed and the Wicomico watershed. Data analysis and assessment is ongoing, and summary reports are in the process of being prepared.

## **Ambient Surface Water Quality Monitoring Program - FY 2020**

The purpose of the Ambient Surface Water Quality Monitoring Program is to collect data on the chemical, physical and biological characteristics of Delaware's surface waters. The information that is collected under this Program is used to:

Describe surface water quality conditions in the State;

Identify long term trends in surface water quality;

Determine the suitability of Delaware surface waters for water supply, recreation, fish and aquatic life, and other uses;

Monitor achievement of Surface Water Quality Standards;

Identify and prioritize high quality and degraded surface waters;

Calculate annual nutrient and select metal loads and track progress toward achieving Total Maximum Daily Load (TMDL) targets; and

Evaluate the overall success of Delaware's water quality management efforts.

Major components of Delaware's Surface Water Quality Monitoring Program include the following:

General Assessment Monitoring

Chesapeake Non-tidal Monitoring

Continuous Water Quality Monitoring

Biological Assessment Monitoring

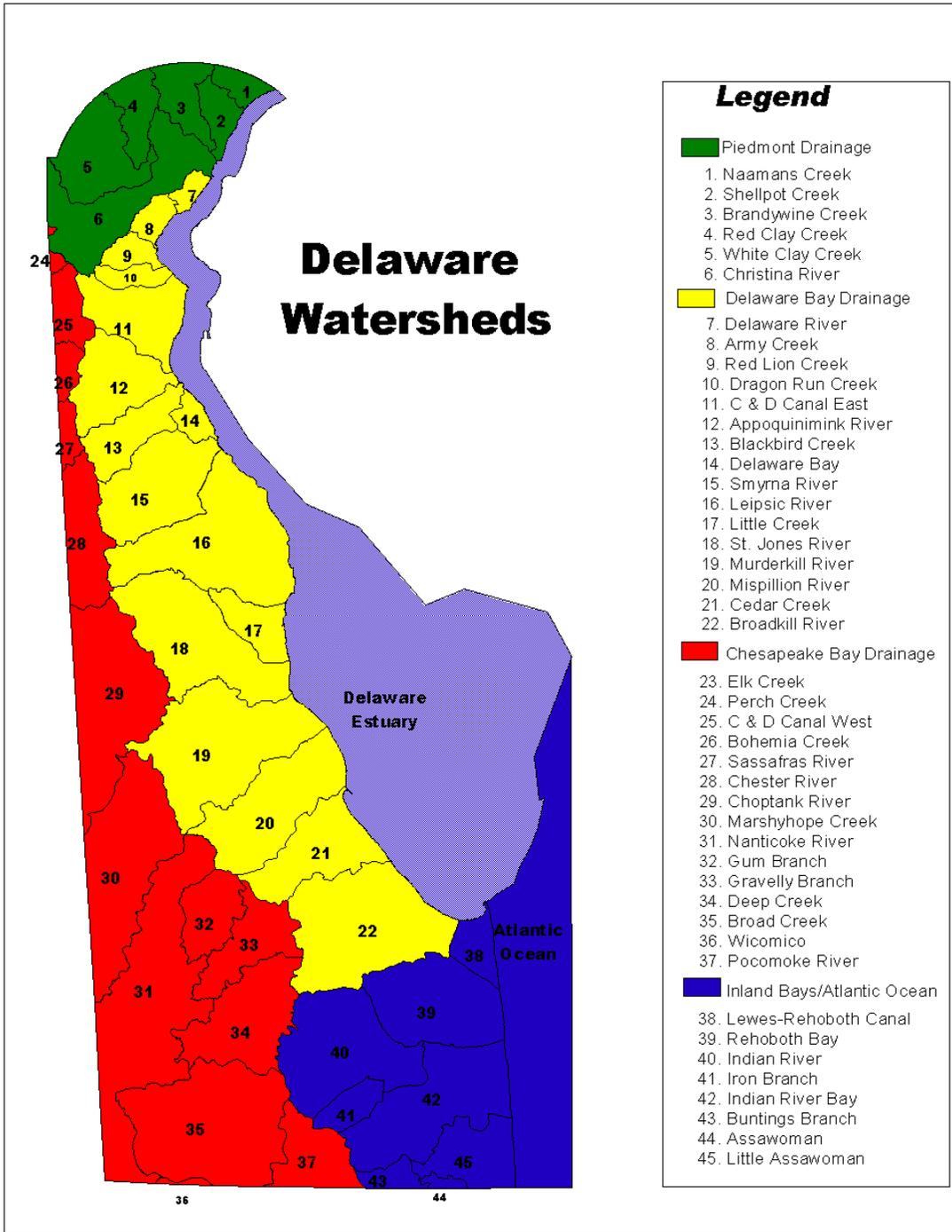
Toxics in Biota Monitoring

Toxics in Sediment Monitoring

Monitoring under the Watershed Approach to Toxics Assessment and Restoration (WATAR) Plan.

This report discusses the General Assessment Monitoring in detail. In addition, it briefly discusses other components of the Delaware's Surface Water Quality Monitoring Program including the Biological Assessment Monitoring, Toxics in Biota Monitoring, Toxics in Sediment Monitoring, and WATAR monitoring.





**Figure 1 – State of Delaware Watersheds and Basins**



## **The General Assessment Monitoring Network (GAMN)**

The General Assessment Monitoring Network (GAMN) provides for routine water quality monitoring of surface waters throughout the State of Delaware. Currently the monitoring network includes 139 monitoring stations (see Table 1). Each station is monitored for conventional parameters such as nutrients, bacteria, dissolved oxygen, pH, alkalinity, and hardness (Table 2). Some stations are monitored for dissolved metals as well as the parameters that are needed to conduct Biotic Ligand Model (BLM) analysis for metals toxicity (see Tables 1, 3 and 4).

The data collected as part of this effort is entered into the EPA's STORET database. In addition, the data is reviewed and analyzed to assess water quality condition of the State's waters to be included in the Integrated Watershed Assessment Report (CWA Sections 305 (b)/303(d) Report) which Delaware Department of Natural Resources and Environmental Control produces every 2 years. Furthermore, the data is used to assess water quality status and trends as well as tracking progress toward achieving water quality standards and TMDL targets.

As stated earlier, the GAMN currently has a total of 139 stations. These stations fall into 2 categories:

- a. C1 - Category 1 stations are high priority stations. Currently GAMN contains 23 Category 1 sites. Data collected at C1 Stations are used for calculating annual loads and long-term trends. These stations are generally co-located with a United States Geological Survey (USGS) stream gaging station or are located at the mouth of a tidal river. Monitoring at these stations is conducted monthly, regardless of rotating priority basin schedule. In addition, annually 4 storm samples (1 per season) are collected at these sites.
- b. C2 - The remaining 116 stations are Category 2 stations and are monitored monthly for 2 years and bi-monthly for 3 years according to a 5-year rotating priority basins schedule.

Figure 2 shows the location of monitoring sites and C1 and C2 stations. During FY 2020, the Piedmont and Chesapeake Bay Drainage Basins are priority basins and all stations in these two basins are monitored monthly. Stations in the 3 remaining basins are monitored 6 times per year (bi-monthly). Figure 3 shows Delaware's Priority Rotating Basins.

Data collected as part of this monitoring effort is archived in the US EPA's STORET data base. In addition, the data can be viewed or downloaded from the University of Delaware's Environmental Observatory System (DEOS) Water Quality Data Portal site at the following url: <http://demac.udel.edu/waterquality/>

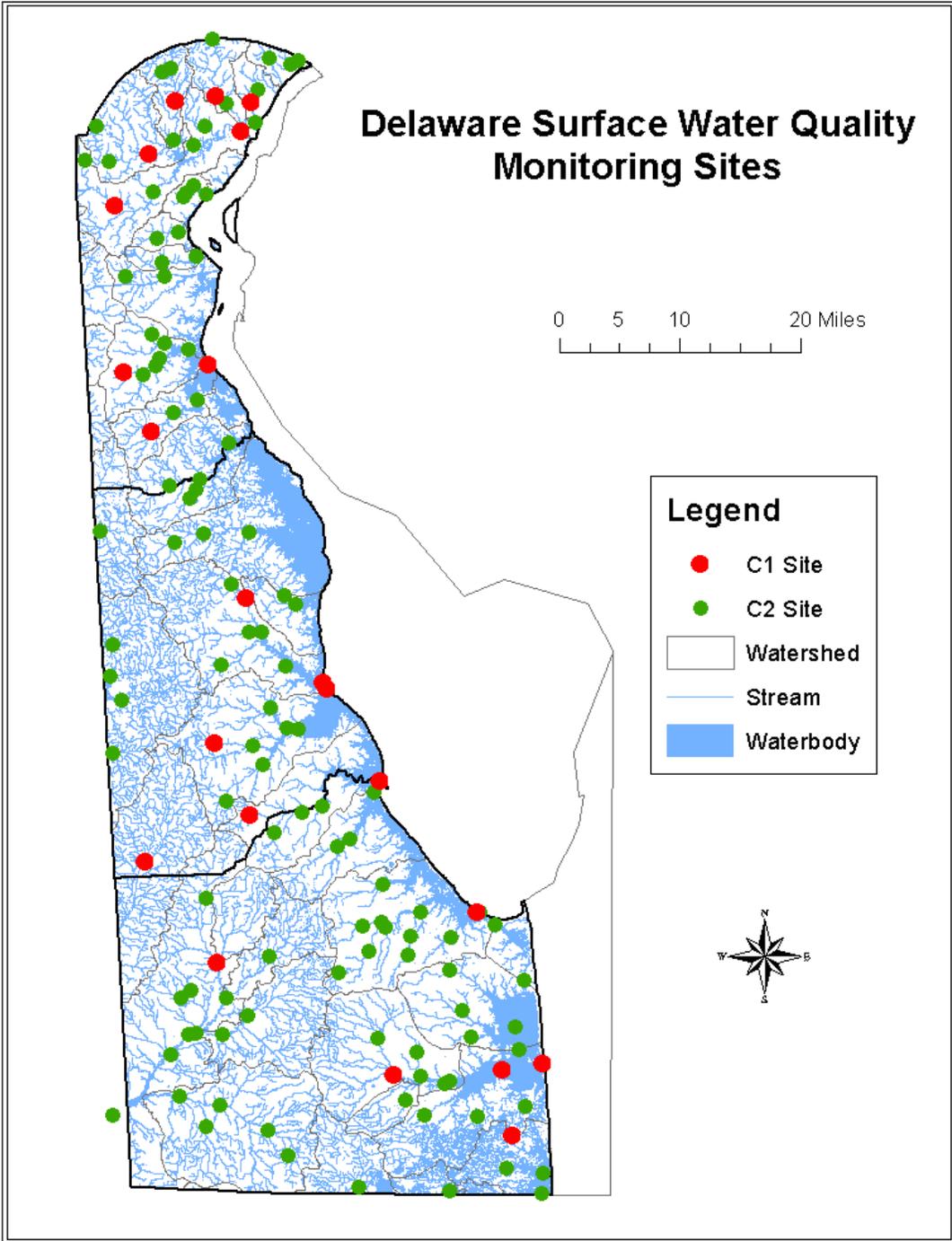
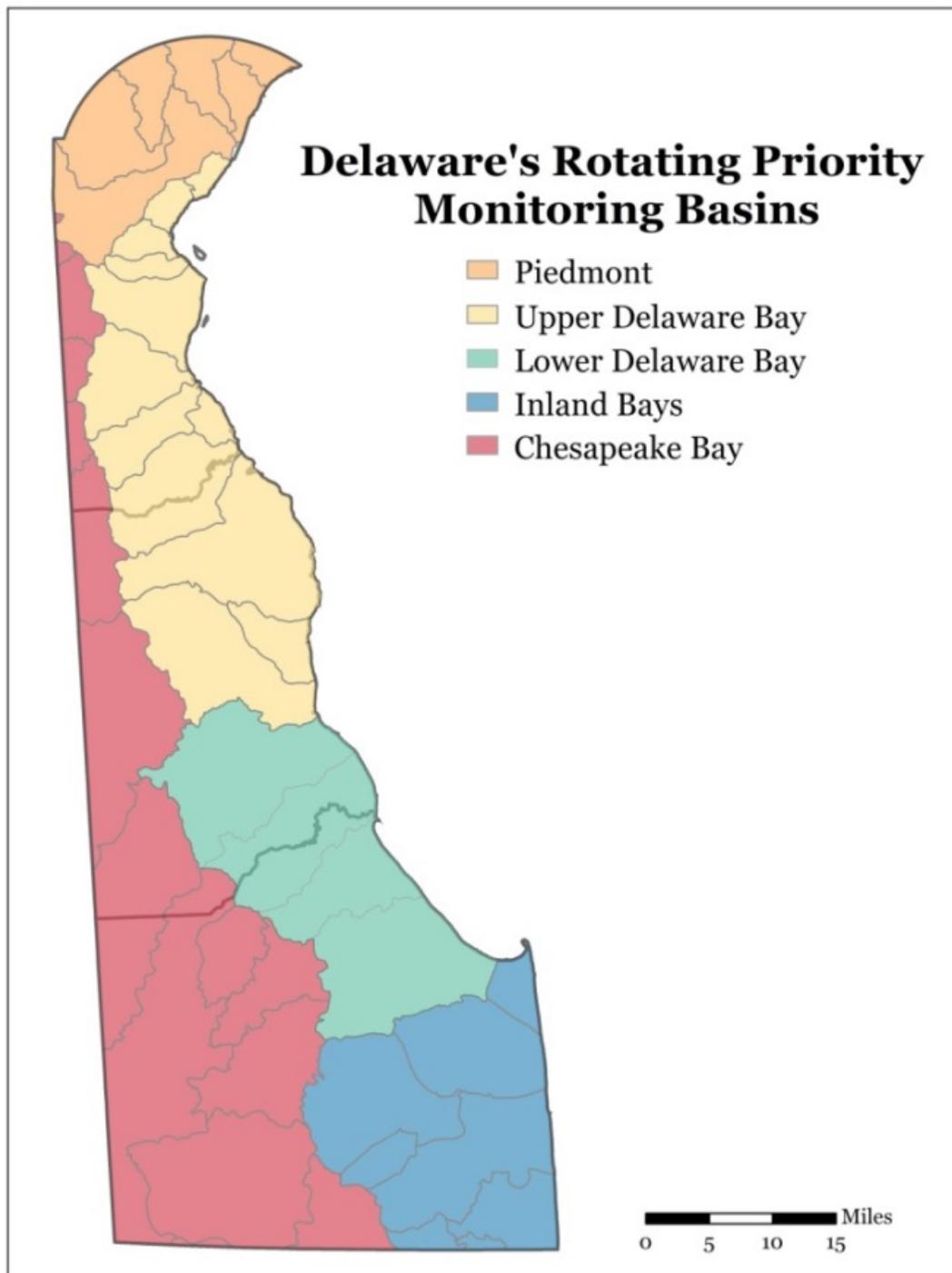


Figure 2 - Delaware's Surface Water Quality Monitoring Sites



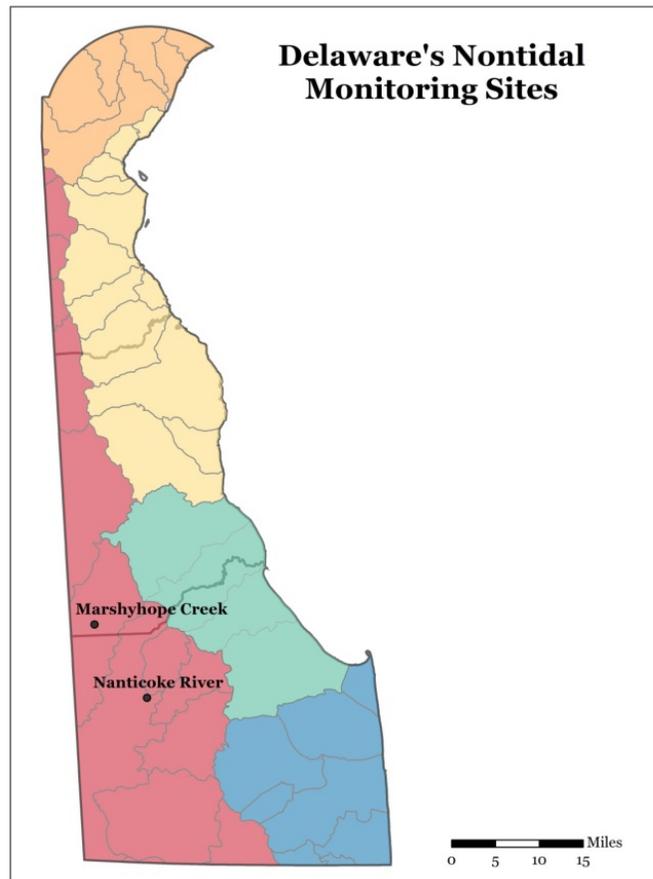
**Figure 3 - Delaware's Rotating Priority Monitoring Basins**

## Chesapeake Bay Non-tidal Monitoring

Delaware DNREC is participating in a multi-State non-tidal monitoring Program conducted by the Chesapeake Bay Program and other jurisdictions including Maryland, Virginia, West Virginia, Pennsylvania, New York, and the District of Columbia. The Chesapeake Bay Non-tidal Monitoring Network has about 120 monitoring sites and the following two sites are in Delaware:

1. Nanticoke River near Bridgeville
2. Marshyhope Creek at Fishers Bridge Rd

Location of the Chesapeake Bay Non-tidal monitoring sites in Delaware is shown in Figure 4. Monitoring at the above two sites is conducted monthly using sample collection protocol developed by the Chesapeake Bay Program Non-tidal Monitoring Workgroup (1). In addition to monthly sampling, 8 storm samples per year (2 per season) are collected at these sites.



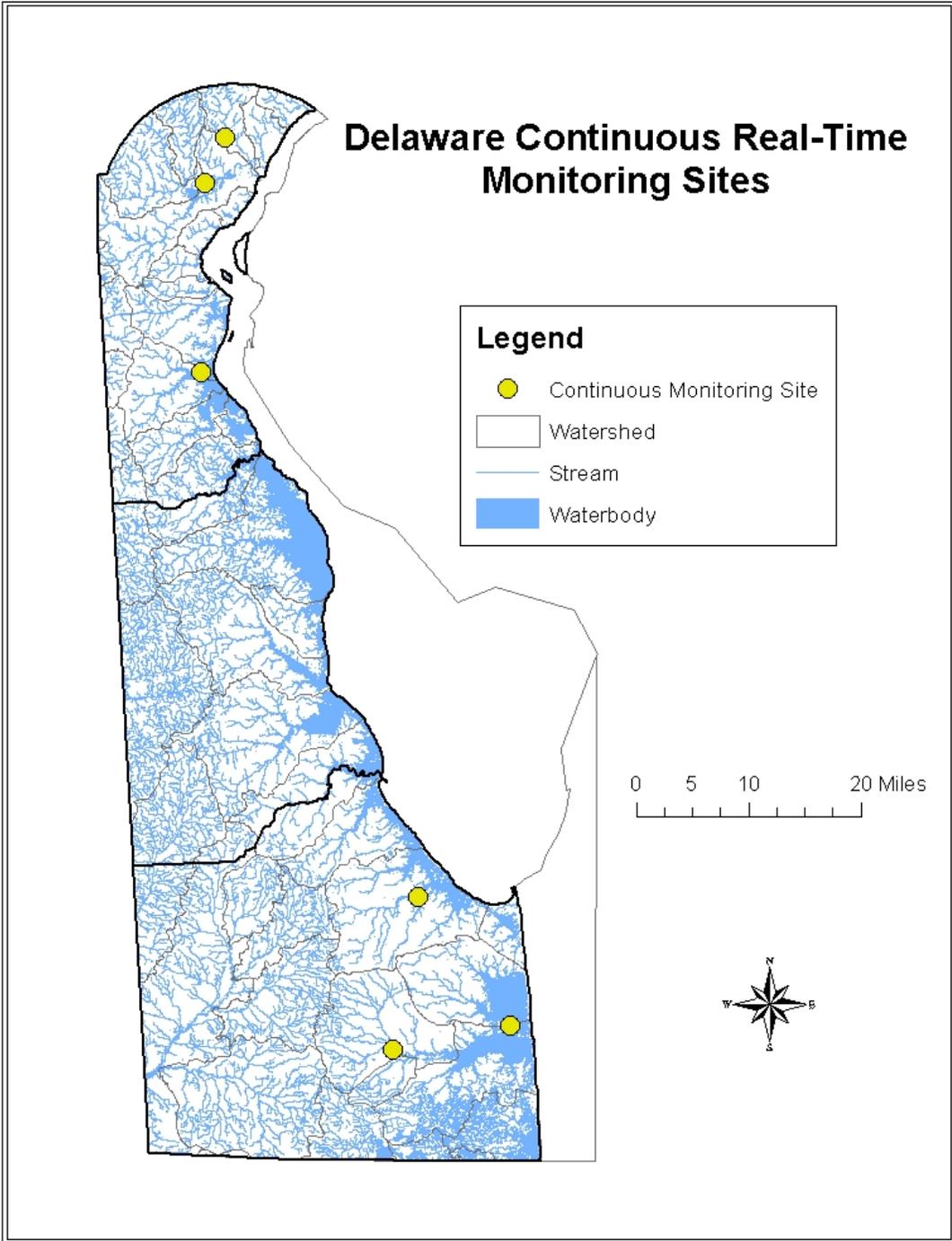
**Figure 4 - Delaware's Non-tidal Monitoring Sites**

## **Continuous Water Quality Monitoring**

Delaware DNREC, in cooperation with the Delaware Geological Survey (DGS) and the United States Geological Survey (USGS), is maintaining a number of continuous Monitoring sites in the State. During FY 2020, six sites in Delaware are being monitored continuously. These sites include:

1. Brandywine Creek at Wilmington
2. Christina River at Newport
3. Appoquinimink River near Odessa
4. Millsboro Pond Outlet at Millsboro
5. Broadkill River near Milton
6. Massey Ditch at Massey Landing

Figure 5 shows the location of the above continuous monitoring sites. Measurements of water temperature, dissolved oxygen (DO), pH, and specific conductance at these sites are conducted at every fifteen minutes interval by using multi-parameter water-quality data sondes (such as YSI sondes). All data are collected following USGS protocols and are stored in USGS National Water Information System (NWIS) databases, <http://waterdata.usgs.gov/de/nwis/current/?type=quality>



**Figure 5 - Delaware's Continuous Monitoring Sites**

## **Biological Assessment Monitoring**

To assess habitat and biological integrity of Delaware's surface waters, Delaware DNREC conducts habitat and biological monitoring of its streams. Macroinvertebrate and habitat assessments are generally performed at perennial, non-tidal, wadable streams throughout the State of Delaware using a probabilistic design. Random sites are selected through the assistance by the Environmental Protection Agency (EPA) using an EMAP approach. Randomization of sites will allow for a statewide, unbiased probability-based estimate of stream conditions throughout the state. Data from this survey will be used for 305(b) analysis.

During FY 2020, Delaware DNREC is not conducting any new habitat/biological survey. Instead, it will review the results of surveys conducted over the past several years to evaluate the condition of habitat/biota and to identify any areas where data gap exist and where additional monitoring is needed. Future habitat/biological monitoring will be based on the findings of this data review and analysis.

## **Toxics in Biota Monitoring**

The FY 2020 Toxics in Biota Monitoring program is being incorporated into the WATAR monitoring effort (see below).

## **Toxics in Sediment Monitoring**

The FY 2020 Toxics in Sediment Monitoring program is being incorporated into the WATAR monitoring effort (see below).

## **Monitoring under the Watershed Approach to Toxics Assessment and Restoration (WATAR) Plan**

During FY2018 and FY2019, DNREC's WATAR Team focused its monitoring efforts on watersheds that flow from Delaware to the Chesapeake Bay. Water, sediment and/or fish samples were collected from 18 locations within 15 watersheds, including the Elk Creek watershed, Perch Creek watershed, C&D Canal West watershed, Bohemia Creek watershed, Sassafra River watershed, Chester River watershed, Choptank River watershed, Marshyhope Creek watershed, Nanticoke River watershed, Gum Branch watershed, Gravely Branch watershed, Deep Creek watershed, Broad Creek watershed, Pocomoke River watershed and the Wicomico watershed (see Figure 6).

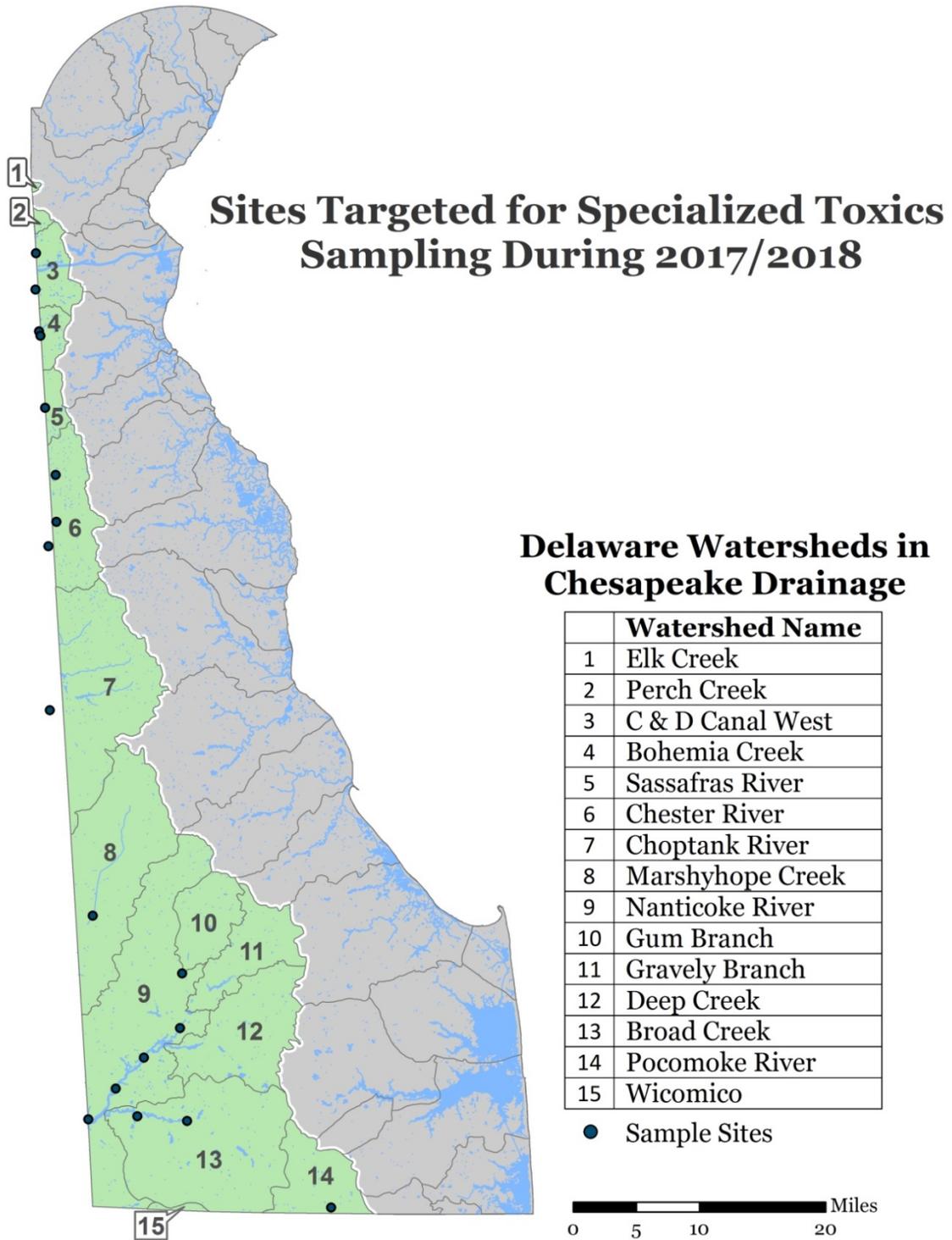
All water samples collected during the first year were analyzed for total suspended solids (TSS), particulate carbon (PC), particulate organic carbon (POC), dissolved organic carbon (DOC), and chlorophyll-a (Chl a). In addition to these conventional water quality parameters, samples were analyzed for polychlorinated biphenyls (PCBs), dioxins and furans (DxF), organonitrogen (ON) pesticides, MRES pesticides (organochlorine (OC) pesticides, organophosphate (OP) pesticides, triazine herbicides, total pyrethroids and ON

herbicides), polyaromatic hydrocarbons (PAHs), carbamates, glyphosates, AMPA, glufosinate, and acid extractable herbicides.

All sediment samples collected during the first year were analyzed for total organic carbon/black carbon (TOC/BC), grain size, moisture content, bulk density, and specific gravity. In addition to these physical parameters, samples were analyzed for PCBs, DxF, TAL metals including mercury and cyanide, MRES pesticides, ON pesticides, PAHs, carbamates, glyphosates, AMPA and glufosinate.

All fish samples collected during the first year were analyzed for PCBs, DxF, MRES pesticides, ON pesticides, PAHs, and lipid content.

The second year of sampling focused on select “emerging contaminants” and included analysis of surface water and surficial sediments for neonicotinoids; specific pyrethroids (depending on whether total pyrethroids are detected in year 1); plus hormones and sterols. Additional fish tissue samples were analyzed from 12 ponds located within Delaware’s Chesapeake Bay drainages. These samples were analyzed for the same parameters as noted above for the first year’s fish tissue samples.



**Figure 6 - WATAR Sampling sites**

A comprehensive Quality Assurance Project Plan for the above WATAR work was approved by the USEPA Chesapeake Bay Office in September 2017. Sampling work was conducted in the fall of CY 2017 and CY 2018. Data evaluation and a summary report will be prepared, beginning in FY20 (CY 2019). For additional details about the scheduled work, please see the approved QAPP (2).

In addition to the Chesapeake Bay drainage summary report preparation in FY20, the WATAR team plans to focus its annual sampling efforts on fish tissue within the Saint Jones River, C&D Canal, and Red Lion Creek. The data collected will inform trend assessments submitted to USEPA in CY 2018. Additional surface water and/or sediment sampling will be conducted in support of potential TMDL development for DxF TEQs in the upper Saint Jones and Silver Lake. For more detailed information on planned activities, please refer to the WATAR 5-year workplan for 2018-2022 (5).

### **Field and Laboratory Procedures**

Field procedures for sample collection activities are detailed in DNREC's Environmental Laboratory Services Quality Manual (3). Method references, STORET codes and reporting levels for parameters listed in Table 2 are provided by the DNREC's Environmental Laboratory Section. Any deviation from standard field, laboratory procedures, or this sampling plan shall be documented with a complete description of the alteration.

### **Quality Assurance, Documentation, Data Usage and Reporting**

The quality assurance objectives and quality control procedures for these surveys are documented in the Quality Assurance Project Plan prepared by the Watershed Assessment and Management Section, Division of Watershed Stewardship (4).

A duplicate water column sample will be collected and analyzed on 10% of the samples from this project. All analytical results from the duplicate analyses shall be reported with the other data.

All analytical results shall be reported to the Watershed Assessment and Management Section digitally (using standard Environmental Laboratory Section's data report forms).

**Table 1 - Station Locations, Descriptions, Parameters, and Sampling Frequency**

BASIN	PROJECT	SITE DESCRIPTION	STORET	Category	Freq.	Arsenic (As)	Iron (Fe)	Copper, Lead and Zinc	BLM Parameters
PIEDMONT	North Piedmont	Little Mill Creek @ DuPont Rd.	106281	C2	12			X	X
		Christina River near Conrail Bridge	106291	C1	12			X	X
		Brandywine Creek @ Foot Bridge in Brandywine Park	104011	C2	12			X	X
		Brandywine Creek @ New Bridge Rd. (Rd. 279)	104021	C1	12			X	X
		Red Clay Creek @ Lancaster Pike (Rt. 48)	103031	C1	12			X	X
		Red Clay Creek @ Barley Mill Rd. (Rd. 258A)	103041	C2	12			X	X
		Burroughs Run @ Creek Rd. (Rt. 82)	103061	C2	12			X	X
		Brandywine Creek @ Smith Bridge Rd. (Rd. 221)	104051	C2	12			X	X
		Christina River beneath Rt. 141 Bridge	106021	C2	12			X	X
		Red Clay Creek @ W. Newport Pike (Rt. 4)	103011	C2	12			X	X
		White Clay Creek @ Delaware Park Blvd.	105151	C1	12			X	X
		White Clay Creek @ McKees Lane	105171	C2	12			X	X
		Christina River @ Nottingham Rd. (Rt. 273)	106191	C2	12			X	X
		White Clay Creek @ Chambers Rock Rd. (Rd. 329)	105031	C2	12			X	X
		Christina River @ Sunset Lake Rd. (Rt. 72)	106141	C1	12			X	X
	Smalleys Dam Spillway @ Smalleys Dam Rd.	106031	C2	12			X	X	
	Northeast Piedmont	Naaman Creek S. Branch @ Darley Rd. (Rd. 207)	101031	C2	12				
		Naaman Creek @ State Line near Hickman Rd.	101021	C2	12				
		Naaman Creek South Branch @ Marsh Rd. (Rt. 3)	101061	C2	12				
		Shellpot Creek @ Carr Rd.	102081	C2	12				
Shellpot Creek @ Market St. (Rt. 13 Bus.)		102051	C1	12					
Shellpot Creek @ Hay Rd. (Rd. 501)		102041	C2	12		X			
UPPER	North Delaware	Army Creek @ S. DuPont Hgwy. (Rt. 13)	114021	C2	6				

BASIN	PROJECT	SITE DESCRIPTION	STORET	Category	Freq.	Arsenic (As)	Iron (Fe)	Copper, Lead and Zinc	BLM Parameters
DELAWARE BAY	Bay	Army Creek @ Rt. 13 near Rt. 40	114051	C2	6				
		Trib Army Crk. @ Rt. 13 near Airport Ind. Park	114041	C2	6				
		Army Creek @ River Rd. (Rt. 9)	114011	C2	6				
		Red Lion Creek @ Rt. 9	107031	C2	6				
		Dragon Creek @ Wrangle Hill Rd. (Rt. 9)	111011	C2	6				
		C & D Canal @ DuPont Pkwy. (Rt. 13) N. side	108021	C2	6				
		Dragon Creek @ S. DuPont Hwy. (Rt. 13)	111031	C2	6				
		Red Lion Creek @ Bear Corbitt Rd. (Rt. 7)	107011	C2	6				
		Lums Pond @ Boat Ramp	108111	C2	6				
	Appoquinimink River	Drawyer Creek off Rt. 13 @ parking area	109071	C2	6			X	X
		Shallcross Lake @ Shallcross Lake Rd. (Rd. 420)	109191	C2	6			X	X
		Deep Creek Branch @ Summit Bridge Rd. (Rt. 71)	109251	C1	12			X	X
		Noxontown Pond @ Noxontown Rd. (Rd. 38)	109131	C2	6			X	X
		Appoquinimink River @ DuPont Pkwy. (Rt. 13)	109041	C2	6			X	X
		Appoquinimink River @ MOT Gut (west bank)	109171	C2	6			X	X
		Appoquinimink River @ Silver Run Rd. (Rt. 9) NE	109121	C2	6			X	X
		Appoquinimink River @ Mouth	109091	C1	12			X	X
	Delaware Bay Drainage	Little River @ Bayside Dr. (Rt. 9)	204031	C2	6				
		Little River @ N. Little Creek Rd. (Rt. 8)	204041	C2	6				
		Leipsic River @ Denny St. (Rt. 9)	202031	C2	6				
		Smyrna River @ Flemings Landing (Rt. 9)	201041	C2	6				
		Blackbird Creek @ Taylors Bridge Rd. (Rt. 9)	110041	C2	6				
		Blackbird Creek @ Blackbird Station Rd. (Rd. 463)	110011	C1	12				
		Blackbird Creek @ Blackbird Landing Rd. (Rd. 455)	110031	C2	6				
		Duck Creek @ Smyrna Landing Rd. (Rd. 485)	201051	C2	6				
		Mill Creek (Lake Como outfall) @ Rt. 13	201011	C2	6				
		Providence Creek @ Duck Creek Rd. (Rt. 15)	201161	C2	6				
		Mill Creek @ Carter Rd. (Rd. 137)	201021	C2	6				
		Garrisons Lake @ DuPont Hwy. (Rt. 13)	202021	C2	6				

BASIN	PROJECT	SITE DESCRIPTION	STORET	Category	Freq.	Arsenic (As)	Iron (Fe)	Copper, Lead and Zinc	BLM Parameters
	St. Jones River	Leipsic River @ Mt. Friendship Rd. (Rt. 15)	202201	C2	6				
		St. Jones River @ mouth, Bowers Beach	205011	C1	12				
		St. Jones River @ Barkers Landing	205041	C2	6				
		St. Jones River @ East Lebanon Rd. (Rt. 10)	205091	C2	6				
		Derby Pond @ Boat Ramp (Rt. 13A)	205211	C2	6				
		Moores Lake @ S. State St. (Rd. 27)	205181	C2	6				
		Fork Branch @ State College Rd. (Rd. 69)	205151	C2	6				
		Silver Lake @ Spillway (Dover City Park)	205201	C2	6				
LOWER DELAWARE BAY	Murderkill River	Murderkill River @ Rt. 13	206011	C1	12			X	X
		Browns Branch @ Milford-Harrington Hwy. (Rt. 14)	206041	C2	6			X	X
		McColley Pond @ Canterbury Rd. (Rt. 15)	206361	C2	6			X	X
		Coursey Pond @ Canterbury Rd. (Rt. 15)	206451	C2	6			X	X
		Double Run @ Barratts Chapel Rd. (Rd. 371)	206561	C2	6			X	X
		Murderkill River @ Bowers Beach Wharf (mouth)	206101	C1	12			X	
		Murderkill River near levee @ MNWA (RM 3.25)	206141	C2	6			X	X
		Murderkill Rv. @ confl. of KCWWTF discharge ditch	206231	C2	6			X	X
	Murderkill River @ Bay Rd. (Rt. 1/113)	206091	C2	6			X	X	
	South Delaware Bay	Beaverdam Branch @ Deep Grass Ln. (Rd. 384)	208231	C1	12				
		Abbotts Pond @ Abbots Pond Rd. (Rd. 620)	208181	C2	6				
		Silver Lake @ Maple Ave.	208211	C2	6				
		Misphillion River @ Rt. 1	208021	C2	6				
		Misphillion River @ Cedar Creek confluence	208061	C1	12				
		Cedar Creek @ Cedar Beach Rd. (Rt. 36)	301091	C2	6				
		Cedar Creek @ Coastal Hwy. (Rt. 1)	301031	C2	6				
	Broadkill River	Swiggetts Pond @ Cedar Creek Rd. (Rt. 30)	301021	C2	6				
		Savannah Ditch @ Savannah Drive (Rd. 246)	303011	C2	6				
		Ingram Branch @ Gravel Hill Rd. (Rd. 248)	303021	C2	6				
		Beaverdam Creek @ Carpenter Rd. (Rd. 259)	303181	C2	6				
		Beaverdam Creek @ Cave Neck Rd. (Rd. 88)	303171	C2	6				

BASIN	PROJECT	SITE DESCRIPTION	STORET	Category	Freq.	Arsenic (As)	Iron (Fe)	Copper, Lead and Zinc	BLM Parameters
		Round Pole Branch @ Cave Neck Rd. (Rd. 88)	303311	C2	6				
		Broadkill River @ Union St (Rt. 5)	303031	C2	6				
		Pemberton Branch @ Gravel Hill Rd. (Rt. 30)	303341	C2	6				
		Red Mill Pond @ Rt. 1	303051	C2	6				
		Broadkill River 0.10 Miles From Mouth	303061	C1	12				
		Broadkill River @ Rt. 1 Bridge	303041	C2	6				
		Waples Pond @ Rt. 1	303331	C2	6				
INLAND BAYS	Inland Bays w/ Pocomoke & Delaware Bay	Indian River Inlet @ Coast Guard Station	306321	C1	12	X		X	
		Little Assawoman Bay Mid-Bay (Ocean Park Lane)	310071	C2	6	X		X	
		Little Assawoman Bay @ Rt. 54 (The Ditch)	310011	C2	6	X		X	
		Dirickson Creek @ Old Mill Bridge Rd. (Rd. 381)	310031	C2	6	X		X	X
		Beaver Dam Ditch @ Beaver Dam Rd. (Rd. 368)	310121	C1	12	X		X	X
		Blackwater Creek @ Omar Rd. (Rd. 54)	308361	C2	6	X		X	X
		White Creek @ mouth of Assawoman Canal	312011	C2	6	X		X	
		Bundicks Branch @ Rt. 23	308371	C2	6	X		X	X
		Pocomoke River @ Bethel Rd. (Rd. 420)	313011	C2	6				
		Whartons Branch @ Rt. 20 (Dagsboro Rd.)	309041	C2	6	X		X	X
		Pepper Creek @ Rt. 26 (Main St.)	308091	C2	6	X		X	X
		Buntings Branch @ Rt. 54 (Polly Branch Rd.)	311041	C2	6	X		X	X
		Millsboro Pond @ Rt. 24	308071	C1	12	X		X	X
		Cow Bridge Branch @ Zoar Rd. (Rd. 48)	308281	C2	6	X		X	X
		Swan Creek @ Mount Joy Rd. (Rd. 297)	308341	C2	6	X		X	X
		Guinea Creek @ Banks Rd. (Rd. 298)	308051	C2	6	X		X	X
		Burton Pond @ Rt. 24	308031	C2	6	X		X	X
		Indian River @ Buoy 49 (Swan Creek)	306181	C2	6	X		X	
		Indian River @ Island Creek	306331	C2	6	X		X	
		Island Creek upper third	306341	C2	6	X		X	
		Indian River Bay @ Buoy 20	306121	C1	12	X		X	
Massey Ditch @ Buoy 17	306111	C2	6	X		X			
Rehoboth Bay @ Buoy 7	306091	C2	6	X		X			

BASIN	PROJECT	SITE DESCRIPTION	STORET	Category	Freq.	Arsenic (As)	Iron (Fe)	Copper, Lead and Zinc	BLM Parameters
		Lewes & Rehoboth Canal @ Rt. 1	305011	C2	6	X		X	
		Lewes & Rehoboth Canal @ Rt. 9	305041	C2	6	X		X	
		Roosevelt Inlet, mouth	401011	C2	12				
CHESAPEAKE	Nanticoke River	Raccoon Prong @ Pepperbox Rd. (Rd. 66)	307371	C2	12			X	X
		Hitch Pond Branch @ Pepper Pond Rd. (Rd. 449)	307081	C2	12			X	X
		Nanticoke River @ Rt. 13	304471	C2	12			X	X
		Concord Pond @ German Rd. (Rd. 516)	304311	C2	12			X	X
		Deep Creek @ Old Furnace Rd. (Rd. 46)	304741	C2	12			X	X
		Gravelly Branch @ Coverdale Rd. (Rd. 525)	316011	C2	12			X	X
		Gravelly Branch @ Deer Forest Rd. (Rd. 565)	316031	C2	12			X	X
		Nanticoke River @ Beach Hwy. (Rt. 16)	304681	C2	12			X	X
		Clear Brook @ Cannon Rd. (Rt. 18)	304371	C2	12			X	X
		Bucks Branch @ Conrail Rd. (Rd. 546)	304381	C2	12			X	X
		Williams Pond @ East Poplar St.	304321	C2	12			X	X
		Broad Creek @ Bethel Rd. (Rd. 493)	307031	C2	12			X	X
		Records Pond @ Willow Street	307011	C2	12			X	X
		Horsey Pond @ Sharptown Rd. (Rt. 24)	307171	C2	12			X	X
		Nanticoke River @ Sharptown	304011	C2	12			X	X
		Nanticoke River @ Buoy 66 (mouth of DuPont Gut)	304151	C2	12			X	X
	Chesapeake Drainage	Sewell Branch @ Sewell Branch Rd. (Rd. 95)	112021	C2	12				
		Tappahanna Ditch @ Sandy Bend Rd. (Rd. 222)	207081	C2	12				
		Culbreth Marsh Ditch @ Shady Bridge Rd. (Rd. 210)	207091	C2	12				
		Cow Marsh Creek @ Mahan Corner Rd. (Rd. 208)	207021	C2	12				
		White Marsh Br. @ Cedar Grove Church Rd. (Rd. 268)	207111	C2	12				
	Chesapeake Bay Nontidal	Nanticoke River @ Rifle Range Rd. (Rd. 545)	304201	C1	12			X	X
		Marshyhope Creek @ Fishers Bridge Rd. (Rd. 258)	302031	C1	12			X	X
	Chesapeake Bay Nontidal Storm	Nanticoke River @ Rifle Range Rd. (Rd. 545)	304201	C1	8			X	X
		Marshyhope Creek @ Fishers Bridge Rd. (Rd. 258)	302031	C1	8			X	X

BASIN	PROJECT	SITE DESCRIPTION	STORET	Category	Freq.	Arsenic (As)	Iron (Fe)	Copper, Lead and Zinc	BLM Parameters
		258)							
State-Wide Storm		Shellpot Creek @ Market St. (Rt. 13 Bus.)	102051	C1	4				
		Brandywine Creek @ New Bridge Rd. (Rd. 279)	104021	C1	4			X	X
		Red Clay Creek @ Lancaster Pike (Rt. 48)	103031	C1	4			X	X
		White Clay Creek @ Delaware Park Blvd.	105151	C1	4			X	X
		Christina River @ Sunset Lake Rd. (Rt. 72)	106141	C1	4			X	X
		Deep Creek Branch @ Summit Bridge Rd. (Rt. 71)	109251	C1	4			X	X
		Blackbird Creek @ Blackbird Station Rd. (Rd. 463)	110011	C1	4				
		Murderkill River @ Rt. 13	206011	C1	4			X	X
		Millsboro Pond @ John Williams Hwy. (Rt. 24)	308071	C1	4	X		X	X
		Silver Lake @ Spillway (Dover City Park)	205201	C2	4				
		Beaver Dam Ditch @ Beaver Dam Rd. (Rd. 368)	310121	C1	4				
		Beaverdam Branch @ Deep Grass Ln. (Rd. 384)	208231	C1	4				

**Table 2 - Water Quality Parameters to be monitored at all stations - FY 2020**

<i>Parameter</i>	<i>Method Reference<sup>1</sup></i>	<i>Reporting Level<sup>2</sup></i>
<b><i>Water Column Nutrients</i></b>		
Ammonia Nitrogen	EPA 350.1, Rev. 2.0 (1993)	0.010 mg/l N
Nitrite+Nitrate Nitrogen	EPA 353.2, Rev. 2.0 (1993)	0.010 mg/l N
Nitrogen, Total, Alkaline Persulfate	SM 4500-P J-2011	0.100 mg/l N
Soluble Ortho-phosphorus	EPA 365.1, Rev. 2.0 (1993)	0.005 mg/l P
Phosphorus, Total, Alkaline Persulfate	SM 4500-P J-2011	0.010 mg/l P
<b><i>Carbon and Organics</i></b>		
Total Organic Carbon	SM 5310 B-2011	1 mg/l
Dissolved Organic Carbon	SM 5310 B-2011	1 mg/l
Chlorophyll-a (Corr)	EPA 445.0, Rev. 1.2 (1997)	1 µg/l
<b><i>Biochemical Oxygen Demand</i></b>		
BOD <sub>5</sub> , N-Inhib (CBOD)	SM 5210 B-2011	2.4 mg/l
BOD <sub>20</sub> , N-Inhib (CBOD)	SM 5210 B-2011	2.4 mg/l
<b><i>Field Measurements</i></b>		
Conductivity	SM 2510 B-2011	1 µS/cm
Dissolved oxygen	SM 4500-O G-2011 or ASTM D888-09 (C)	0.1 mg/l
pH - Field	SM 4500-H+ B-2011	0.2 pH units
Salinity	SM 2520 B-2011	0.1 ppt
Temperature	SM 2550 B-2010	Water -5.00 °C Air -10 °C
Secchi Depth <sup>3</sup>	EPA-841-R-14-007	0.1 meters
Light Attenuation <sup>4</sup>	EPA-841-R-14-007	0.1 µmol/s/m <sup>2</sup>
<b><i>General</i></b>		
Alkalinity	SM 2320 B-2011	2.3 mg/l
Chloride	SM 4500-Cl <sup>-</sup> E-2011	3 mg/l
Hardness	SM 2340 C-2011	5 mg/l as CaCO <sub>3</sub>
Total Suspended Solids	SM 2540 D-2011	2.5 mg/l <sup>5</sup>
Turbidity	SM 2130 B-2011	1 NTU
<b><i>Bacteria</i></b>		
Enterococcus	Enterolert®	1 mpn/100 ml

- <sup>1</sup> SM refers to Standard Methods.
- <sup>2</sup> The Environmental Laboratory Section defines the Limit of Quantitation (LOQ) as the lowest standard in the calibration curve or, in instances where a standard curve is not specified by the procedure, LOQ represents the limitations of the method. For those tests where reference spiking material exists, the ELS measures Method Detection Limit (MDL), as defined in the Federal Register 40 CFR Part 136 Appendix B. MDL values are generated or verified once per year. Results less than the MDL are considered to be not detected and “< MDL” is reported. Results greater than the MDL but less than the LOQ are qualified with a J to indicate a result that is extrapolated or estimated. For tests where MDL is not applicable, results less than the LOQ are reported as “< LOQ”. ELS MDLs meet or exceed (i.e., are lower than) the reporting level requirements listed in Table 3. The reporting levels listed represent the LOQ or method defined limit.
- <sup>3</sup> Secchi Depth to be measured at designated stations. The reappearance depth is recorded.
- <sup>4</sup> Light attenuation to be conducted as practical to obtain correlation with Secchi disk readings. PAR at the surface and at one meter depth is recorded and reported.
- <sup>5</sup> Reporting Limit based on 1000 ml filtration volume. The reporting limit will be adjusted according to actual volume filtered. The method specifies to decrease volume if complete filtration takes more than 10 minutes.

**Table 3 - Metal Parameters**

<i>Dissolved Metals (dissolved and total)</i>	<i>Method Reference (EPA)</i>	<i>Reporting Level<sup>6</sup></i>
Copper	EPA 200.8, Rev. 5.4 (1994)	1.0 ug/l
Lead	EPA 200.8, Rev. 5.4 (1994)	1.0 ug/l
Zinc	EPA 200.8, Rev. 5.4 (1994)	2.0 ug/l
Iron	EPA 200.7, Rev. 4.4 (1994)	100 ug/l
Arsenic	EPA 200.8, Rev. 5.4 (1994)	1.0 ug/l

<sup>6</sup> High levels of dissolved solids in the sample may cause analytical interferences. For example, EPA method 200.8 recommends that the dissolved solids levels not exceed 0.2% (w/v) (~2,000 mg/L) to reduce such effects. Samples may be diluted during analysis to minimize the instrument interferences associated with high salinity/conductivity. The reported MDLs and LOQs for the parameters will be adjusted due to the sample dilution.

**Table 4 - Additional parameters needed for freshwater stations with Biotic Ligand Model Sampling for Copper (BLM Parameters)**

<i>Dissolved Parameters</i>	<i>Method Reference (EPA)</i>	<i>Reporting Level</i>
Alkalinity	SM 2320 B-2011	2.3 mg/l
Chloride	SM 4500-Cl <sup>-</sup> E-2011	3 mg/l
Calcium	EPA 200.7, Rev. 4.4 (1994)	1000 ug/l
Magnesium	EPA 200.7, Rev. 4.4 (1994)	1000 ug/l
Potassium	EPA 200.7, Rev. 4.4 (1994)	1000 ug/l
Sodium	EPA 200.7, Rev. 4.4 (1994)	1000 ug/l
Sulfate	EPA 300.0	0.75 mg/l

References:

1. Chesapeake Bay Program. 2008. Chapter V, Non-tidal Water Quality Monitoring. Annapolis, MD.
2. DNREC. 2017. Quality Assurance Project Plan - Collection and Analysis of Surface Water, Sediment and Fish Tissue Samples for Toxics in Delaware Watersheds that Flow to the Chesapeake Bay. Division of Watershed Stewardship, Delaware Department of Natural Resources and Environmental Control, Dover, DE.
3. DNREC. 2019. Quality Manual for DNREC Environmental Laboratory and Field Operations, Environmental Laboratory Section, Division of Water.
4. DNREC. 2019. Delaware Ambient Surface Water Quality Monitoring Program Quality Assurance Program Plan (QAPrP), Division of Watershed Stewardship, Watershed Assessment and Management Section.
5. DNREC. 2018. Watershed Approach to Toxics Assessment and Restoration 2018-2022. DNREC Division of Watershed Stewardship and Division of Waste and Hazardous Substances.