Maryland's Final Combined 2020-2022 Integrated Report of Surface Water Quality

Submitted in Accordance with Sections 303(d), 305(b), and 314 of the Clean Water Act

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

For this Integrated Report (IR) and in compliance with sections 303(d), 305(b) and 314 of the federal Clean Water Act (CWA), Maryland is submitting a combined 2020-2022 IR of Surface Water Quality (IR). The 'combining' of two cycles of water quality data and assessments into one document, while unusual, was necessary so that the 2020 cycle assessments could still be captured while allowing Maryland to catch up and still meet the 2022 IR deadline of April 1, 2022. The decision to 'combine' these reports (2020 and 2022) was made in consultation and with the support of U.S. Environmental Protection Agency (EPA) Region 3, and is consistent with EPA's Integrated Reporting guidance for the 2022 cycle (*Information Concerning 2022 CWA Section 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions)*.

In this guidance document, EPA states that "If a state is significantly behind in submitting an IR, one option to catch-up with a late submission while also meeting the reporting deadline for the current IR cycle is to combine the IR submissions (for example, submit a combined 2020/2022 IR by April 1, 2022). Articulation of this strategy is not intended to obviate the requirement to submit an IR every two years, nor is it intended to offer an opportunity to slow down preparation of CWA 303(d) lists moving forward. Rather, the strategy of combining IRs has been employed for states to catch-up on their past CWA 303(d) lists, submit their current cycle IR on-time, and maintain the biennial reporting cycle with an April 1 deadline moving forward."

In using this option of combining reports, Maryland's combined IR of Surface Water Quality covering the 2020 and 2022 reporting cycles incorporates assessments using all data that normally would have been included for these IR cycles separately. As a result, Maryland used an extended data window, and all assessments reflect both the full record of data from both cycles and the most up-to-date data possible.

As in previously submitted IRs, this report describes ongoing efforts to monitor, assess, track and restore the chemical, physical and biological integrity of Maryland waters. This report presents the current status of water quality in Maryland by placing all waters of the state into one of five categories, which are described in detail in the introductory section of this document. In addition, the report provides information about the progress on addressing impaired waters by documenting:

- Completed Total Maximum Daily Loads (TMDLs), which re-categorize impairments from Category 5 (impaired and needs a TMDL: the "list of impaired waters") to Category 4a (TMDL completed, but still impaired).
- Analyses of new water quality data that shows areas previously identified as impaired that are attaining standards. This can result from remediation, changes in water quality standards, or improved monitoring and/or data analysis.
- Assessment methodologies and watershed segmentation that enhance the use of available data and provide consistency with management and implementation strategies.
- Statewide water quality statistics for Maryland's surface waters, including summaries of the size of impaired or non-impaired water by waterbody type, the status of waters by designated use, and the size of waters impaired by various pollutants or sources.
- Maryland's prioritization of impairments for TMDL development.

For this combined 2020-2022 reporting cycle, changes were made to three assessment methodologies and another new assessment methodology was created. These assessment methodologies provide a consistent logical framework for reviewing water quality data and are used in making water body impairment determinations for the IR. The *Listing Methodology for Identifying Waters Impaired by Bacteria in Maryland's IR*, the Fish Tissue Assessment Methodology section, which is part of the *Methodology for Determining Impaired Waters By Chemical Contaminants for Maryland's IR of Surface Water Quality*, and the *Temperature Assessment Methodology for Use III (-P) Streams in Maryland* were all updated for this cycle and the *Delisting Methodology for Biological Assessments* was created.

Maryland continues to make significant efforts to incorporate non-state government data in ways that increase the resolution of the state's water quality assessments. For the combined 2020-2022 IR, the Maryland Department of the Environment (MDE) partnered with the Chesapeake Monitoring Cooperative (CMC) to obtain non-governmental organization (NGO) and citizen data for assessing water quality. The CMC is a group of organizations under agreement with the EPA Chesapeake Bay Program (CBP) that provides programmatic and technical support to non-traditional monitoring groups and connects them with state or federal agencies using data for regulatory or management decisions. The CMC maintains a centralized database, the Chesapeake Data Explorer (CDE), and they assist NGO and citizen groups in loading quality data into the database while collaborating with agencies and other data users to access vetted data from the database to incorporate into their assessments. Partnering with the CMC has allowed MDE to compile a greater quantity and spatial coverage of water monitoring data by sharing the workload of evaluating data quality, quality assurance/quality control of datasets, organizing, and storing data within CDE. MDE successfully used citizen data from the CMC's Chesapeake Data Explorer for this combined 2020-2022 IR cycle and plans to continue working closely with the CMC in future cycles.

As done previously, MDE is submitting this IR to EPA through the Assessment, TMDL Tracking and Implementation System (ATTAINS), an online system for accessing information about the condition of the nation's surface waters. New for this report, MDE utilized the ATTAINS reporting function to produce all assessment results and summary calculations in the report. All IR information will be made available in ATTAINS through web reports and other query tools. ATTAINS data are made available to the public through EPA's How's My Waterway interactive webpage and mapping tool, which can be found at epa.gov/waterdata/hows-my-waterway. For general information about the ATTAINS reporting system, please visit epa.gov/waterdata/attains. MDE will also continue to make Maryland's IR information available to the public in several user-friendly formats on their webpage. Accessible via the web, users can query MDE's searchable IR database to find individual assessments or groups of assessments that are of interest. The searchable IR database and companion clickable map application are available online at mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/303d.aspx. MDE will also continue to maintain the GIS map, which displays water quality assessment information overlaid on top of TMDL watersheds online at mdewin64.mde.state.md.us/WSA/IR-TMDL/index.html. MDE also hosts a TMDL Data Center webpage online at mde.maryland.gov/programs/water/tmdl/datacenter/pages/index.aspx that contains documents, maps, and additional information on TMDLs. Users should note that IR resources will only be updated following EPA approval of Maryland's IR.

Maryland's Water Quality Highlights

The risk posed by exposure to Per- and polyfluoroalkyl substances (PFAS) is an emerging and evolving state and national concern. On July 1, 2021, MDE released a new report detailing the sampling of nearly 130 Maryland public drinking water treatment plants for PFAS. Additionally, on October 18, 2021, EPA announced the agency's PFAS Strategic Roadmap, which lays out a whole-of agency approach to addressing PFAS. PFAS have been manufactured and used in a variety of industries around the globe, including in the United States since the 1940s. These chemicals are persistent in the environment and the human body, and there is an increasing body of evidence that exposure to PFAS can lead to adverse human health effects, such as: increased cholesterol levels, decreased fertility, increased risk of cancer, and others. In Maryland, PFAS are being studied as an emerging contaminant of concern with MDE monitoring for PFAS in specific water bodies that have been identified as having nearby potential sources of PFAS as well as sampling in locations known to be frequented by subsistence anglers and fishers. Recently, MDE established a fish consumption advisory threshold for the health risks posed by levels of PFOS (perfluorooctane sulfonate), one of the more widely studied PFAS chemicals, and found that levels of PFOS exceeded a human health threshold in the fish tissue of three species captured from Piscataway Creek (a tributary to the Potomac River in Prince George's County). Consequently, on Oct. 15, 2021, MDE released a news report announcing that the department had issued its first fish consumption advisories for redbreast sunfish and yellow bullhead catfish in the non-tidal portion of Piscataway Creek, and largemouth bass in the tidal headwaters of Piscataway Creek. This, in turn, will result in Maryland's first ever Category 5 (impaired, may need a TMDL) listings for PFOS in fish tissue for the tidal and non-tidal waters of Piscataway Creek in this combined 2020-2022 IR.

Other persistent water quality challenges facing the state include the continued increasing trends of conductivity and related aquatic life toxicant, chloride, in non-tidal streams due to road deicers. MDE has now documented 28 watersheds as impaired for chloride. New for this report, MDE created a Subcategory 5s (Waterbody impairment is caused by chloride from road salt) to specifically acknowledge the ongoing contribution to pollution from road salt. Waters assessed in Category 5s are high priorities to be addressed through pollution control requirements and restoration approaches, and are a lower priority for TMDL development. Maryland's salt reduction strategies include: the requirement for a salt management plan in state law for Maryland Department of Transportation State Highway Administration (MDOT SHA); requirements for salt management plans in MS4 permits, which cover over 90% of Maryland's impervious surface area; voluntary actions, such as private applicator training; public awareness partnerships with other state agencies and NGOs, and engagement with elected officials. Through adaptive management, trend analysis, and responsible implementation, long-term goals can be established to lessen the usage of salt and reduce its impact while maintaining safety and mobility. MDE plans to utilize these 'straight-to-implementation' approaches to expedite restorative practices and therefore water quality improvements.

Maryland also continues to document a number of temperature impairments in Class III (and Class III-P) coldwater streams. In this IR cycle, there were 74 new Category 5 temperature impairments across nine different watersheds, increasing the total temperature impairments to 174. The exceedance of the temperature criterion in these streams threatens the persistence of coldwater obligate species and presents an additional challenge for restoration efforts aimed at providing biological uplift.

Long term water quality trend analyses conducted by the U.S. Geological Survey and Maryland Department of Natural Resources (DNR) show that temperature trends are degrading in both tidal and nontidal waters in Maryland. However, historical Chesapeake Bay restoration spending has been successful, and there are significant reductions in nitrogen (N), phosphorus (P) and sediment (TSS) concentrations in both tidal and non-tidal trend monitoring stations. The analyses show that nutrient trends are improving in the State of Maryland, and that the restoration efforts display measurable positive impacts on water quality in many locations.

Water quality monitoring continues to be a priority for Maryland. MDE and DNR have recognized the need for continued lake monitoring and are partnering to address known sampling gaps, coordinating sampling protocols, and have developed a prioritization list to identify an order in which lakes will be sampled. One of the primary goals is to monitor and assess all significant (>5 acres surface area), publicly-owned lakes in Maryland for impacts due to nutrients. As part of this effort, MDE assessed new data for 15 lakes in this IR cycle and will continue to monitor and assess lakes each cycle according to the monitoring prioritization list. EPA has also released new water quality criteria to address nutrient pollution in lakes and reservoirs, and MDE plans to review these criteria and reevaluate and update lake assessment methodologies to improve future lake assessments.

MDE also coordinated with EPA on a water quality monitoring investigation in the Conococheague Creek watershed for high pH impairments. In response to comments by EPA on the 2018 IR, MDE developed a study in 2019 and 2020 to further investigate if the cause of high pH impairments in the Conococheague Creek watershed were due to the natural geology of the area and could be delisted, as MDE proposed in the 2018 IR, or if they were caused by nutrients and should remain impaired. MDE deployed pH loggers at multiple stations around the Conococheague Creek, Antietam Creek, and Little Conococheague watersheds, and EPA conducted a robust analysis of the data. The data demonstrated that the high pH in the Conococheague watershed is due to a combination of the Karst geography, high nutrient input, and a dam at a specific station that caused nutrients and water to remain trapped. Based on this study, MDE listed the entire Conococheague Creek watershed in Category 5 (impaired, may need a TMDL) for high pH, which corresponds with the current impairment listings for the Conococheague Creek watershed for nutrients. Both the nutrient and the high pH listings will be addressed by a nutrient TMDL in the future.

Maryland continues to make progress in establishing TMDLs for the state’s impaired water bodies. To date, Maryland has established 568 TMDLs out of a total of 972[1] water body-pollutant impairments. The water body size addressed by TMDLs for each major pollutant-type is shown in the figures below. As evident from these figures, some pollutants have been almost completely addressed by TMDLs (e.g., nutrients, TSS, bacteria) while others have not (e.g., chlorides, sulfates, stream temperature). For chlorides and stream temperature, the state has developed water quality modeling methodologies for estimating loads and impacts, which can be used to establish TMDLs for these pollutants in the future or for management decisions and implementation purposes.

[1] These numbers can go up or down from IR cycle to IR cycle as impairments get added or delisted based on updated information and data.

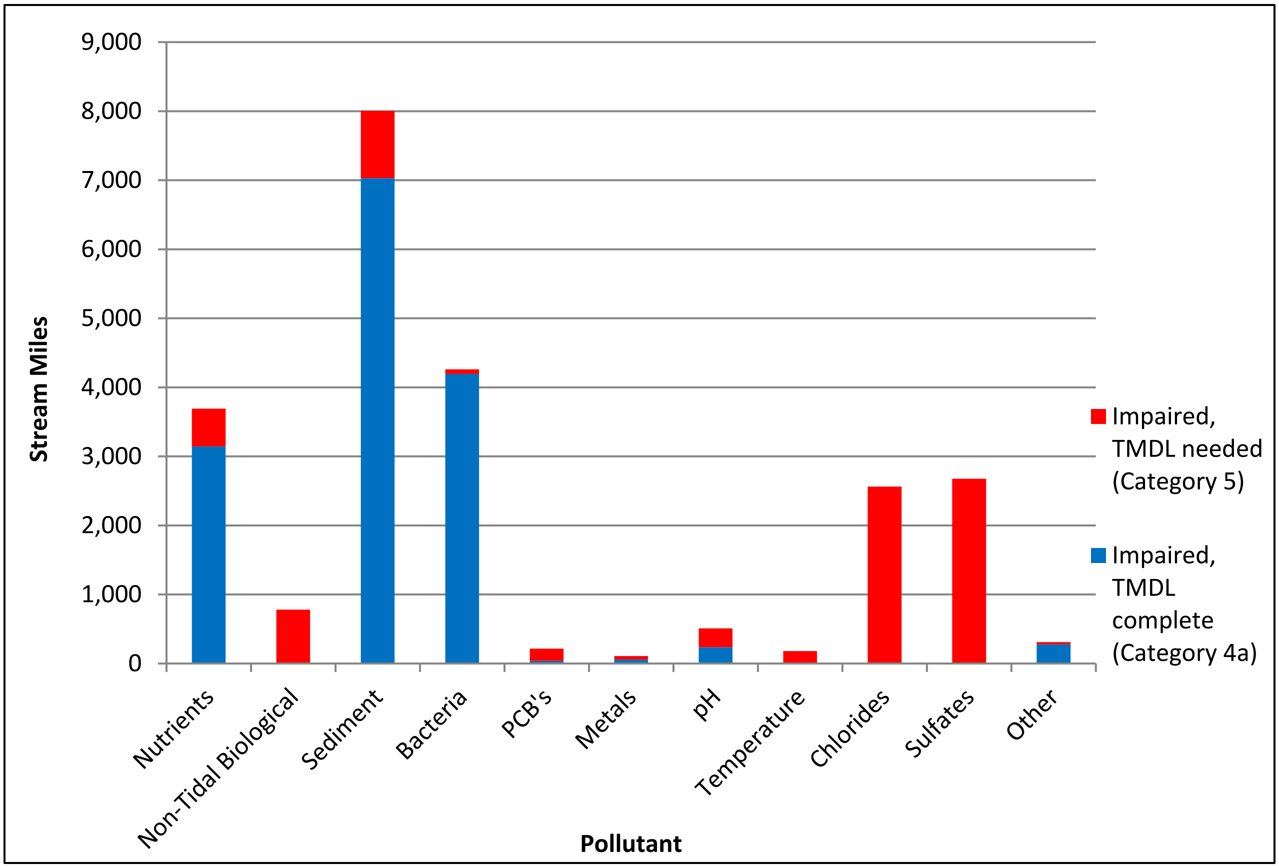

Figure 1: Stream miles impaired by various pollutants in 2020-2022. Colors denote the stream miles currently addressed by TMDLs (blue) and those that still require TMDLs (red).

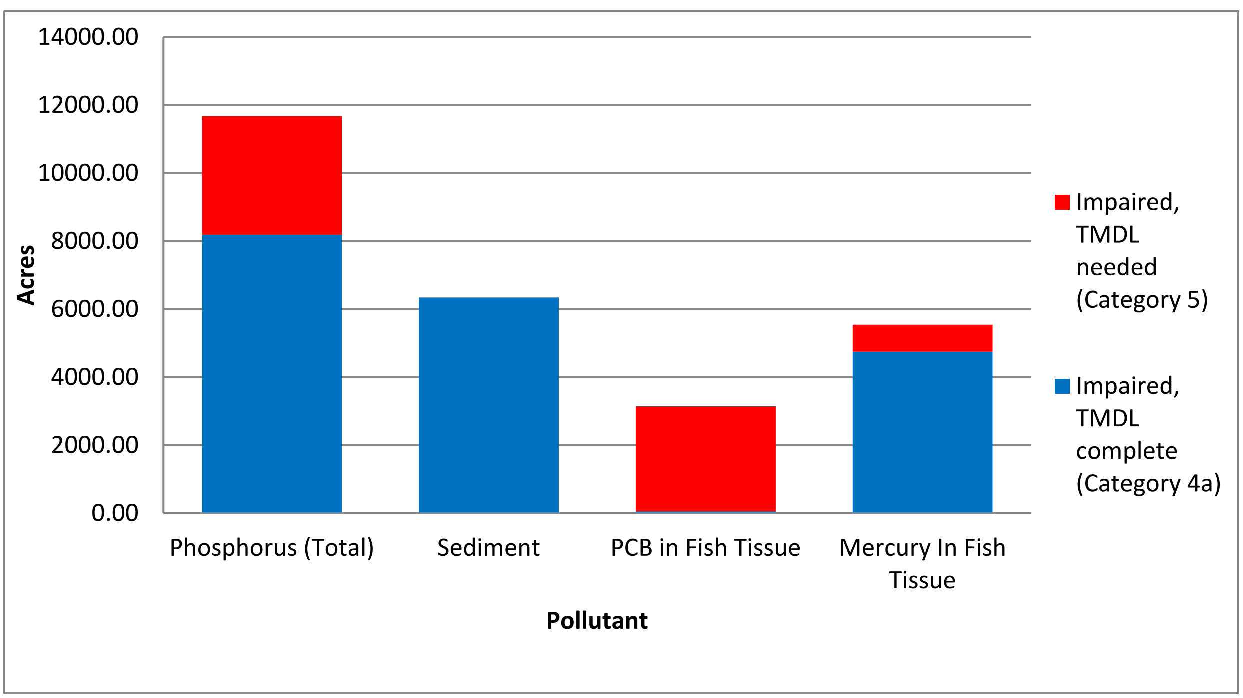

Figure 2: Impoundment size impaired by various pollutants in 2020-2022. Colors denote the impoundment acres currently addressed by TMDLs (blue) and those that still require TMDLs (red).

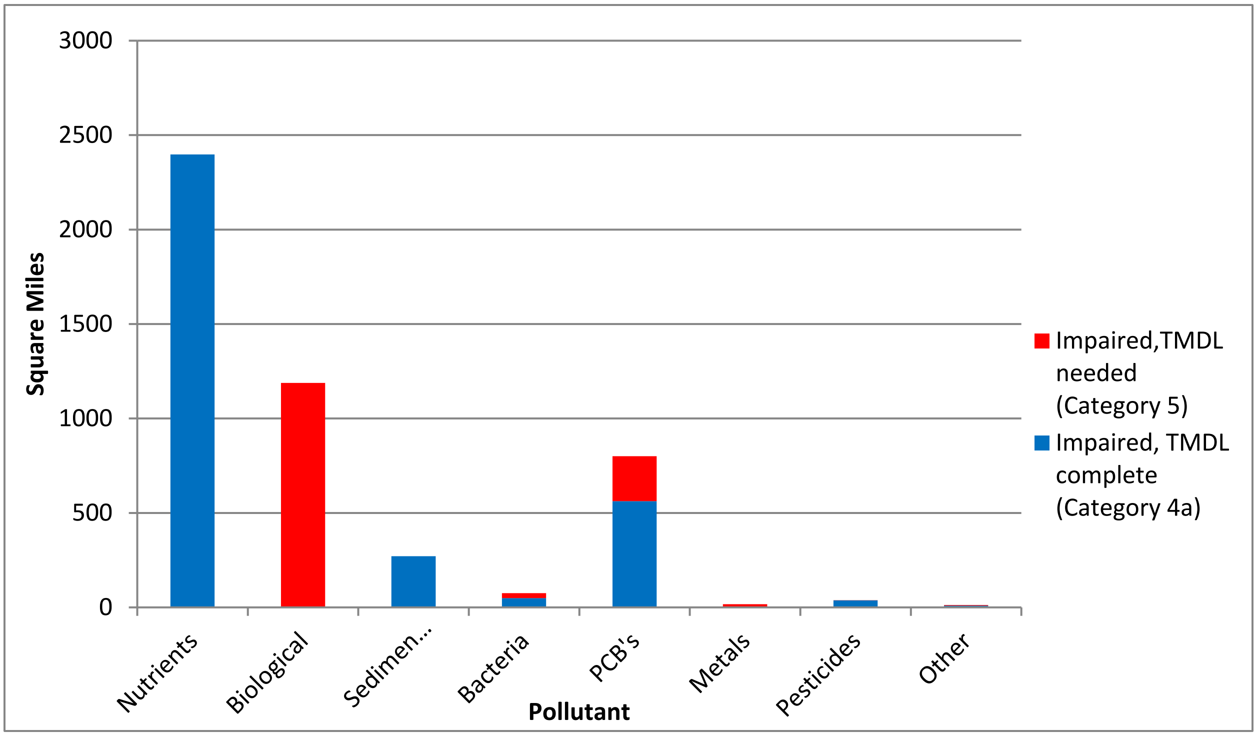

Figure 3: Size of estuarine waters impaired by various pollutants in 2020-2022. Colors denote the square mileage of estuarine waters currently addressed by TMDLs (blue) and those that still require TMDLs (red).

Summary of Changes in the Combined 2020-2022 IR

There are a total of 101 additions to the list of Category 5 waters in 2020-2022. Two are new impairment listings for sulfate based on Biological Stressor Identification (BSID) analyses. Another 16 are new listings for fecal coliform in shellfish harvesting waters. There are 74 new impairment listings for high water temperatures in Class III or III-P cold water stream segments. In addition, there are three new phosphorus listings and three new chlorophyll *a* listings for lakes. Finally, there are two new listings for PFOS in fish tissue and one new listing for high pH.

Table 1: Changes to Category 5 Listings from 2018 to 2020-2022

IR Year/Status	Category 5 Listings
2018 Total Category 5 Listings	**284**
2020-2022 New Category 5 Listings	101
2020-2022 New Delistings (Category 5 to Category 2 or 3) *(See Table 2)*	-10
Approved TMDLs (since the 2018 IR)	-16
2020-2022 Grand Total Category 5 Listings	**359**

Ten waterbody-pollutant combinations were removed from Category 5 in 2020-2022. One biological listing without a specified impairing substance has been replaced by a sulfate listing from the BSID analyses. Another listing was removed from Category 5 for temperature because the waterbody was erroneously assessed as a use Class III stream when it is actually a use Class I stream and is meeting the use Class I temperature criterion. One listing was removed from Category 5 for high pH and was replaced by another high pH listing covering a larger area. The last seven listings removed from Category 5 included three for mercury in fish tissue and four for Polychlorinated biphenyls (PCBs) in fish tissue. All seven of these listings were moved to Category 2 on the basis of new data that demonstrated water quality that met the applicable criterion or impairment threshold.

Some of these listings were originally based on limited data. In these cases, it is usually impossible to attribute these waters now meeting standards to a particular restorative action. It is possible that the extensive restoration practices that have been applied statewide might be playing a contributory role, but it may also be true that these listings were made based upon insufficient data. However, it is important to note that it is highly likely that the mercury (Hg) and PCB delistings are due to decreasing trends in atmospheric mercury deposition and natural attenuation of PCBs. Table 2 shows the general water body-pollutant combinations that have been delisted from Category 5.

Table 2: 2020-2022 Water body-pollutant combinations removed from Category 5 - impaired, TMDL needed) and placed in Category 2 or 3 (non-impaired).

Type of Impairment Listing	Number of Listings Removed from Category 5
Generic Biological Listings removed – specific pollutant now specified (by BSID analysis)	1
Temperature- erroneous impairment listing removed for a use class I stream	1
High pH listing removed (this listing was replaced by a new category 5 listing covering the 8-digit watershed)	1
Hg - fish tissue concentrations now meeting fishing designated use	3
PCBs - fish tissue concentrations now meeting fishing designated use	4
2020-2022 Total Number of Delistings	**10**

In addition, there were eight other water quality listings removed from the impaired part of the IR that were not counted in Table 2 because they were previously in Category 4a. One such delisting occurred in the Choptank River [Choptank River Mesohaline 1 (CHOMH1)] due to recent assessment data that demonstrated attainment of the shallow water submerged aquatic vegetation (SAV) use and water clarity criteria (i.e., SAV coverage and water clarity). Two listings for total phosphorus in lakes were removed since recent data demonstrated that the lakes assessed were meeting the criteria for the aquatic life designated use. Three other fish tissue-related listings were removed from Category 4a, two for Hg in fish tissue and one for PCBs in fish tissue, since recent assessment data demonstrated that fish tissue was meeting the applicable criterion/thresholds. The final two listings moved from Category 4a to 2 were for tidal shellfish harvesting waters since new fecal coliform data now demonstrate these waters as meeting the shellfish harvesting criteria. For more details on the Category 4a delistings, please see Section C.3.1.3.

Other notable actions taken by the state include:

- MDE issued a Section 401 Water Quality Certification for Conowingo Dam Hydroelectric Project on April 27, 2018. MDE reached a settlement agreement associated with Exelon's legal challenge to Maryland's Water Quality Certification under Section 401 of the CWA. The settlement agreement requires Exelon to invest more than $200 million in environmental projects and operational enhancements to improve water quality in the Lower Susquehanna River and Chesapeake Bay.
- Starting in 2018, MDE formed a Cold Water Advisory Committee made up of a diverse stakeholder group with the goal of providing policy, procedural, and regulation recommendations to better protect recently discovered cold or cool water streams while at the same time, reducing regulatory uncertainty. This work has thus far yielded proposed regulation clarifications for Tier I Antidegradation policy, a procedure to protect those streams with a cold or cool water existing use, several cold/cool water existing use determinations, and several new Class III or III-P designations. Future work of this advisory committee will involve the investigation of a new 'coolwater' use class, better defining what a Class IV (or IV-P) water is, and the development of a process for conducting use attainability analyses.
- In 2015, to address the urgency and wide-ranging impacts of climate change on the state, the Maryland Climate Change Commission (MCCC) was codified into law and directed with advising the Governor and General Assembly "on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change". Chaired by the MDE Secretary, MCCC, its workgroups and MDE are leading the Governor's efforts to reduce both the causes of and impacts due to climate change. In this leadership role, MDE has been a staunch participant in the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort between states to reduce carbon dioxide emissions generated by fossil fuel-fired power plants. In addition to air quality concerns, MDE recognizes the impacts of climate change on the water resources of Maryland and especially on that of disadvantaged communities. In the effort to improve Maryland's mitigation, adaptation, and resilience to these water-based impacts, MDE has developed a cross-programmatic team with the charge of using the latest science to develop next generation strategies, priorities, and policies.
- Finally, in 2013, states and EPA collaborated to develop a new approach to manage the work of the CWA 303(d) program, culminating in the development "A Long-Term Vision for Assessment, Restoration, and Protection under the CWA Section 303(d) Program". This 10-year 'Vision' concentrated on six core principles or goals: prioritization of waters for plan development based on state-specific water quality priorities and the ability to set both short- and long-term priorities; assessment of waters to provide supporting information; flexibility to develop plans using alternative approaches in lieu of traditional TMDL development if more appropriate; ability to also develop plans for water quality protection in addition to the traditional focus on restoration; improved integration of the 303(d) program with the other state and federal environmental programs; and improved outreach and communication with the public and other program partners. The 2013 Vision period is set to conclude in September 2022 and EPA, states, territories, and tribes have expressed interest in renewing the 303(d) program

Vision for another 10-year period. The Association of Clean Water Administrators (ACWA) released the document “ACWA Recommendations for Updating the 2013-Long Term Vision for the CWA 303(d) Program” on Aug. 31, 2021 and have invited states, territories, and tribes to comment and work with ACWA toward the development of the next iteration of the ‘Vision’. MDE is participating in the discussion and process to work toward this new framework that will go through 2032. As part of the new Vision, MDE will also be revising Maryland’s prioritization of impairments for TMDL development in the next two years.

PART A: INTRODUCTION

Maryland's Integrated Report, when approved by EPA, will satisfy Sections 303(d), 305(b) and 314 of the federal CWA. In Maryland, DNR and MDE are the two principal agencies responsible for water resources monitoring, assessment and protection. DNR is the primary agency responsible for ambient water monitoring. MDE sets WQS, compiles and assesses water quality data, submits the Integrated Report, regulates discharges to Maryland waters through multiple permits, enforcement and compliance activities, and develops Total Maximum Daily Loads (TMDLs) for impaired waters. Historically, water quality monitoring results were submitted in two separate reports, the annual §305(b) reports and the biennial §303(d) List (list of impaired waters). Since 2002 and in compliance with Environmental Protection Agency guidance on 303(d) listing and 305(b) reporting, these formerly independent responsibilities have evolved into a combined reporting structure called the Integrated Report (IR).

The IR utilizes five reporting categories that not only include impaired waters requiring TMDLs, but also waters that are clean or need additional monitoring data to make an assessment. These categories are:

Category 1: water bodies that meet all WQS and no use is threatened;

Category 2: water bodies meeting some WQS but with insufficient data and information to determine if other water quality standards (WQS) are being met;

Category 3: Insufficient data and information are available to determine if a water quality standard is being attained. This can be related to having an insufficient quantity of data and/or an insufficient quality of data to properly evaluate a water body's attainment status.

Category 4: one or more WQS are impaired or threatened but a TMDL is not required or has already been established. The following subcategories are included in Category 4:

- **Subcategory 4a**: TMDL already approved or established;
- **Subcategory 4b**: Other pollution control requirements (i.e., permits, consent decrees, etc.) are expected to attain WQS; and,
- **Subcategory 4c**: Water body impairment is not caused by a pollutant (e.g., habitat is limiting, dam prevents attainment of use, etc.).

Category 5: Water body is impaired, does not attain the water quality standard, and a TMDL or other acceptable pollution abatement initiative is required. This is the part of the IR historically known as the 303(d) List.

Subcategory 5s: Waterbody impairment is caused by chloride from road salt. Waters assessed in Category 5s are high priority to be addressed through pollution control requirements and restoration approaches, and lower priority for TMDL development.

Maryland uses these categories by placing each 'water body-pollutant' combination into one of the five categories. Doing this often causes a single water body to be included in multiple categories for different pollutants. For example, Loch Raven Reservoir is listed in Category 4a (impaired, TMDL completed) for sedimentation/siltation and also in Category 2 (meets WQS) for having levels of copper that meet WQS. This helps Maryland track the status of each pollutant for which a water body has been assessed.

A.1 Data Sources and Minimum Requirements

Section 130.7(B)(5) of the CWA requires that states "assemble and evaluate all existing and readily available water quality-related data and information" when compiling their Integrated Report. This includes but is not limited to the following:

(i) Waters identified by the state in its most recent Section 305(b) Report as "partially meeting" or "not meeting" designated uses;

(ii) Waters for which dilution calculations or predictive models indicate non-attainment of applicable WQS;

(iii) Waters for which water quality problems have been reported by local, state, or federal agencies; members of the public or academic institutions; and,

(iv) Waters identified by the state as impaired in a nonpoint source assessment submitted to EPA under Section 319 of the CWA or in any updates of the assessment.

With the integration of sections 305(b) and 303(d) of the CWA and the adoption of a multi-category reporting structure, Maryland originally maintained a two-tiered approach to data quality. For the Combined 2020-2022 IR, Maryland reevaluated the system to promote greater consistency with Virginia Department of Environmental Quality (DEQ) and The Chesapeake Monitoring Cooperative and has refined the data evaluation process to incorporate three tiers of data quality.

Tier III data are legally defensible data that can be used for regulatory decision-making purposes. Tier III data are used to list or delist waters (Category 2 or 5) on the Integrated Report and are subject to the highest data quality standards. Maryland waters identified as impaired using Tier III data may require a TMDL or other regulatory actions. These data should be accompanied by a Quality Assurance Project Plan (QAPP) consistent with EPA data guidance specified in Guidance for QAPPs (U.S. EPA 2002a). Tier III data analysis must also be consistent with Maryland's Assessment Methodologies (see Section C.2).

Tier II data are data with a defined methodology but do not meet Tier III data requirements and are not used to make regulatory assessment decisions (Category 2 or Category 5 of the IR). However, waters with this level of data may be placed in Category 3 of the IR, denoting that there are insufficient data to make an assessment and that follow up monitoring is necessary. Tier II data may be used to track performance of TMDL implementation, help target stream segments for WQS attainment assessments, or identify waters for MDE follow-up monitoring. These data should be accompanied by a QAPP consistent with EPA data guidance specified in Guidance for QAPPs (U.S. EPA 2002a) or other equivalent documentation. Tier II data may have an incomplete QAPP or may use a monitoring method similar to MDE protocols but not fully approved by MDE due to differences in sampling or testing methodology.

Tier I data do not meet the requirements of Tier II and Tier III but are of known quality and as a result still contribute to the understanding of the health of Maryland's waters. Tier I data may be used for educational or outreach purposes, location information where monitoring is taking place, baseline data, assessing the general conditions of surface waters in Maryland, and highlighting community projects that are implemented to improve the health of water bodies. These data do not require a QAPP consistent with EPA data guidance specified in Guidance for QAPPs (U.S. EPA 2002a) but uniform methodology is recommended. Tier I data may have a QAPP, SOPs and/or lab methods that do not meet MDE quality assurance/quality control methods. These data may include land use data, visual observations of water quality condition, or data not consistent with Maryland's Assessment Methodologies.

For more information on data quality tiers, please see MDE's webpage for submitting water quality data found here: https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Pages/Data-Solicitation.aspx

Table 3 below identifies the organizations and/or programs that submitted data to MDE for the Combined 2020-2022 IR.

Table 3: Organizations/Programs that submitted water quality data for consideration in the Combined 2020-2022 Integrated Report.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Anne Arundel Community College Environmental Center	Bacteria data and physical parameters collected around Anne Arundel County.	physical parameter, bacteria	I	Data used for informational purposes. Data needs to be accompanied by a QAPP or similar documentation.
Anne Arundel County	Non-tidal biological monitoring data from streams around Anne Arundel County.	benthic and fish indices of biological integrity	II	Data used for informational purposes. Biological data will undergo full vetting to be integrated into the biological assessment for future IRs.
Antietam-Conococheague Watershed Alliance	Monthly water quality, bacteria, and temperature sampling in the Antietam and Conococheague Creek Watersheds.	water quality, bacteria, benthic macroinvertebrates, water temperature logger	III	Data used to update nontidal assessments.
Arundel Rivers Association	Water quality and bacteria assessments for tidal and nontidal South River.	water quality, bacteria	Tidal- III, Nontidal- I	After full vetting, tidal dissolved oxygen data was integrated with the Chesapeake Bay Program assessments used for this IR. Nontidal data used for informational purposes. Clarifications needed in QAPP documentation.
Audubon Naturalist Society	Non-tidal biological monitoring data from streams around Montgomery County.	benthic index of biological integrity	I	Data used for informational purposes - Benthic index of biotic integrity calculated using family level identification. Integration with state dataset not yet possible.
Baltimore County Department of Environmental Protection and Sustainability (DEPS)	Water quality, bacteria, and biological monitoring data from streams around Baltimore County.	water quality, bacteria, benthic and fish indices of biological integrity, trash	II	Water quality data used to prioritize follow-up assessments. Additional data are needed for a conclusive assessment. Some coordinates require greater precision. Biological data will undergo full vetting to be integrated into the biological assessment for future IRs.
Blue Water Baltimore	Bacteria, nutrient, and physical parameters for the Gwynns Falls and Jones Falls watersheds as well as bacteria, nutrient, and physical parameters for the tidal Patapsco River.	water quality, bacteria	III	Data used to update non-tidal assessments and specifically pH assessments. Tidal data has completed QAQC checks and will be integrated with the Chesapeake Bay Program assessments for future IRs.

Calvert County Health Department	Bacteria data collected at designated bathing beaches in Calvert County	Enterococcus levels	III	Data used to update beach assessments.
City of Baltimore, DPW, office of Compliance and Research	Water quality data from the City of Baltimore's Ammonia Screening and Stream Impact Sampling Programs.	water quality, nutrients, bacteria	I	Data used for informational purposes. Data needs to be accompanied by metadata and a QAPP or similar documentation.
Frederick County	Non-tidal biological monitoring data from streams around Frederick County.	benthic macroinvertebrates	I	Data used for informational purposes. Data needs to be accompanied by station coordinates, metadata and a QAPP or similar documentation.
Inframark	Data from the Elkton MD water treatment plant.	pH and turbidity	I	Data used for informational purposes. Data needs to be accompanied by station coordinates, metadata and a QAPP or similar documentation.
MD Coastal Bays	Water quality data from the Coastal Bays watershed.	Nutrients, temperature, salinity, pH, DO, secchi depth, chlorophyll	II	Data used to prioritize follow-up assessments. Additional data are needed for a conclusive assessment.
MD DNR	Trophic State Index for toxic algae blooms for Transquaking and Higgins Mill Pond.	water quality and nutrients	I	Data used for informational purposes. Data needs to be accompanied by station coordinates, metadata and a QAPP or similar documentation.
MD DNR and Chesapeake Bay Program	Results of Water Quality Interpolator Model, based on measured DO levels in Chesapeake Bay.	Percent exceedance of CFD curves	III	Data used to update the DO/nutrient assessments for the Chesapeake Bay and its tidal tributaries.
MD DNR Core Trends Program	In-situ water quality and nutrients.	A comprehensive suite of nutrient species and in-situ physical parameters such as DO, pH, water temperature, etc.	III	Data used to update non-tidal assessments.
MD DNR, MDE and CBL	Baseline monitoring between 2013-2016 for constituents that might be discharged during potential Marcellus shale drilling (fracking) operations in Western Maryland.	PAH's, conductivity, strontium, barium, methane, nutrients, pH, alkalinity, ammonia, ANC, TSS, TDS, ions, metals.	III	Data used to update non-tidal assessments in Western Maryland.

MDE - Compliance Program's Sewage Overflow Database	Web-accessible Sewage Overflow Database provides data on location and volume of sewage overflows.	gallons of untreated sewage discharged from leaky infrastructure	III	Data summarizes the areas with most frequent sewage overflows. No actual water quality data.
MDE- Beach Certification Program	Bacteria data collected at designated bathing beaches by County HDs.	Enterococcus levels	III	Data used to update beach assessments.
MDE- Drinking Water	Cryptosporidium and E Coli results from raw water samples at surface water treatment plants.	Cryptosporidium and E Coli	III	Data used for informational purposes at this time due to differences in sampling methods and lack of applicable criteria.
MDE- Fish Tissue Monitoring Program	Fish Tissue data on Chlordane, Heptachlor Epoxide, PCBs, PFAS, and Hg content.	Concentration of Chlordane, Heptachlor Epoxide, PCBs, PFAS and mercury in fish tissue	III	Data used to update fish consumption assessments for Heptachlor Epoxide, PFAS, PCBs, mercury, and chlordane.
MDE- Integrated Water Planning and Field Services Programs	pH data for the Conococheague Creek watershed.	pH	III	Data used to update this pH assessment.
MDE- Lakes	Water quality and profile data collected at lakes.	Nutrients, depth, temperature, salinity, pH, DO, secchi depth, chlorophyll a, flow.	III	Data used to update lake assessments.
MDE- Shellfish Certification Program	Bacteria data for stations in the Tidal areas of the Chesapeake Bay and Coastal Bays in MD.	Fecal coliform	III	Data used to update bacteria assessments as they relate to the shellfish harvesting designated use.
MDE Temperature	Continuous water temperature data.	Temperature logger data	III	Data used to update temperature assessments.
Nanticoke Watershed Alliance	Physical water quality parameters, nutrients, chlorophyll a, and bacteria samples collected from both tidal and nontidal waters in the Nanticoke River watershed.	DO, salinity, Secchi depth, temperature, fecal coliform, enterococcus, chlorophyll a, nutrients	III	Data used to update nontidal assessments. Tidal data has completed QAQC checks and will be integrated with the Chesapeake Bay Program assessments for future IRs.
Octoraro Watershed Association	Water quality data for the Octoraro Watershed.	Conductivity, DO, nutrients, pH, salinity, water temperature	I	Data used for informational purposes. Data needs to be accompanied by a QAPP or similar documentation.

Prince George's County	Non-tidal biological monitoring data from streams around Prince George's County.	benthic and fish indices of biological integrity	II	Data used for informational purposes. Biological data will undergo full vetting to be integrated into the biological assessment for future IRs.
Shore Rivers	Tidal water quality data for the Chester, Choptank, Miles-Wye, and Sassafras Rivers.	Depth, water clarity, salinity, DO, temperature, nutrients, chlorophyll a.	I	Full vetting of data still needed (through the CMC). Data may be integrated with Chesapeake Bay Program assessments in future IRs.
The Elk and North East River Watershed Association (ENERWA)	Water quality data for the Elk and North East Rivers.	Conductivity, DO, nutrients, pH, water clarity, water temperature	II	Data used for informational purposes. Data needs to be accompanied by QAPP or similar documentation. pH sampling methods not comparable to methods for assessment.
VA DEQ Fish Tissue project	Fish tissue metals study. Samples were collected from 6 Potomac River Embayments.	Metals in fish tissue	III	Data used to update fish consumption assessments.
Virginia Institute of Marine Science and MD DNR	Counts of areal submerged aquatic vegetation (SAV) coverage and measured water clarity for select tidal tributaries to the Chesapeake Bay.	SAV coverage (acres) and water clarity acres	III	Data used to update the SAV/sediment assessments for the Chesapeake Bay and its tidal tributaries.

A.1.1 Quality Control of Water Quality Datasets

Data quality in Maryland's water monitoring programs is defined through implementation of the agency's quality control program (e.g. DNR's and MDE's Quality Management Plan), QAPP for each monitoring program, and field and laboratory Standard Operating Procedures (SOP). Water monitoring programs conducted under contract to EPA must have QAPPs approved by the EPA Regional or Chesapeake Bay Program Quality Assurance (QA) Officer prior to initiating monitoring activities.

Details in each program's QAPP define data quality indicators by establishing quality control and measurement performance criteria as part of the program's planning and development. Such measures help ensure there is a well-defined system in place to assess and ensure the quality of the data.

Water monitoring programs conducted by a local agency, educational institution, consultant or citizen group that intend to have their data used for regulatory decisions (Tier III data) should have a QAPP consistent with EPA data guidance specified in Guidance for QAPPs (U.S. EPA 2002a). For state analysts to review these contributed data with any confidence, the quantitative aspects of these data need to be defined.

Some of the data quality aspects that need to be considered include:

Precision - How reproducible are the data? Are sample collection, handling and analytical work done consistently each time samples are collected and processed?

Accuracy/Bias - How well do the measurements reflect what is actually in the sample? How far away are results from the "true" value, and are the measures consistently above or below this value?

Representativeness - How well do the sample data characterize ambient environmental conditions?

Comparability – How similar are results from other studies or from similar locations of the same study, or from different times of the year, etc.? Are similar sampling and analytical methods followed to ensure comparability? Do observations of field conditions support or explain poor comparability?

Completeness – Is the quality and amount of data collected sufficient to assess water quality conditions or can this data be appended to other, existing data collected at the same site or nearby to provide enough information to make an assessment decision?

Sensitivity - Are the field and/or laboratory methods sensitive enough to quantify parameters at or below the regulatory standards and at what threshold can an analytical measure maintain confidence in results?

QAPPs will likely not address all of these issues and there are often no quantitative tests or insufficient Quality Control (QC) data available to do so. In these instances, best professional judgment may be required as these aspects can be difficult to address, even if there is a monitoring QAPP. For some issues, there is no quantitative test and often little, if any, quality assurance data provided with contributed data. In most instances, an analyst's review of available monitoring program documentation and data are subjective. Once data quality is considered acceptable (or at least not objectionable), the dataset review process moves to a more quantitative review stage.

A.1.2 Water Quality Data Review

The designated uses defined in the Code of Maryland Regulations are assessed by relatively few field and analytical measures. Water temperature, dissolved oxygen, pH, turbidity, water clarity (Secchi depth or light extinction), acres of estuarine grasses, ammonia, biological integrity, and certain bacteria levels define the principal data used to assess criteria attainment. Various measures of nitrogen and phosphorus (nutrients) have not been defined in terms of criteria, although exceedance of dissolved oxygen or chlorophyll a criteria or nuisance levels of algae are attributed to high levels of nutrients. Except for special studies or as a discharge permit requirement, metals, inorganic and organic parameters defined as criteria are not routinely measured due to the high cost of analysis and few of these substances are found in ambient waters at levels exceeding criteria. Specific toxins known to be directly related to human health (i.e., mercury and PCBs) are assessed through MDE's fish and shellfish monitoring programs.

Water quality datasets reviewed for assessing use support are first examined in terms of a QAPP or other reports that define monitoring objectives and quality control. For selected parameters, the data are reviewed for sufficient sample size, data distribution (type and outliers/errors) and spatial and temporal distribution in the field. Censored data and field comments are examined for unusual events that may affect data quality (e.g., storm event). Data are examined for seasonality and known correlations (e.g., conductivity and salinity) are reviewed. Censored data are noted and may be excluded from the analysis.

Not all water quality criteria are assessed using this approach. Some assessments are conducted by other state programs using peer-reviewed or defined methods (e.g., Maryland's assessment methodologies) and are not re-evaluated using other approaches. Examples include; assessment of algal samples, the state's probabilistic non-tidal living resource survey (MD Biological Stream Survey), fish kill and bacterial assessments, bathing and shellfish harvesting restrictions, and toxic contaminants in fish tissue, shellstock and sediments.

Some criteria assessments are conducted externally by other agencies and programs such as VA institute of Marine Science, MD DNR, Versar, Inc., Old Dominion University, and EPA's Chesapeake Bay Program. In these circumstances, the assessment methods are peer reviewed and results are provided to the state. Criteria assessed in this manner are not re-evaluated. Examples include; for Maryland's Chesapeake Bay and tidal tributaries, benthic community criteria, aquatic grass coverage, water clarity, and dissolved oxygen.

MDE supports the use of computer models and other innovative approaches to water quality monitoring and assessment. Maryland and the Bay partners have also relied heavily on the Chesapeake Bay model to develop loading allocations, assess the effectiveness of best management practices, and guide implementation efforts. Several different modeling approaches have also been used in TMDL development. With the large number of biological impairments in Category 5 of the IR, Maryland has been relying more heavily on land use analyses, GIS modeling, data mining, and other innovative approaches to identify stressors, define ecological processes, and develop TMDLs.

PART B: BACKGROUND

B.1 Total Waters

Maryland is fortunate to have an incredible diversity of aquatic resources. The low-lying, coastal plain region in the eastern part of the state includes the oceanic zone as well as the estuarine waters of both the Coastal and Chesapeake Bays. Moving further west and up through the rolling hills of the Piedmont region, the tidal influences give way to flowing streams and the Liberty, Loch Raven, and Prettyboy reservoir systems. Along the western borders of the state is the Highland region where the state's highest peaks are located, and which includes three distinct geological provinces (the Blue Ridge, the Ridge and Valley province, and the Appalachian Plateaus). Estimates of Maryland's total surface waters across these regions are given in Table 4.

Table 4: Scope of Maryland's Surface Waters.

		Value	Scale	Source
State population		6,177,224	N/A	U.S. Census Bureau, 2020
Surface Area	Total (square miles)	12,193	Unknown	DNR 2001
	Land (square miles)	9,844		
Rivers and streams (miles)		19,127	1:24,000 NHD Coverage	National Hydrography Dataset, 2012
Impoundments	All Lakes/Reservoirs (number/acres)	947 lakes / 77,965	1:100,000 (RF3)	EPA, 1991
	Significant Publicly-owned (number/acres)	60 lakes / 21,876	1:24,000 NHD Coverage	USGS, MDE, 2012
Estuaries/Bays (square miles)		2,451	1:24,000	Chesapeake Bay Program, MDE, 2012
Ocean coast (square miles)		107	1:24,000	MDE, 2012
Wetlands	Freshwater (acres)	528,877	Unknown	Genuine Progress Indicator, 2013
	Tidal (acres)	237,042	Unknown	Genuine Progress Indicator, 2013

*Most of these numbers are based on the use of the 1:24,000 scale, USGS National Hydrography Dataset (NHD) coverage.

B.1.1 Water Quality Standards

A water body is considered "impaired" when it does not support a designated use [see Code of Maryland Regulations §26.08.02.02 at https://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.02.htm]. Maryland's water quality standards (WQS) assign use classes or groupings of specific designated uses to each body of water. The following is a generalized list of the four primary classes. Each of these may also be given a "-P" suffix which denotes that the water body also supports public water supply.

Class I waters: Water contact recreation, and protection of non-tidal warm water aquatic life;
Class II waters: Support of estuarine and marine aquatic life and shellfish harvesting;
Class III waters: Non-tidal cold water; and,
Class IV waters: Non-tidal Recreational trout waters.

Each class then has an appropriate subset of specific designated uses. Water bodies assigned a use class are expected to support the entire subset of designated uses for that class. The only exception to this is for Class II waters which may or may not support shellfish harvesting (based on possible shellfish habitat) or other subcategory designated uses (e.g. denoted with an asterisk in the table below) specific to certain locales. Table 5 illustrates the specific designated uses that apply to each use class. This table shows all possible use classes in the column headings.

Table 5: Specific Designated Uses that apply to each Use Class.

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Water Contact Sports	✔	✔	✔	✔	✔	✔	✔	✔
Leisure activities involving direct contact with surface water	✔	✔	✔	✔	✔	✔	✔	✔
Fishing	✔	✔	✔	✔	✔	✔	✔	✔
Growth and Propagation of fish (other than trout), other aquatic life and wildlife	✔	✔	✔	✔	✔	✔	✔	✔
Agricultural Water Supply	✔	✔	✔	✔	✔	✔	✔	✔
Industrial Water Supply	✔	✔	✔	✔	✔	✔	✔	✔
Propagation and Harvesting of Shellfish			✔	✔				
Seasonal Migratory Fish Spawning and Nursery Use*			✔	✔				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use*			✔	✔				
Open-Water Fish and Shellfish Use*			✔	✔				
Seasonal Deep-Water Fish and Shellfish Use*			✔	✔				
Seasonal Deep-Channel Refuge Use*			✔	✔				
Growth and Propagation of Trout					✔	✔		
Capable of Supporting Adult Trout for a Put and Take Fishery							✔	✔
Public Water Supply		✔		✔		✔		✔

*These particular designated uses apply only to specific segments of the Chesapeake Bay and its tidal tributaries. They are discussed in more detail in Section B.1.1.1.

Each of the designated uses has associated water quality criteria that are then used to determine if the designated use is being supported. Such criteria can be narrative or numeric. Numeric Water Quality Criteria establish threshold values, usually based upon risk analyses or dose-response curves, for the protection of human health and aquatic life. These apply to pollutants that can be monitored and quantified to known levels of precision and accuracy, such as toxins concentrations, pH, and dissolved oxygen. Narrative criteria are less quantitative in nature but generally prohibit any undesirable water quality conditions that would preclude a water body from supporting a designated use.

The Federal CWA and its amendments require that states update their WQS every three years in what is referred to as the Triennial Review of WQS. This action includes a robust public comment process and is subject to review and approval by EPA. Maryland's WQS are updated through changes to the regulatory language in the Code of Maryland Regulations (COMAR). For more information please visit: https://mde.maryland.gov/programs/water/TMDL/WaterQualityStandards/Pages/index.aspx.

B.1.1.1 WQS for Chesapeake Bay and its Tidal Tributaries

Maryland has detailed WQS for Chesapeake Bay and its tidal tributaries to protect both aquatic resources and to provide for safe consumption of shellfish. The current aquatic resource protection standards are subcategories under Class II waters and establish five designated uses (see Figure 4) for Chesapeake Bay and its tidal tributaries, including:

Seasonal Migratory Fish Spawning and Nursery Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival, growth, and propagation of balanced populations of ecologically, recreationally, and commercially important anadromous, semi-anadromous and tidal-fresh resident fish species inhabiting spawning and nursery grounds from February 1 through May 31.

Seasonal Shallow-Water Submerged Aquatic Vegetation Designated Use –includes tidal fresh, oligohaline and mesohaline waters of the Chesapeake Bay and its tributaries that have the potential for or are supporting the survival, growth, and propagation of rooted, underwater bay grasses in tidally influenced waters between April 1 and October 1.

Open-Water Fish and Shellfish Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival, growth, and propagation of balanced, indigenous populations of ecologically, recreationally, and commercially important fish and shellfish species inhabiting open-water habitats. This subcategory applies to two distinct periods: summer (June 1 to September 30) and non-summer (October 1 through May 31). In summer, the open-water designated use in tidally influenced waters extends from shoreline to adjacent shoreline, and from the surface to the bottom or, if a pycnocline exists (preventing oxygen replenishment), to the upper measured boundary of the pycnocline. October 1 through May 31, the boundaries of this use include all tidally influenced waters from the shoreline to adjacent shoreline and down to the bottom, except when the migratory spawning and nursery designation applies.
NOTE: If a pycnocline exists but other physical circulation patterns, such as the inflow of oxygen-rich oceanic bottom waters, provide oxygen replenishment to the deep waters, this use extends to the bottom. This is mostly prevalent in the Virginia portion of the Bay.

Seasonal Deep-Water Fish and Shellfish Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival, growth, and propagation of balanced, indigenous populations of important fish and shellfish species inhabiting deep-water habitats from June 1 through September 30:

NOTE 1: In tidally influenced waters located between the measured depths of the upper and lower boundaries of the pycnocline, where a pycnocline is present and presents a barrier to oxygen replenishment; or
NOTE 2: From the upper boundary of the pycnocline down to the sediment/water interface at the bottom, where a lower boundary of the pycnocline cannot be calculated due to the depth of the water column.
NOTE 3: From October 1 to May 31, criteria for Open Water Fish and Shellfish Subcategory apply.

Seasonal Deep-Channel Refuge Designated Use - includes waters of the Chesapeake Bay and its tidal tributaries that have the potential for or are supporting the survival of balanced, indigenous populations of ecologically important benthic infaunal and epifaunal worms and clams, which provide food for bottom-feeding fish and crabs. This subcategory applies from June 1 through September 30 in tidally influenced waters where a measured pycnocline is present and presents a barrier to oxygen replenishment. Located below the measured lower boundary of the pycnocline to the bottom.
NOTE: From October 1 to May 31, criteria for Open Water Fish and Shellfish Subcategory apply.

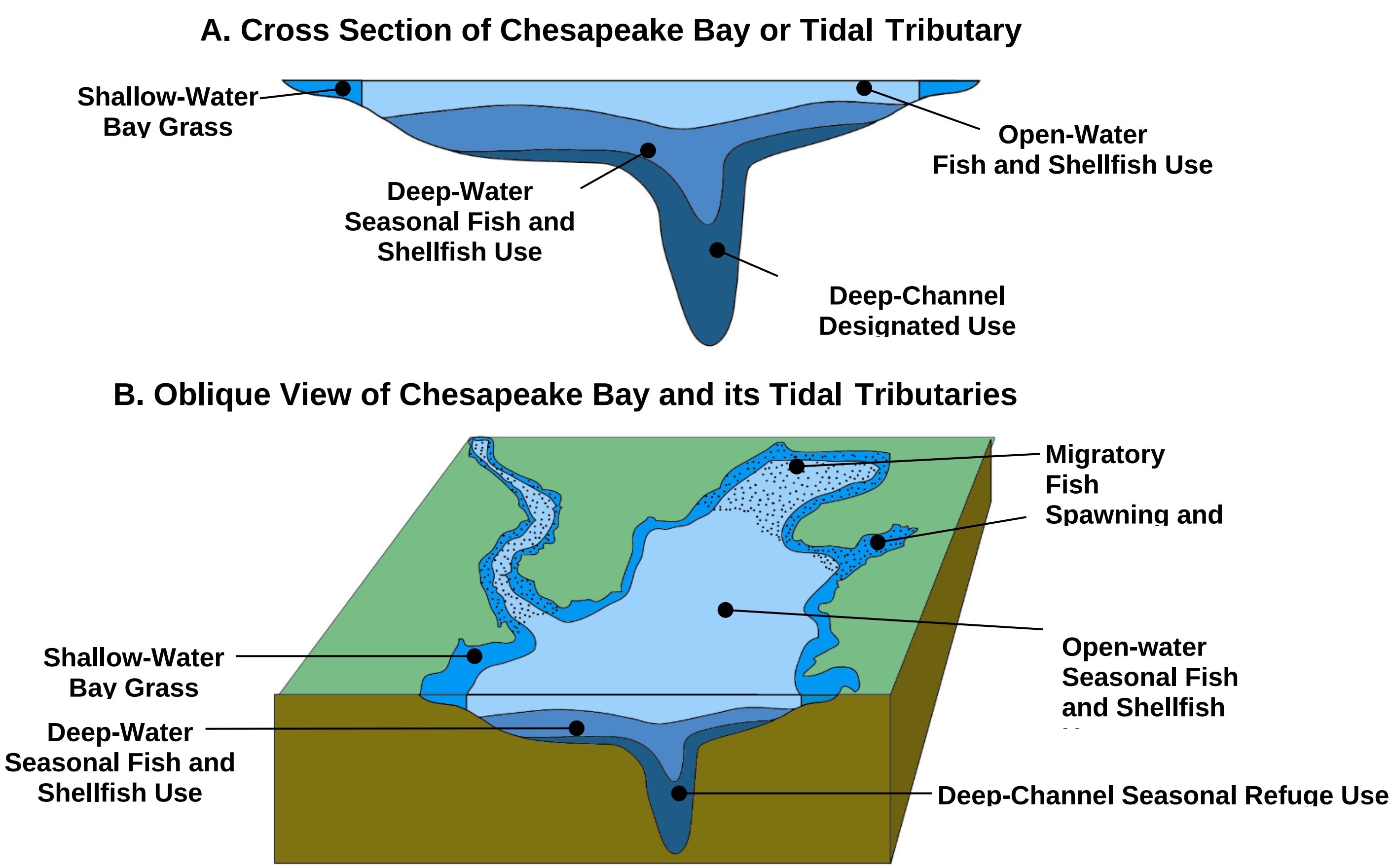

Figure 4: Illustration of the designated uses for Chesapeake Bay (Chesapeake Bay Program, 1998). Uses are both overlapping and three-dimensional.

B.2 Water Pollution Control Programs

Maryland implements a host of water pollution control programs to ensure that WQS are attained, many of which are funded by federal dollars under the CWA. Some programs are administered by different state agencies within Maryland or by local jurisdictions. Some of the programs administered by MDE are briefly cited below and web links are provided for access to more detailed information.

B.2.1 Permits

MDE is responsible for administering several permit programs to reduce the impacts of surface water and groundwater discharges to state waters. More detailed information on the State's water permits is available at: https://mde.maryland.gov/programs/Permits/WaterManagementPermits/Pages/index.aspx.

B.2.2 Tier II Waters and Antidegradation

Maryland continues to implement antidegradation regulations to better protect state waters where data indicate that water quality is significantly better than that required to support the applicable designated uses (COMAR 26.08.02.04). MDE has recently updated its web resources to clarify how these regulations are implemented and created web pages specifically designed to assist applicants for Wetlands and Waterways permits and General Permits for Stormwater associated with Construction Activity to understand what is expected during a Tier II review of their project. The antidegradation program aims to protect high quality waters by requiring more rigorous permit application reviews. The reviews identify practices that avoid, minimize, and/or mitigate the amount of buffering capacity (i.e., assimilative capacity) used by a permitted discharge. More information on Tier II can be found at: https://mde.maryland.gov/programs/Water/TMDL/WaterQualityStandards/Pages/Antidegradation_Policy.aspx.

B.2.3 Grant Programs

A number of financial assistance programs are offered and/or facilitated by MDE. Funding may be in the form of grants, low interest loans, or direct payments for specific projects. More detailed information on the range of programs administered by MDE can be found at: https://mde.maryland.gov/programs/Water/WQFA/Pages/index.aspx.

B.2.4 Total Maximum Daily Loads (TMDLs)

Waters listed on Category 5 of this Integrated Report may require a TMDL. A TMDL is an estimate of the amount or load of a particular pollutant that a water body can assimilate and still meet WQS. After a total load has been developed, upstream discharges will be further regulated to ensure the prescribed loading amounts are attained. More information on Maryland's TMDL program can be found at: https://mde.maryland.gov/programs/Water/TMDL/Pages/index.aspx. Changes to assessments in this Integrated Report that are based on newly approved TMDLs (TMDLs approved by EPA within the last two years) are described in this document in Section C.3. Worth noting, MDE has created the Maryland "TMDL Data Center" on MDE's website to make it easier for the public to search for applicable TMDLs and waste load allocations, and to see the geographic extent of waters addressed by TMDLs. This webpage also has links to the Stormwater Toolkit, other stormwater documents, and information about the Chesapeake Bay and tidal tributary Phase 6 model development process, all to assist stakeholders engaged in implementing TMDLs and restoring their waters. Maryland's TMDL Data Center is accessible at: https://mde.maryland.gov/programs/Water/TMDL/DataCenter/Pages/index.aspx.

B.2.5 Functional Stream Assessment for Stream Restoration Projects in Maryland

Due to increases in proposals to restore or enhance streams and wetlands to meet watershed restoration objectives in the Chesapeake and Coastal Bays, MDE had a need to improve assessment methodologies for assessing both adverse impacts and benefits of restoration projects when the projects are proposed in regulated resources.

To meet this need, MDE's Wetlands and Waterways Program entered into an interagency agreement with the U.S. Fish and Wildlife Service to adapt its functional pyramid approach to stream restoration specifically for Maryland. Detailed and rapid assessments and a restoration process were developed, as well as specific checklists for different types of stream restoration practices. These practices include natural channel design, valley restoration, regenerative stormwater conveyance, and analytical design approaches. The project was field tested, revised and completed in 2016. The final guidance documents may be found at: https://www.fws.gov/ChesapeakeBay/restoring-habitat/stream-restoration/stream-protocols.html.

B.2.6 Drinking Water Source Protection

MDE's Water Supply Program (WSP) is responsible for the implementation of the Safe Drinking Water Act (SDWA). In Maryland, the CWA and the SDWA are aligned very closely under the one water concept promoting a holistic approach toward protection, usage and management of the State water resources. Ensuring safe drinking water supplies for Maryland's citizens is one of the primary responsibilities of the WSP. This Program oversees numerous activities to make sure public water systems that serve about 84% of Marylanders provide safe and adequate supply of drinking water. Having safe and reliable drinking water sources, whether it is from surface water or groundwater, is of paramount importance. Therefore, protecting the drinking water sources in concert with the CWA activities is an integral function of this Administration. In addition, to protect the sustainability of the State water resources for present and future generations, the Program administers the Water Withdrawal Appropriation and Use Permitting Program.

MDE WSP promotes and encourages local governments and water suppliers to utilize tools at their disposal to protect the watershed areas contributing to their surface water supplies and wellhead protection areas providing recharge to their groundwater suppliers. Local governments have adopted ordinances to enact performance standards to protect water resources and have adopted development review procedures and restricted development through special overlay zoning ordinances in sensitive watershed and wellhead protection areas. Completed source water assessments for Maryland's public water systems document the most significant risks and vulnerabilities of water supply sources to different sources and classes of contaminants. For more information on MDE's Source Protection efforts please see:
https://mde.maryland.gov/programs/Water/water_supply/Source_Water_Assessment_Program/Pages/index.aspx.

The WSPs Water Appropriation and Use Permitting Program ensures the sustainability of the State's water resources for current and future Marylanders. Maryland law requires that water users do not unreasonably impact the State's water resources or other users of the resources. The WSP implements testing and evaluation procedures to ensure that the potential impacts from a proposed use is well understood, and that an appropriate permit decision can be made. Permits include conditions to protect the State's water resources and may include special conditions for protecting other users or downstream aquatic life. Such conditions include requirements for withdrawals to cease when low flows are reached in a water body, release minimum flows behind impoundments or design screen intakes to minimize adverse impacts on aquatic life. Groundwater permits may contain conditions for a permittee to monitor water levels or be financially responsible for replacing or upgrading nearby water supplies that are or are likely to be adversely impacted by a withdrawal. More information on Water Appropriation and Use Permits may be found at: https://mde.maryland.gov/programs/Water/water_supply/Pages/WaterAppropriationsOrUsePermits.aspx.

The WSP is actively involved in the activities of the Susquehanna River Basin Commission (SRBC) and the Interstate Commission for the Potomac River Basin (ICPRB). As a Commission member, MDE works to ensure that these valuable water resources are managed and protected for the best interests of Maryland's citizens. Both Commissions are actively involved in facilitating the protection of drinking water sources in the basins and carry out planning functions to ensure that the cumulative impact of water uses throughout the basins are properly accounted for and managed. These partnerships have fostered interstate cooperation for the improvement of water quality and managing water supply sources.

More information on Maryland's WSPs can be found at: https://mde.maryland.gov/programs/water/water_supply/Pages/index.aspx.

B.2.7 Corsica River Targeted Watershed

The Corsica River Watershed Project is a long-standing dedicated program designed to demonstrate that a tidal tributary of Chesapeake Bay can be successfully restored with a highly focused watershed restoration effort. This project was initiated in 2005 after both a TMDL (2000) and Watershed Restoration Action Strategy had been developed for the watershed. Using a variety of funding mechanisms and restoration practices, great strides have been made in reducing the estimated loads of nitrogen, phosphorus, and sediments coming from both point and nonpoint sources in the watershed. Partners to the Corsica River Targeted Program include DNR, MDE, Queen Anne's County Soil Conservation District, the Town of Centreville, Queen Anne's County, and the Corsica River Conservancy. More detailed progress information on this project can be found in the 2005-2011 Progress report at: https://mde.maryland.gov/programs/Water/319NonPointSource/Documents/Corsica_report.pdf and the Section 319 Success Story brief: https://mde.maryland.gov/programs/Water/319NonPointSource/Documents/Success%20Stories/md_corsica_success_story.pdf. For other information related to the restoration of the Corsica River please visit: https://www.corsicariverconservancy.org/.

B.2.8 Program Coordination

State agency staff participate in many work groups, committees, task forces, and other forums to coordinate and communicate state efforts with interested stakeholders. Coordination with the Chesapeake Bay Program and participation by state staff in the associated subcommittees and goal implementation teams continues to be a nexus for Maryland's water quality restoration activities. MDE staff also communicates regularly with other state agencies and stakeholders on topics including WQS development, water quality monitoring and assessment, TMDL development, and permitting. State staff also participate in groups such as the Maryland Water Monitoring Council, to ensure program coordination with local and federal government agencies, as well as the private sector, academia, non-governmental organizations, and Maryland's citizens.

B.3 Cost/Benefit Assessment

One specific reporting requirement of the CWA under §305(b), is a cost-benefit analysis of water pollution control efforts to ensure that the benefits of these programs are worth the costs. Economists have defined various ways to measure water quality benefits (e.g., Smith and Desvousges, 1986) and a number of agencies have produced estimates of water quality values based on uses (e.g., flood control value of wetlands – Leschine et al., 1997) or specific activities (e.g., recreational fishing - US Fish and Wildlife Service, 1998). Data for these efforts are often difficult to obtain, the results are complex or often address only a single use, and comparability between states or regions can be impossible. There are increasing efforts, led primarily by the academic community, to establish ecosystem service values for a variety of attributes provided by natural areas and waters. However, it is difficult at this time to apply values broadly across a range of regional and jurisdictional boundaries.

B.3.1 Program Costs

A substantial level of federal funding for water pollution control efforts comes from some agencies (EPA) while funding for aquatic resource protection and restoration may be substantially provided by other federal agencies (e.g., US Fish and Wildlife Service). Funds usually are transferred to states through a variety of appropriations – for example, certain provisions of the federal Water Pollution Control Act and its amendments provide for grants to states, including Sections 104(b) (NPDES), 106 (surface and ground water monitoring and permitting), 117 (Chesapeake Bay Program), 319 (nonpoint source pollution control), and 604(b) (water quality planning). These funds often provide seed money or low-interest loans that must be matched by state or local funds or documented in-kind efforts used on the project. A summary of federal water quality/aquatic resource-related grants to state agencies is shown in Figure 5.

While some new water programs are occasionally initiated, over the last 11 years, there has been a general decline of federal funding available to states for various water quality-related programs. That being said, more recently, small increases in Section 106, 319 and Public Water Supply funding sources have led to an increase in water program funding from 2013-2021. The figure below shows a summary of EPA budget data from traditional water grants (CWA §106, §319, §104b planning, wetlands, targeted watersheds, public water supply, and beach monitoring).

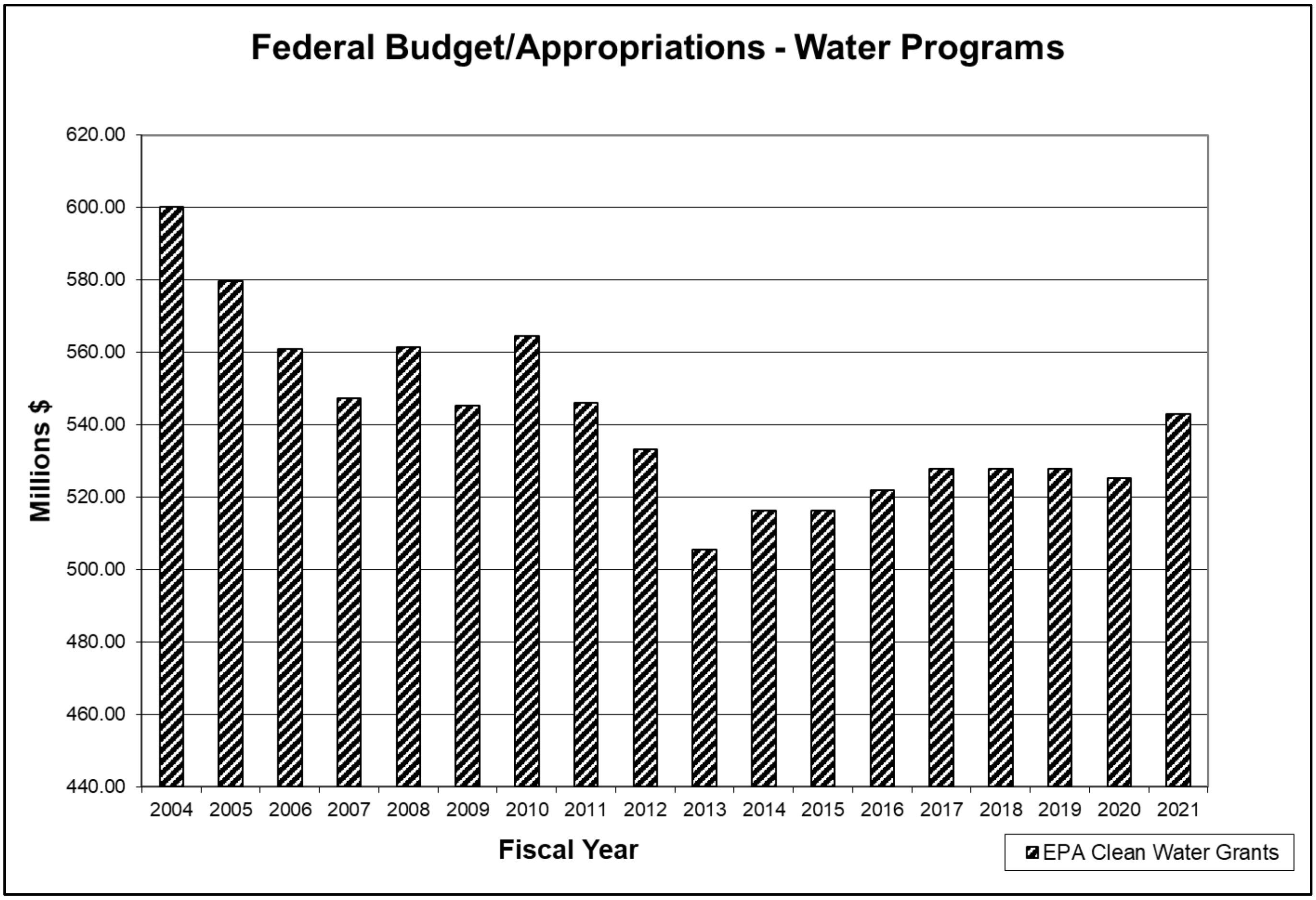

Figure 5: Federal Budget Appropriations to Water Programs (2004-2021). (Source: Association of Clean Water Administrators (ACWA) President's FY21 Budget Request Funding Chart, Updated 2-1-2020)

Although the changes may appear gradual, the loss for state programs is increased when programs that require matching funds are reduced. An example of the impact of national funding variance in §319 funding appropriation and what Maryland received is shown in Figure 6.

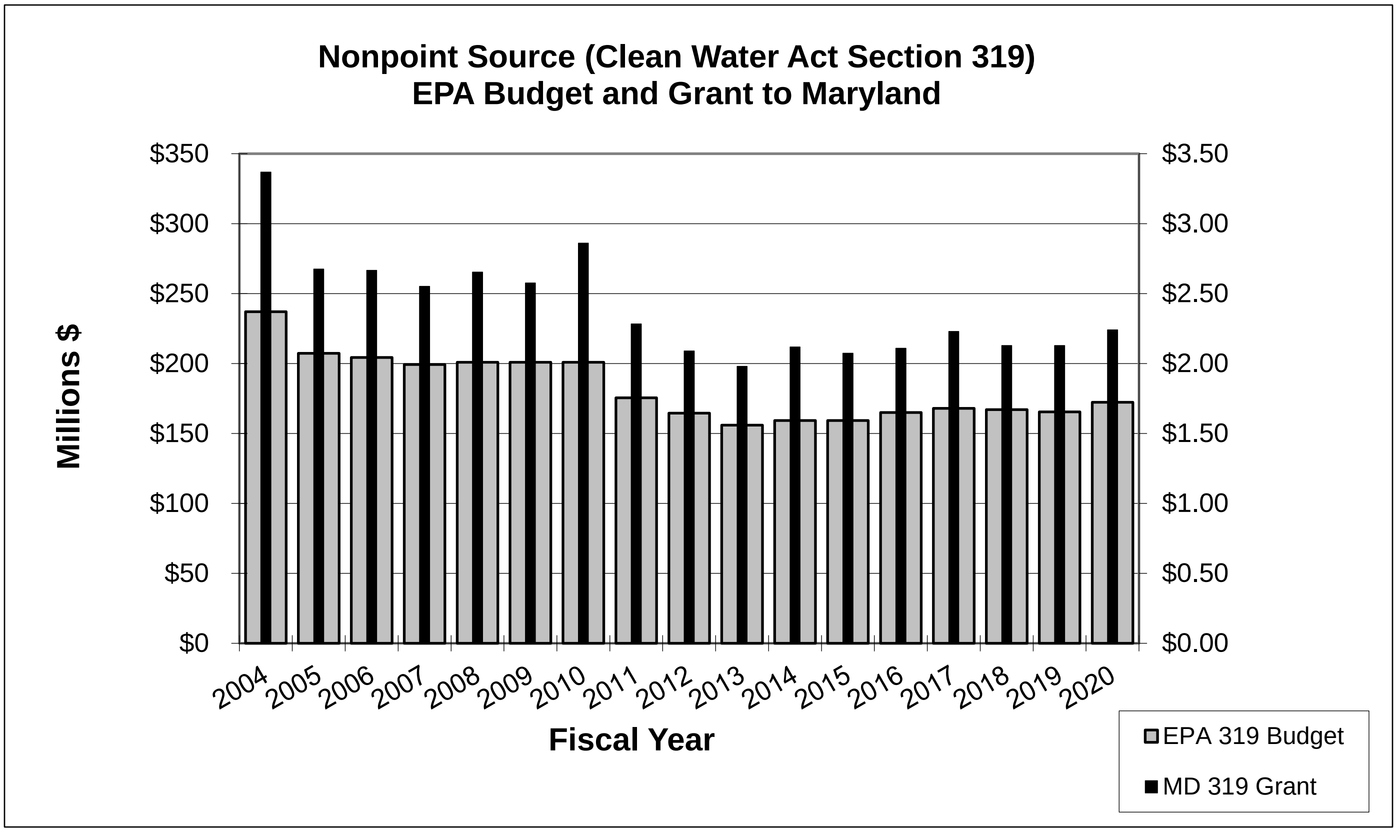

Figure 6: Federal nonpoint source total budget allocation including the Maryland totals. (Sources: Association of Clean Water Administrators FY21 Report and MDE's 319 Annual Report)

As the federal funding for water programs vary and program costs increase annually, maintenance of nearly every water program activity requires either an increased share from state/local budgets or reductions in program function.

B.3.2 Program Benefits

Clean water offers many valuable uses to individuals and communities as direct and indirect economic benefits. Beautiful beaches, whitewater rivers, and calm, cool lakes add to aesthetic appeal and contribute to a recreation and tourism industry. A plentiful supply and good quality drinking water encourages economic growth and development, increased property values, and water-based recreational opportunities and commerce. Though environmental quality ranks high in the public's perception of livable communities, an economic valuation of each of these benefits is difficult to develop.

Most often, economic benefits are determined for single uses (e.g., fishing). For example, approximately 347,000 Maryland residents are anglers (about one in 17) and residents comprise more than 81 percent of the State's anglers. In 2011, these anglers spent $535 million in the State on fishing expenses - an average of $1,212 per angler per year. Most of these expenses (62 percent) were equipment-related which included things like fishing equipment, clothing, boats, tents, etc. Trip-related costs (food, lodging, transportation, equipment rental) accounted for another large portion (37 percent) and other items (membership dues, magazines, permits, stamps and leases) amounted to $7 million (1%) (US Fish and Wildlife Service, 2013).

B.3.3 Summary

Water pollution control efforts are very costly. Much of the federal funds provided to the State, and cost-shared with additional state and local funds, are used to implement local pollution control and/or restoration programs. On an annual basis, the funds available are but a fraction of the estimated cost.

EPA needs to clearly define meaningful and comparable cost/benefit information that would enable states to assess the value of implementing directives of the CWA. A pilot state or regional program or a national study with recognized economists and federal and state participation could help simplify the complexities of this economic analysis.

B.4 Special State Concerns and Recommendations

The Chesapeake Bay continues to be a major focal point for water quality planning and restoration efforts across the state. Since 1985, it has been estimated that Maryland has reduced its nitrogen, phosphorus, and sediment loads reaching the Chesapeake Bay by 32 million pounds per year nitrogen (N), 3.5 million pounds per year phosphorus (P), and 598 million pounds per year sediment (TSS). As Maryland focuses on meeting the 2025 reduction targets established in the 2010 TMDL goals, it is estimated that the state has met its TSS goals, but will need to reduce an additional 5 million lbs. of N and 100,000 lbs. of P. The Phase III Watershed Implementation Plan (WIP) provides the strategy for how Maryland will achieve its 2025 nutrient and sediment targets. Under this plan, Maryland planned to exceed both its 2025 N and P reduction targets, setting the state on a path to meet the additional load reductions that have been recently assigned by EPA and that are required due to 2025 climate change conditions. The Phase III WIP strategy focuses on investments in wastewater and agriculture to help meet Maryland's 2025 targets, but realizes that additional reductions will also need to come from other source sectors in the future. The strategy to meet the additional climate change allocations focuses on incentives to achieve additional reductions in the wastewater sector. Maryland's progress toward meeting 2025 goals reflects the implementation of cost-effective reduction strategies. This emphasis on getting the most reductions for the lowest cost has been a key factor in all state strategies. The state and local governments have spent billions of dollars to institute the most efficient pollution reduction practices; investments that will need to continue. (MD's 2019 Chesapeake Bay Annual Progress)

An emerging contaminant of concern, PFAS are a group of man-made chemicals that include Perfluorooctanoic acid, PFOS, GenX, and many others. PFAS have been manufactured and used in a variety of both household (e.g., Teflon-coated frying pans) and industrial (e.g., fire-fighting foams) products around the globe, including in the United States since the 1940s. These chemicals do not readily break down and can accumulate in living tissue over time. Since exposure to PFAS has been linked to adverse human health effects the MDE has been actively studying the presence of PFAS in drinking water, natural water bodies, and the tissue of frequently consumed aquatic organisms.

Recent monitoring in Piscataway Creek has shown elevated levels of PFOS in both water column samples, and fish tissue as compared to control samples. After conducting a study of the health risk thresholds and comparing the levels found in fish tissue, MDE issued several fish consumption advisories (for redbreast sunfish, brown bullhead catfish, and largemouth bass) for the tidal and non-tidal portions of Piscataway Creek. As a result, these parts of Piscataway Creek were listed as impaired (Category 5) on this IR. MDE is collecting additional, targeted monitoring for PFAS compounds in certain water bodies that have been identified as having nearby potential sources of PFAS as well as sampling in locations known to be frequented by subsistence anglers and fishers. MDE will assess these sampling results and develop additional advisories and impairment listings as necessary. MDE is putting a priority on the implementation of a science-based comprehensive plan for PFAS risk that is focused first on determining whether there are locations in Maryland where there are unacceptable risks to human health associated with exposures to PFAS and whether there are locations of continuing releases of PFAS compounds. Earlier this year, MDE released a report on a first phase of sampling of public drinking water systems across Maryland. A report on the results of a second round of sampling of additional public drinking water systems, and a third round of sampling is ongoing. While maintaining this monitoring and reporting effort, Maryland will need to keep up with new advancements in PFAS monitoring, detection, and threshold development at the federal level to better understand and convey the presence, impacts, and risk reduction strategies for Maryland citizens.

The Conowingo Dam's impacts on the water quality and flow along the Susquehanna River and the downstream Chesapeake Bay continue to be a concern for Maryland and the other Chesapeake Bay watershed states. When the TMDL was first published in 2010, it was estimated that Conowingo Dam would be trapping sediment and associated nutrients through 2025. New science has determined that this is not the case, and that the reservoir behind Conowingo Dam has reached capacity. As a result, more P, TSS and N are now entering the Chesapeake Bay than were estimated when the TMDL was written. This additional pollutant load (estimated at 6 million pounds total N and 260,000 pounds total P) must be addressed in order to meet the Bay's water quality standards. Recognizing this reality, Maryland is leading a multi-pronged approach to address the Conowingo Dam's impacts. This includes:

1. Working with the CBP in developing a regional approach to address these impacts through a separate Conowingo WIP (CWIP) that pools resources from Bay jurisdictions to put pollution reduction practices in the most cost-effective locations. CWIP milestones are also being developed and will be submitted to EPA in January 2022. This collaborative and alternative approach is exploring both financing and Best Management Practice (BMP) innovations to leverage different funding sources (state, federal, local, private, other) develop creditable nature-based and in-water practices to accelerate and expand restoration efforts; and
2. MDE reached a settlement agreement associated with the Conowingo Dam and Exelon's legal challenge to Maryland's Water Quality Certification under section 401 of the federal Clean Water Act. Maryland negotiated a related $200 million settlement agreement requiring Exelon to reduce Conowingo nutrient pollution, and other ecosystem impacts such as fish passage and debris management. As of this writing, the first down payment of this settlement agreement has been received by the state. MDE is also in the process of wrapping up a stakeholder engagement process to receive public input on the type of nutrient reduction projects funded with settlement monies; and,
3. Maryland is also showing strong state leadership in addressing Conowingo impacts by implementing a sediment characterization and innovative reuse and beneficial use pilot project to provide better information on the quality of sediments behind the dam, dredging costs, dredged material reuse options, scaling, and feasibility as a solution for addressing Conowingo's impacts. The sediment characterization information is being used to categorize the dredged material according to Maryland's Innovative Reuse and Beneficial Use of Dredged Material Guidance Document to help determine environmentally safe and economically feasible reuse options. Maryland also performed a Conowingo dredging demonstration in October 2021 that included additional sediment characterization and reuse evaluation of dredge area sediments. This will be followed by an economic analysis to assess the market value of different Conowingo sediment reuses and modeling to simulate different dredging scenarios and their influence on Bay water quality. The overall pilot project should be complete in spring 2022, and the lessons learned will help expand our understanding of the pollution load reductions associated with dredging and the cost-effectiveness of dredging as a BMP. Achieving success in managing the impacts of Conowingo Dam will require ongoing monitoring and diligence to ensure that the commitments of the settlement agreement are met, and upstream partners do their part in reducing loads of pollutants coming down the Susquehanna River.

Maryland also continues to grapple with the global and local concerns associated with climate change. With 3,100 miles of shoreline, Maryland is the fourth most vulnerable state to suffer the effects of sea-level rise associated with climate change. MDE is leading Governor Hogan's efforts to reduce greenhouse gas (GHG) emissions while creating jobs and benefiting the economy, as required by the Greenhouse Gas Reduction Act (GGRA). Although many initiatives throughout the State contribute to these efforts, the Regional Greenhouse Gas Initiative (RGGI) and the Maryland Commission on Climate Change (MCCC) are key efforts by MDE.

In addition, in fall 2019, MDE released a comprehensive, economy-wide draft plan to dramatically reduce GHG emissions that contribute to climate change. After more than a year of analysis using the latest science, and listening to Marylanders and a variety of stakeholders, the final plan was published. Its 100-plus bold and comprehensive programs and measures set Maryland on an ambitious path to serve as a model for how the nation can respond to climate change while also supporting economic growth and adding new jobs. The plan pays particular attention to address the needs of underserved and disadvantaged areas throughout our state. In addition, MDE's Water and Science Administration has adopted the mantra that "climate change is water change," and has implemented a climate change team within the administration to identify new opportunities for building on policies and procedures for mitigating, adapting to and providing resilience to climate change.

Related to the impacts of climate change and also those of urban stormwater, Maryland, like many other states, is seeing trends of increasing surface water temperatures. In an effort to mitigate these trends and the future impacts of climate change, Maryland has placed a renewed emphasis on monitoring for thermal pollution, developing temperature modeling tools to guide management efforts, and clarifying its water quality standards for protecting Class III (and III-P) cold waters. For this IR, 74 new impairment listings for temperature were added to an already existing 100 temperature impairments. If Maryland is to make significant headway in protecting its diminishing cold water streams, it will have to move forward with the water quality standards improvements proposed and use the modeling tools at its disposal to guide local management actions and restoration practices.

The salinization of state fresh waters due to road salt application continues to be a major challenge. Declining aquatic life communities have been linked to elevated chloride levels throughout Maryland. Salt usage and its impacts, including chloride impairments, can be reduced while maintaining safety and mobility. State requirements for MDOT SHA's Salt Management Plan are already in place and being implemented. Revised five-year permits for Maryland's large Phase I MS4s, issued in 2021, include similar Salt Management Plan requirements. Other strategies for reducing salt application include increasing public awareness through MDE's salt web pages, and voluntary actions such as private applicator training. This issue will require ongoing study and adaptation as the state and its partners determine the most effective ways to reduce impacts of road salt usage.

Since early 2020 through to the present, the world has experienced an incredibly deadly and disruptive pandemic due to COVID-19. Similar to how it has affected other aspects of daily life, the pandemic has also impacted the field of water quality monitoring and assessment. In some cases, field studies had to be postponed. In other cases, new field procedures were devised, and technological adaptations had to be implemented quickly to facilitate the continued work of water quality assessment. Interestingly, water monitoring even became a source of information for combating the virus as it was used for predicting outbreaks and hotspots. All through it, the work of water quality continues to be completed as staff have proven their commitment to the task and flexibility in how to get it done. It is this entrepreneurial spirit and creative thinking that will enable states like Maryland to continue the work of assessing, restoring, and protecting our nation’s and state’s waters through future challenges that are sure to come.

PART C: SURFACE WATER MONITORING AND ASSESSMENT

C.1 Monitoring Program

In December 2009, Maryland completed the last update of its comprehensive water monitoring strategy https://mde.maryland.gov/programs/Water/TMDL/MD-AWQMS/Documents/Maryland_Monitoring_Strategy2009.pdf. Maryland's water quality monitoring programs are designed to support State WQS (Code of Maryland Regulations Title 26, Subtitle 08) for the protection of both human health and aquatic life. This strategy identifies the programs, processes and procedures that have been institutionalized to ensure state monitoring activities continue to meet defined programmatic goals and objectives. The strategy also discusses data management and quality assurance/quality control procedures implemented across the state to preserve data integrity and guarantee that data are of sufficient quality and quantity to meet the intended use. Finally, this document serves as a road map for assigning monitoring priorities and addressing gaps in current monitoring programs. It has proven to be especially useful as declining monitoring budgets have increased the need for greater monitoring efficiency.

C.2 Assessment Methodologies Overview

Starting in 2002, Maryland developed and solicited public review of the assessment methodologies used to document the state's assessment of its WQS and which establish objective and statistically based approaches for determining water body impairment. These methodologies are designed to provide consistency and transparency in Integrated Reporting so that the public and other interested stakeholders understand how assessment decisions are made and can independently verify listing decisions. The assessment methodologies are living documents that can be revised as new statistical approaches, technologies, or other improved methods are identified. For the Combined 2020-2022 reporting cycle, changes were made to three assessment methodologies and another new assessment methodology was created. The Listing Methodology for Identifying Waters Impaired by Bacteria in Maryland's Integrated Report, The Fish Tissue Assessment Methodology section which is part of the Methodology for Determining Impaired Waters By Chemical Contaminants for Maryland's Integrated Report of Surface Water Quality, and the Temperature Assessment Methodology for Use III (-P) Streams in Maryland were all updated. The Delisting Methodology for Biological Assessments is a new methodology. Please refer to Section H of this report for more details on the updates and links to the methodologies.

All of Maryland's current assessment methodologies are also available on MDE's website at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/ir_listing_methodologies.aspx. The public is invited to review and comment on any of these methodologies during the public review period for the Integrated Report. Comments should be submitted in writing to Matthew Stover at matthew.stover@maryland.gov.

C.3 Assessment Results

Maryland assesses state waters using data generated by both long-term ongoing monitoring programs as well as short-term targeted monitoring efforts. These monitoring programs predominantly sample four water body types (flowing waters, impoundments, estuarine waters, and beaches) found throughout Maryland and collect water quality samples for both conventional and toxic pollutants. Although many assessments are still based on data collected by state agencies, MDE continues to make greater use of data collected by County governments and NGOs. Using datasets from such organizations can help to fill data gaps and create valuable partnerships for meeting clean water goals. The following sections provide assessment summaries for the whole state as well as for particular water body types found throughout Maryland.

C.3.1 Assessment Summary

The following table summarizes the water quality status of all of Maryland's waters. It should be noted that for the combined 2020-2022 IR cycle, Maryland utilized EPA's Assessment, TMDL Tracking and Implementation System (ATTAINS) for all assessment summaries. Starting with the 2018 Integrated Report, EPA requires all states to submit their assessment decisions to ATTAINS, which is EPA's electronic reporting database for Integrated Reports and TMDLs. ATTAINS data are made available to the public through EPA's How's My Waterway interactive webpage and mapping tool. To promote greater consistency between the information the public will access in How's My Waterway and the Integrated Report, Maryland is reporting the summary information that is calculated within ATTAINS reports.

ATTAINS reporting calculates assessment summary numbers differently than Maryland has done in the past. In previous reports, Maryland tallied assessment results by hand defaulting to the worst-case scenario categories that symbolize impairment (4a, 4b, 4c, or 5) when a single water body was assessed for multiple pollutants and was impaired for at least one. Calculating the assessment summary numbers by hand also ensured that any assessment units that overlapped geospatially (i.e. a portion of a waterbody is covered by two or more assessment unit IDs) would only be counted towards the total size once. ATTAINS reporting also defaults to the worst-case scenario categories that symbolize impairment if a single waterbody has been assessed for multiple pollutants and is impaired for at least one, but it also counts every assessment unit separately even if the assessment units overlap geospatially. Therefore, the assessment summaries on the assessment unit level using the ATTAINS reporting will have larger numbers for each Category due to the double or even triple counting of a single geographic area if that area is covered by multiple assessment units. This also causes the size of the waters assessed to appear greater than the size of the total waters in the State. Alternatively, certain designated use summary numbers will be accurate since some designated uses never result in overlapping assessment units (i.e. fishing, recreation, Chesapeake Bay-specific uses); whereas, the aquatic life designated use summary numbers will be larger than expected since many of those related assessment units overlap. Finally, because identical parameters never result in overlapping assessment units (i.e. a portion of a waterbody will not be assessed for the same parameter in more than one assessment unit), parameter summary numbers are expected to be accurate and not impacted by the overlapping assessment unit issue.

For more information on ATTAINS please see https://www.epa.gov/waterdata/attains.

To access How's My Waterway please see https://www.epa.gov/waterdata/hows-my-waterway.

The reader is cautioned against using these summary numbers to track statewide water quality progress. In addition to the changes in this cycle from the ATTAINS reporting, there have also been changes in the GIS scales used to calculate the waterbody sizes in this cycle as well as in the 2012 IR cycle. There are also other various changes from cycle to cycle in assessment methodologies, reporting calculations and even the normal category changes. MDE is committed to addressing the issue related to overlapping assessment units in a successive IR cycle so that the ATTAINS reporting summaries accurately represent MD's water quality status. Other useful water quality tracking information can be found at the MDE's web page describing Maryland's Two Year Milestones for Chesapeake Bay restoration (https://mde.maryland.gov/programs/Water/TMDL/TMDLImplementation/Pages/milestones.aspx) which describes the State's progress towards meeting the Chesapeake Bay TMDLs.

Table 6: Size of Surface Waters Assigned to Reporting Categories.

Waterbody Type	Category							Total in State	Total Assessed**
	1	2	3	4a	4b	4c	5		
River/stream miles	0	6,650.04	1,851.48	6,570.69	1.05	345.33	9,775.86	19,185.29	23,342.97
Lake/pond acres	0	2,445.83	414.05	13,126.48	0	0	4,288.02	21,876.08	19,860.33
Estuarine square miles	0	422.81	214.82	1,584.41	0	0	1,960.55	4,183.02	3,967.77
Ocean square miles	0	0	107.39	0	0	0	0	107.39	0.00
Beach miles	0	14.83	0.44	0	0	0	0	15.27	14.83
Freshwater wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tidal wetland acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*Maryland utilizes a multi-category report structure for the IR which can potentially report a single water body in multiple listing categories. In some cases, this causes the size of the waters assessed to be greater than the size of the total waters in the State due to double counting.
**The Total Assessed column is the sum of every Category except for Category 3 waters since Category 3 includes waters that are unassessed. The Category 3 waters are included in the "Total in State" calculations.

C.3.1.1 New Impairment Listings

There are one hundred one (101) additions to the list of Category 5 (impaired, TMDL needed) waters in 2020-2022. Two of the new Category 5 listings resulted from MDE's Biological Stressor Identification Analyses (BSID). The purpose of these analyses, as discussed in the Biological Assessment Methodology for Non-tidal Streams, is to identify the probable pollutants that are responsible for impairing watershed biological integrity. Both of the biostressor listings are for sulfate. One replaced a category 5 listing with cause unknown and one was a new sulfate listing from a 2014 BSID. In addition, there are seventy four new temperature listings, sixteen new fecal coliform listings in shellfish harvesting waters, three new phosphorus listings in lakes, three new chlorophyll-a listings in lakes, two new perfluorooctane sulfonate (PFOS) in fish tissue listings, and one new high pH listing. The table below provides more detailed information regarding these new listings.

Table 7: New Category 5 (impaired, may need a TMDL) Listings on the 2020-2022 Integrated Report.

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-021311050955-Centennial_Lake	Little Patuxent River	IMPOUNDMENT	Public Water Supply	Chlorophyll-a
MD-021402080857-Clopper_Lake	Seneca Creek	IMPOUNDMENT	Public Water Supply	Chlorophyll-a
MD-050202020026-Broadford_Lake	Little Youghiogheny River	IMPOUNDMENT	Public Water Supply	Chlorophyll-a
MD-021301030687-T-HerringTurville_Creeks	Isle of Wight Bay	ESTUARY	Shellfishing	Fecal Coliform
MD-CB5MH-ST_JEROMES_CREEK-2	CB5MH - Chesapeake Bay 5 Mesohaline	ESTUARY	Shellfishing	Fecal Coliform
MD-CHOMH1-Northwest_Branch_Harris_Creek	Lower Choptank River	ESTUARY	Shellfishing	Fecal Coliform
MD-EASMH-St.Michaels_Harbor	Miles River	ESTUARY	Shellfishing	Fecal Coliform
MD-FSBMH-Tedious_Creek	Fishing Bay	ESTUARY	Shellfishing	Fecal Coliform
MD-LCHMH-Fishing_Creek	Little Choptank River	ESTUARY	Shellfishing	Fecal Coliform
MD-LCHMH-Gary_and_Lee_Creeks	Little Choptank River	ESTUARY	Shellfishing	Fecal Coliform
MD-LCHMH-Pomeroy_Cove	Little Choptank River	ESTUARY	Shellfishing	Fecal Coliform
MD-LCHMH-Slaughter_Creek	Little Choptank River	ESTUARY	Shellfishing	Fecal Coliform
MD-LCHMH-Smith_Cove	Little Choptank River	ESTUARY	Shellfishing	Fecal Coliform
MD-PAXMH-Battle_Creek-4	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform
MD-PAXMH-Sotterly_Creek	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform
MD-PAXMH-Wells_Cove	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform
MD-POTMH-Smith_Creek	Potomac River Lower tidal	ESTUARY	Shellfishing	Fecal Coliform
MD-POTMH-Upper_Wicomico_River	Wicomico River	ESTUARY	Shellfishing	Fecal Coliform
MD-RHDMH_Upper_Headwaters	RHDMH - Rhode River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform
MD-02140203-Mainstem	Piscataway Creek	RIVER	Fishing	PERFLUOROOCTANE SULFONATE (PFOS) IN FISH TISSUE
MD-PISTF	PISTF - Piscataway Creek tidal Fresh	ESTUARY	Fishing	PERFLUOROOCTANE SULFONATE (PFOS) IN FISH TISSUE
MD-02140504	Conococheague Creek	RIVER	Aquatic Life and Wildlife	pH, High

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-02130306-Smithville_Lake	Marshyhope Creek	IMPOUNDMENT	Aquatic Life and Wildlife	Phosphorus, Total
MD-021304040488-Lake_Williston	Upper Choptank River	IMPOUNDMENT	Aquatic Life and Wildlife	Phosphorus, Total
MD-021305030437-WyeMills_Community_Lake	Wye River	IMPOUNDMENT	Aquatic Life and Wildlife	Phosphorus, Total
MD-02130202	Lower Pocomoke River	RIVER	Aquatic Life and Wildlife	Sulfate
MD-02141004	Georges Creek	RIVER	Aquatic Life and Wildlife	Sulfate
MD-021202020321-Deer_Creek4	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020322-Deer_Creek5	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020322-Hollands_Branch	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020322-Mill_Brook	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020323-Thomas_Run	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020324-Deer_Creek6	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020324-UTDeer_Creek	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020325-Stout_Bottle_Branch	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020327-Deer_Creek7	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020328-UTLittle_Deer_Creek	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020329-Deer_Creek8	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021202020332-Deer_Creek9	Deer Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021306090380-Principio_Creek4	Furnace Bay	RIVER	Aquatic Life and Wildlife	Temperature
MD-021306090380-Principio_Creek5	Furnace Bay	RIVER	Aquatic Life and Wildlife	Temperature
MD-021306090380-Principio_Creek6	Furnace Bay	RIVER	Aquatic Life and Wildlife	Temperature
MD-021306090380-Principio_Creek7	Furnace Bay	RIVER	Aquatic Life and Wildlife	Temperature
MD-021306090380-UTPrincipio_Creek5	Furnace Bay	RIVER	Aquatic Life and Wildlife	Temperature
MD-021306090380-UTPrincipio_Creek6	Furnace Bay	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-Deep_Run	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-DippingPond_Run2	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-Jones_Falls1	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-021309041036-Jones_Falls2	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-Jones_Falls3	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-Jones_Falls4	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-Jones_Falls5	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-Jones_Falls6	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-NBranchJones_Falls2	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-UTDippingPond_Run	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-UTJones_Falls2	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-UTJones_Falls3	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-UTMoores_Branch	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309041036-UTNBranch_Jones_Falls2	Jones Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-Gwynns_Falls1	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-Gwynns_Falls2	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-Gwynns_Falls3	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-Gwynns_Falls4	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-Red_Run2	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-Red_Run3	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-UTGwynns_Falls1	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309051045-UTRed_Run3	Gwynns Falls	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309071048-GlenFalls_Run2	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309071048-Norris_Run	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309071050-Morgan_Run2	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309071050-UTMorgan_Run	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309071052-EastBNBranch_Patapsco_River2	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309071057-UTBeaver_Run	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	Temperature

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-021309081020-UTSBranchPatapsco_River1	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081023-Piney_Run3	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081023-Piney_Run4	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081023-Piney_Run5	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081025-Gillis_Falls5	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081026-Piney_Branch	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081027-Hay_Meadow_Branch	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081028-UTSBranchPatapsco_River2	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021309081029-Middle_Run2	South Branch Patapsco River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021310021001-Jabez_Branch1	Severn River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021310021001-Jabez_Branch2	Severn River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021310021001-Jabez_Branch3	Severn River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021310021001-Jabez_Branch4	Severn River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021310021001-Jabez_Branch5	Severn River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021310021001-Jabez_Branch6	Severn River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030240-Little_Tuscarora_Creek	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030243-Fishing_Creek2	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030250-Beaver_Branch	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030250-Owens_Creek2	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030251-BigHunting_Creek3	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030251-Muddy_Run	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030252-UTHunting_Creek_Lake	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403030253-Owens_Creek1	Upper Monocacy River	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403050217-LittleCatoctin_Creek2	Catoctin Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403050218-Catoctin_Creek2	Catoctin Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403050219-Catoctin_Creek	Catoctin Creek	RIVER	Aquatic Life and Wildlife	Temperature

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant
MD-021403050219-Middle_Creek	Catoctin Creek	RIVER	Aquatic Life and Wildlife	Temperature
MD-021403050220-UTLittleCatoctin_Creek2	Catoctin Creek	RIVER	Aquatic Life and Wildlife	Temperature

It should be noted that one of the new Category 5 listings from the BSID process for the Lower Pocomoke River (assessment unit MD-02130202) replaced a Category 5 cause unknown listing for the same assessment unit. The other BSID-related listing for Georges Creek (assessment unit MD-02141004) was first identified in 2014 and identified elevated sulfate levels attributable to acid mine drainage. The 2014 BSID determined that the most appropriate management action to address the sulfate levels was the 2008 pH TMDL and no further listings would be required. Newer data suggests that elevated sulfate levels are still a concern in the Georges Creek watershed and a new Category 5 listing for sulfate for the Combined 2020-2022 IR is an appropriate action to address this pollutant.

It should also be noted that the listing for high pH in Conococheague Creek (MD-02140504) was created as a replacement of the Conococheague Creek high pH listing (MD-02140504-Multiple_segments_1) from the 2018 IR. New data, available for the 2020-2022 IR, demonstrated that the entire Conococheague Creek watershed was impaired for high pH instead of the limited segments that were designated in 2018. As a result, the assessment record for the original water body-pollutant combination was expanded so as to characterize the change in impairment status at the appropriate spatial extent. This unique assessment and listing is described in more detail in Section G.1 of this report.

Finally, Perfluorooctane Sulfonate (PFOS) is a new cause pollutant for Maryland and the two listings on this cycle are the first ones for the State. This unique assessment and listings are described in more detail in Section G.2 of this report.

There are also five assessment records which were placed directly in Category 4a (TMDL already approved or established by EPA) or 4c (impaired, TMDL not needed as impairment is not caused by a pollutant) in the 2020-2022 IR without first being listed as impaired in Category 5 (impaired, TMDL needed). The 4c assessment records for Assessment Unit MD-02130202 resulted from Biological Stressor Identification analyses that identified the lack of a riparian buffer and channelization as major stressors impacting biological communities in the Lower Pocomoke River. These are both impairments not caused by pollutants themselves but rather, anthropogenic land use changes and as a result were placed in Category 4c. MD-02140302-LAKE_LINGANORE was placed directly in category 4a since the high levels of chlorophyll-a are indicative of a phosphorus impairment that is already covered by an existing phosphorus TMDL for the lake. Two records for MD-NANMH were moved from category 3 to 4a since data showed an exceedance of the 30 day mean DO criteria for the Open Water Fish and Shellfish subcategory and the Nitrogen and Phosphorus listings were already covered by the Chesapeake Bay TMDLs.

Table 8: Listings that were put directly in a Category 4 impairment status without being previously listed in Category 5.

Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Listing Category	Pollution	Notes
MD-02130202	Lower Pocomoke River	02130202	RIVER	Aquatic Life and Wildlife	4c	Riparian Buffer, Lack of	The Biostressor analysis indicates that the lack of a riparian buffer is a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130202	Lower Pocomoke River	02130202	RIVER	Aquatic Life and Wildlife	4c	Habitat Alterations	The Biostressor analysis indicates that channelization is a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140302-LAKE_LINGANORE	Lower Monocacy River	02140302	IMPOUNDMENT	Public Water Supply	4a	Chlorophyll-a	Recent data demonstrates that chlorophyll-a levels are exceeding the criteria for Public Water Supply but the existing phosphorus TMDL covers this impairment since chlorophyll-a is still an indicator for phosphorus.
MD-NANMH	NANMH - Lower Nanticoke River Mesohaline	02130305	ESTUARY	Open-Water Fish and Shellfish Subcategory	4a	Nitrogen, Total	This segment moved from cat 3 to 4a in 2020 since data showed an exceedance of the 30 day mean DO criteria. This specific waterbody-pollutant combination was addressed by a TMDL established on 12/29/2010.
MD-NANMH	NANMH - Lower Nanticoke River Mesohaline	02130305	ESTUARY	Open-Water Fish and Shellfish Subcategory	4a	Phosphorus, Total	This segment moved from cat 3 to 4a in 2020 since data showed an exceedance of the 30 day mean DO criteria. This specific waterbody-pollutant combination was addressed by a TMDL established on 12/29/2010.

C.3.1.2 Impairment Listing Changes

Waters assessed in Category 5 require development of a TMDL. EPA recognizes that there are situations where pursuing advanced restoration approaches before developing a TMDL may be more appropriate to restore water quality (see Alternative Restoration Plans). Federal regulations also recognize that other pollution control requirements may obviate the need for a TMDL (see 40 CFR 130.7(b)(1)(iii)). States may establish additional subcategories to refine their reporting further.

For the 2020-2022 combined IR, Maryland established a new subcategory, 5s, for waters impacted by chloride. Twenty-eight waters were moved from Category 5 (2018 IR) to Subcategory 5s on the 2020-2022 IR. Waters assessed in Category 5s are high priority to be addressed through pollution control requirements and restoration approaches, and lower priority for TMDL development. Please see Table 9 below for more detailed information.

Table 9: Listings that changed from Category 5 (impaired, may need a TMDL) to Subcategory 5s (impairment caused by chloride from road salt) on the 2020-2022 Integrated Report.

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Category	Pollutant	Sources	Notes
MD-02130701	Bush River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130802	Lower Gunpowder Falls	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130805	Loch Raven Reservoir	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130901	Back River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130903	Baltimore Harbor	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing, along with others, replace the biological listing.
MD-02130904	Jones Falls	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130905	Gwynns Falls	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130906	Patapsco River Lower North Branch	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02130907	Liberty Reservoir	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Category	Pollutant	Sources	Notes
MD-02131001	Magothy River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02131003	South River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02131104	Patuxent River upper	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing addresses a portion of the biological listing and therefore replaces it on the list.
MD-02131105	Little Patuxent River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140109	Port Tobacco River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140111	Mattawoman Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140201	Potomac River Upper tidal	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140202-Wadeable_Streams	Potomac River Montgomery County	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140203	Piscataway Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140205	Anacostia River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.

Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Category	Pollutant	Sources	Notes
MD-02140207	Cabin John Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140208	Seneca Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140501-Wadeable_Streams	Potomac River Washington County	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140504	Conococheague Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02140509	Little Tonoloway Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02141002	Evitts Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02141003	Wills Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-02141004	Georges Creek	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicates that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.
MD-05020204	Casselman River	RIVER	Aquatic Life and Wildlife	5s	Chloride	Urban Runoff/Storm Sewers	The Biostressor analysis indicated that chlorides are a major stressor affecting biological integrity in this watershed. This listing replaces the biological listing.

Chloride is naturally present in most surface waters, but elevated concentrations can harm freshwater organisms. The main source of elevated chloride in Maryland Category 5s waters is urban runoff of road salt. Road salt, primarily composed of sodium chloride, is applied to paved surfaces during winter to either remove snow and ice (de-icing), or to prevent them from accumulating (anti-icing). The salt then enters Maryland’s waterways and impacts aquatic life and wildlife. The use of road salt also results in higher levels of sodium in drinking water and causes damage to public and private infrastructure including bridges, roads, cars, and stormwater treatment devices.

Maryland’s biological stressor identification process indicated that chloride is a major stressor affecting biological integrity in these Category 5s watersheds. There are no effective structural best management practices to remove chloride; therefore, an adaptive management approach to reducing salt application is appropriate. Adaptive management is an iterative decision-making process, incorporating monitoring and feedback for evaluating past actions in order to adjust future actions. Chloride pollution controls will be applied statewide.

Maryland’s salt reduction strategies include:

1. Requirement for Salt Management Plan in State law for State Highway Administration;
2. Requirements for Salt Management Plans in MS4 permits, which cover over 90% of Maryland’s impervious surface area;
3. Voluntary actions, such as private applicator training; and
4. Public awareness, partnerships with other State agencies and non-governmental organizations, and engagement with elected officials.

Through adaptive management, trend analysis, and responsible implementation, long-term goals can be established to lessen the usage of salt and reduce its impact while maintaining safety and mobility. State requirements for SHA’s Salt Management Plan are already in place and being implemented. The Plan has helped reduce salt application through increased training, tracking and recording usage, and techniques such as the use of brines. Implementation of SHA’s Plan has already resulted in approximately 50% reduction of road salt application.

More information can be found on MDE’s road salt web page.

C.3.1.3 Impairment Listings Reassessed as Not-impaired

There were a total of ten waterbody-pollutant combinations removed[2] from Category 5 in 2020-2022 (Table 10). One of these was a generic biological listing (cause unknown) that did not specify a particular pollutant or stressor as the cause of impairment. This listing has now been replaced by specific pollutant/stressor listings enumerated by the Biological Stressor Identification analyses (Table 24). Another listing, for high pH was removed from Category 5 since it was replaced with a new Category 5 listing that covered the entire 8-digit watershed. One listing was removed from Category 5 for temperature since it was erroneously assessed using the Use Class III temperature criteria and it is not a Use Class III water. The last seven listings removed from Category 5 included three for mercury in fish tissue and four for PCBs in fish tissue. All seven of these listings were moved to Category 2 on the basis of more recent data that demonstrated water quality that met the applicable criterion or threshold.

[2] The number ten does not include partial delistings (Tables 13 and 14), listings that were addressed by a TMDL (moved to Category 4a, Table 30), or listings that were in Categories 4a, 4b, or 4c but which are now meeting standards (Table 12).

Table 10: New Delistings for 2020-2022 (removed from Category 5). Please note that this table does not include waterbody-pollutant combinations for which a TMDL was established, i.e., listings that changed from Category 5 to Category 4a.

Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Pollutant	Summary Rationale
MD-02130202	Lower Pocomoke River	2130202	RIVER	Aquatic Life and Wildlife	CAUSE UNKNOWN	5
MD-021403010211-UTTuscarora_Creek	Potomac River Frederick County	02140301	RIVER	Aquatic Life and Wildlife	TEMPERATURE	2
MD-02140501-Dam3-4	Potomac River Washington County	02140501	RIVER	Fishing	PCBS IN FISH TISSUE	1
MD-02140501-Dam4-5	Potomac River Washington County	02140501	RIVER	Fishing	PCBS IN FISH TISSUE	1
MD-02140504-Mainstem	Conococheague Creek	02140504	RIVER	Fishing	MERCURY IN FISH TISSUE	1
MD-02140504-Multiple_segments_1	Conococheague Creek	02140504	RIVER	Aquatic Life and Wildlife	PH, HIGH	6
MD-02141001-Mainstem	Lower North Branch Potomac River	02141001	RIVER	Fishing	MERCURY IN FISH TISSUE	1
MD-02141005-Jennings_Randolph_Reservoir	Upper North Branch Potomac River	02141005	IMPOUNDMENT	Fishing	MERCURY IN FISH TISSUE	1
MD-CHOMH1-2-02130403	CHOMH2 - Lower Choptank River Mesohaline 2	02130403	ESTUARY	Fishing	PCBS IN FISH TISSUE	1
MD-POCOH-TF-02130202	Lower Pocomoke River	02130202	ESTUARY	Fishing	PCBS IN FISH TISSUE	1

It should be noted the listing for the unnamed tributary in Tuscarora Creek in the Potomac River Frederick County (MD-021403010211-UTTuscarora_Creek) was originally listed on Category 5 since it was erroneously designated as a Use Class III coldwater stream. The water temperature was exceeding the coldwater, Use Class III, criteria and it was listed as impaired in 2014. Upon further review, this unnamed tributary in Tuscarora Creek is actually designated as a warmwater stream, Use Class I, and is meeting the Use Class I criteria. Therefore, it was moved from Category 5 to Category 2.

Table 11: Key for the last column in Table 10.

Summary Rationale for Delisting of Segment/Pollutant Combinations	Explanation
1	State determines water quality standard is being met
2	Flaws in original listing
3	Other point source or nonpoint source controls are expected to meet WQS
4	Impairment due to non-pollutant
5	Original listing was based on a bioassessment, specific pollutants are now identified in place of biological listing
6	Original listing was removed and replaced by another listing

Another subset of assessment records that are now no longer considered impaired include eight that were previously (2018) in Category 4a (impaired, TMDL completed) but have since been moved to Category 2 (meeting some standards). One of these assessment records was a tidal tributary to the Chesapeake Bay that now meets the submerged aquatic vegetation (SAV)/water clarity criteria. Two other assessment records were listed for Fecal Coliform in Shellfishing waters and now meet the shellfish bacteria criteria. There are also two lake assessment records that were listed for total phosphorus and are now meeting the DO criteria (used as an indicator for nutrient impairment) for the Aquatic Life Designated Use. The final three records include two for Mercury in Fish Tissue and one for PCBs in Fish Tissue. All three of these assessments were moved to Category 2 on the basis of more recent data that demonstrated fish tissue met the applicable criterion or threshold.

Table 12: Whole Listings that moved from Category 4a (impaired, TMDL complete) to Category 2 (meeting some standards).

Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Pollutant	Notes
MD-CHOMH2-Lower_Choptank_River_Mainstem-2	CHOMH2 - Lower Choptank River Mesohaline 2	02130403	ESTUARY	Shellfishing	Fecal Coliform	New data shows this area is meeting the shellfish harvesting criteria. This area was covered under the previous Mainstem TMDL.
MD-02130805-Loch_Raven_Reservoir	Loch Raven Reservoir	02130805	IMPOUND MENT	Fishing	Mercury in Fish Tissue	New fish tissue data shows levels of mercury below the criteria.
MD-021308060313-Prettyboy_Reservoir	Prettyboy Reservoir	02130806	IMPOUND MENT	Fishing	Mercury in Fish Tissue	New fish tissue data shows levels of mercury below the criteria.
MD-CHSMH-02130507	Corsica River	02130507	ESTUARY	Fishing	PCBs in Fish Tissue	New data shows PCB levels above the impairment threshold. This listing only applies to the Corsica River (02130507) portion of CHSMH.
MD-CHOMH1-SWSAV	CHOMH1 - Choptank River Mesohaline mouth 1	02130403	ESTUARY	Seasonal Shallow-Water Submerged Aquatic Vegetation Subcategory	Total Suspended Solids (TSS)	This segment meets the SAV restoration goal and was thus moved to Category 2.
MD-POTMH-ST.PATRICKS_CREEK	POTMH - Lower Potomac River Mesohaline	02140105	ESTUARY	Shellfishing	Fecal Coliform	Recent data shows that the shellfish harvesting criteria are being met.
MD-02140302-LAKE_LINGANORE	Lower Monocacy River	02140302	IMPOUND MENT	Aquatic Life and Wildlife	Phosphorus, Total	Recent data demonstrates that DO levels are meeting the criteria for Aquatic Life.
MD-02130304-Johnsons_Pond	Wicomico River Headwaters	02130304	IMPOUND MENT	Aquatic Life and Wildlife	Phosphorus, Total	Recent data demonstrates that DO levels are meeting the criteria for Aquatic Life.

C.3.1.4 Listings that are split or merged

Several other impairment 'relistings' also occurred but on a more limited spatial scale. In the following instances, each water body-pollutant combination shown on the 2018 IR was reassessed at a finer spatial scale on the 2020-2022 IR. The reassessment for each revealed that some portion of the original water body remained unimpaired while another portion now exceeded water quality criteria. As a result, the assessment record for the original water body-pollutant combination was split so as to characterize the change in impairment status at different spatial scales. This occurs most often with shellfishing waters as boundaries change each cycle with varying bacteria levels and modifications to harvesting locations. The table below describes the listing Category changes and assessment record splits that occurred in the case of Battle Creek and The Little Choptank River.

Table 13: Crosswalk table showing how the original shellfishing assessment units for PAXMH-Battle Creek and LCHMH-Little Choptank River were split in the 2020-2022 Integrated Report.

Former (2018) Assessment Unit ID	Basin Code	Designated Use	Pollutant	Cate gory	New (2020-2022) Split Assessment Unit ID	2020-2022 Cate gory	Rationale
MD-PAXMH-BATTLE_CREEK	02131101	Shellfishing	Fecal Coliform	2	MD-PAXMH-BATTLE_CREEK	2	WQA approved in 2005. The area represented by this listing has been reduced three times since 2010 due to the upstream portions being relisted as impaired due to new data. See listing for Battle_Creek 2, 3, and 4.
					MD-PAXMH-Battle_Creek-4	5	This portion of Battle Creek was split from MD-PAXMH-BATTLE_CREEK to cover station 0902107A since it is not meeting the bacteria criteria for shellfish harvesting.
MD-LCHMH-Little_Choptank_River	02130402	Shellfishing	Fecal Coliform	2	MD-LCHMH-Little_Choptank_River	2	This shellfish harvesting area was split in 2022 because three areas (Gary and Lee Creeks, Smith Cove, and Pomeroy Cove) were exceeding the shellfish harvesting criteria. This main portion of this listing was extended to include the area meeting criteria
					MD-LCHMH-Gary_and_Lee_Creeks	5	This portion of the Little Choptank was split from MD-LCHMH-Little_Choptank_River since new data shows it is not meeting the shellfish harvesting criteria.
					MD-LCHMH-Pomeroy_Cove	5	This portion of the Little Choptank was split from MD-LCHMH-Little_Choptank_River since new data shows it is not meeting the shellfish harvesting criteria.
					MD-LCHMH-Smith_Cove	5	This portion of the Little Choptank was split from MD-LCHMH-Little_Choptank_River since new data shows it is not meeting the shellfish harvesting criteria.

There are also various assessment units that were merged or the Assessment Unit ID was modified to consolidate listings that covered the exact same geographic extent but had different Assessment Unit IDs. Merging these listings under one name supports Maryland's commitment to the use of the ATTAINS reporting system and makes it easier to track the listings. The changes for this cycle include fish tissue and pH assessments that had assessment units created over multiple cycles as different Assessment Unit IDs that are being merged or renamed in this cycle. The Table below describes assessment units that merged into a new or existing assessment unit or have modified Assessment Unit ID names.

Table 14: Crosswalk table showing merged or changed Assessment Units in the 2020-2022 Integrated Report.

Former (2018) Assessment Unit IDs	Basin Code	Designated Use	Pollutant	Category	New (2020-2022) Merged Assessment Unit ID	Pollutant	2020-2022 Category	Rationale
MD-02140504-Multiple_segments_1	02140504	Aquatic Life and Wildlife	pH, High	5	MD-02140504	pH, High	5	MD-02140504-Multiple_segments_1 and MD-02140504-Multiple_segments_2 were merged into one large segment called MD-02140504. A 2020 study showed that the entire watershed is impaired for pH due to high nutrient input and natural karst geology.
MD-02140504-Multiple_segments_2	02140504	Aquatic Life and Wildlife	pH, High	2				
MD-02131104-Mainstem	2131104	Fishing	PCBs in Fish Tissue	2	MD-02131104-Upper_Mainstem	PCBs in Fish Tissue	2	Data on pumpkinseed sunfish, bluegill, green sunfish, and yellow bullhead demonstrate PCB levels below the listing threshold. This record name was changed in 2022 to upper mainstem since it is the same location as the Mercury listing.
MD-02131104-Upper_Mainstem	2131104	Fishing	Mercury in Fish Tissue	2		Mercury in Fish Tissue	2	New data led to this assessment record 2018.
MD-02140205-Mainstem2	02140205	Fishing	Polychlorinated biphenyls (PCBs)	4a	MD-02140205-Mainstem	Polychlorinated biphenyls (PCBs)	4a	The AU name was changed to -Mainstem in 2020-2022 since this listing covered the same geographic extent as the mercury listing. The extent of this listing was changed in 2014 to reflect the mainstem (including Northeast and Northwest main Branches) of the Anacostia downstream to the head of tide. Fish tissue and water data included in this assessment.
MD-02140205-Northeast_Northwest_Branches	02140205	Fishing	Mercury in Fish Tissue	2		Mercury in Fish Tissue	2	The AU name was changed to -Mainstem in 2020-2022 since this listing covered the same geographic extent as the PCB listing. The extent of this listing was changed in 2022 to reflect the mainstem (including Northeast and Northwest main Branches) of the Anacostia downstream to the head of tide.

Former (2018) Assessment Unit IDs	Basin Code	Designated Use	Pollutant	Category	New (2020-2022) Merged Assessment Unit ID	Pollutant	2020-2022 Category	Rationale
MD-ANATF-02140205	2140205	Fishing	PCBs in Fish Tissue	4a	MD-ANATF	PCBs in Fish Tissue	4a	The AU name was changed to ANATF in 2020-2022 since the geographic extent matched the other tidal assessments records. TMDLs for the tidal portion of the Anacostia and Potomac Rivers were jointly developed between VA, DC, and MD. These TMDLs addressed tidal PCB listings in these MD watersheds: 02140101, 02140102, 02140201, and 02140205.
MD-ANATF	2140205	Fishing	Heptachlor Epoxide	5		Heptachlor Epoxide	5	New data shows that fish taken in the tidal portion of the Anacostia have levels of heptachlor epoxide that exceed the human health threshold for fish tissue consumption. This assessment was based on heptachlor epoxide levels in fish tissue.
MD-ANATF	2140205	Fishing	Chlordane	2		Chlordane	2	Data collected in 2010 demonstrated levels of chlordane in fish tissue that were below the human health threshold.
						Mercury in Fish Tissue	2	New data led to this assessment record in 2022.
MD-02140205-Mainstem	02140205	Fishing	Chlordane	2	MD-02140205-Northwest_Branch	Chlordane	2	The extent of this listing was refined in 2022 to reflect the actual assessed waters. This listing only applies to the Northwest Branch so the Assessment Unit name was changed from the mainstem to the Northwest Branch only. Data collected in 2007 and 2012 showed that levels of chlordane in fish tissue were below the threshold.
MD-PATMH-02130903-Mainstem	2130903	Fishing	PCBs in Fish Tissue	4a	MD-PATMH-02130903	PCBs in Fish Tissue	4a	This listing only applies to the Baltimore Harbor (02130903) portion of PATMH. This listing changed in 2022 from only the mainstem to include Curtis Bay Creek and Bear Creek since new data shoes they are impaired for both fish tissue and sediments. The name was changed from MD-PATMH-02130903-mainstem to MD-PATMH-02130903 since the new geographic extent matched the chlordane listing.
MD-PATMH-02130903	2130903	Fishing	Chlordane	4a		Chlordane	4a	This listing only applies to the Baltimore Harbor (02130903) portion of PATMH. Recently collected data on chlordane levels in fish tissue generally show levels to be below the fish tissue threshold. However more data is needed to confirm delisting.

C.3.1.5 Assessments with Insufficient Information

Waters assessed in Category 3 have insufficient data or information available to determine if a water quality standard is being attained. This can be related to having an insufficient quantity of data and/or an insufficient quality of data to properly evaluate a water body's attainment status. For the 2020-2022 IR, twelve assessment records were placed in category 3. Five records for enterococcus, one for benzo(a)pyrene, one for low pH, and five for TSS. The rationale for the decision to place these assessments in category 3 is included in the notes field for each assessment. Follow-up monitoring and assessments will need to be conducted on all category 3 assessments to determine if they are impaired or meeting standards.

Table 15: Assessments placed in Category 3 for the 2020-2022 Integrated Report.

Cycle Last Assessed	Assessment Unit ID	Water Type	Listing Category	Pollutant	Notes
2022	MD-05020201-UT_Youghiogheny_River_Lake	RIVER	3	Benzo(a)pyrene	Data shows a potential exceedance of the human health criteria for Benzo(a)pyrene. However, the data did not meet the required sample size and was not within the data assessment window. MDE will conduct follow-up monitoring to determine impairment status.
2022	MD-CB4MH-Breezy_Point_Beach	BEACH	3	Enterococcus	The beach was assessed using the most recent 2 years of data and one year met the water quality criteria and one year did not. This beach will remain on category 3 until there are two years of data showing that it is impaired or meeting standards.
2022	MD-CB1TF-ElkNeck_StatePark_NorthEastRiver_Beach	BEACH	3	Enterococcus	The beach was assessed using the most recent 2 years of data and one year met the water quality criteria and one year did not. This beach will remain on category 3 until there are two years of data showing that it is impaired or meeting standards.
2022	MD-CB5MH-Elms_Beach	BEACH	3	Enterococcus	The beach was assessed using the most recent 2 years of data and one year met the water quality criteria and one year did not. This beach will remain on category 3 until there are two years of data showing that it is impaired or meeting standards.
2022	MD-CB4MH-North_Beach	BEACH	3	Enterococcus	The beach was assessed using the most recent 2 years of data and one year met the water quality criteria and one year did not. This beach will remain on category 3 until there are two years of data showing that it is impaired or meeting standards.
2022	MD-02130106-T-Public_Landing_Beach_2	BEACH	3	Enterococcus	The beach was assessed using the most recent 2 years of data and one year met the water quality criteria and one year did not. This beach will remain on category 3 until there are two years of data showing that it is impaired or meeting standards.

2022	MD-021410060084-Upper_Headwaters	RIVER	3	pH, Low	Data shows a potential exceedance of pH criteria. However, the data did not meet the required sample size and was not within the data assessment window. MDE will conduct follow-up monitoring to determine impairment status
2022	MD-BOHOH-SWSAV	ESTUARY	3	Total Suspended Solids (TSS)	This segment previously met the SAV/water clarity restoration goal. However, the SAV restoration goal is not currently met and no water clarity data are available. This segment will remain on category 3 until new water clarity data are collected.
2022	MD-HNGMH-SWSAV	ESTUARY	3	Total Suspended Solids (TSS)	This segment previously met the SAV/water clarity restoration goal. However, the SAV restoration goal is not currently met and no water clarity data are available. This segment will remain on category 3 until new water clarity data are collected.
2022	MD-MIDOH-SWSAV	ESTUARY	3	Total Suspended Solids (TSS)	This segment previously met the SAV/water clarity restoration goal. However, the SAV restoration goal is not currently met and no water clarity data are available. This segment will remain on category 3 until new water clarity data are collected.
2022	MD-NANMH-SWSAV	ESTUARY	3	Total Suspended Solids (TSS)	This segment previously met the SAV/water clarity restoration goal. However, the SAV restoration goal is not currently met and no water clarity data are available. This segment will remain on category 3 until new water clarity data are collected.
2022	MD-POTOH2-SWSAV	ESTUARY	3	Total Suspended Solids (TSS)	This segment previously met the SAV/water clarity restoration goal. However, the SAV restoration goal is not currently met and no water clarity data are available. This segment will remain on category 3 until new water clarity data are collected.

C.3.2 Estuarine Assessments

This section provides assessment results and water quality summaries for Maryland's estuarine systems that include both the Chesapeake and Coastal Bays. The Chesapeake Bay assessments continue to evolve as new criteria and assessment methodologies are implemented. Comparatively, the Coastal Bays fall behind the Chesapeake in terms of public awareness and resource allocation for monitoring and assessment activities. However, the completion and approval of TMDLs for all of Maryland's Coastal Bays does represent significant progress towards improving water quality. For additional details on Chesapeake Bay assessments, please see https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/2008%20Ambient%20Water%20Criteria.pdf. For additional information on Maryland's Coastal Bays, please visit https://dnr.maryland.gov/waters/coastalbays/Pages/WaterQuality/CB_Water-Quality.aspx.

The table below depicts the status of estuarine waters with respect to different designated uses. For the 2020-2022 cycle, these numbers were calculated using ATTAINS reporting function. Please see section C.3.1 for more information on ATTAINS reporting calculations.

Table 16: 2020-2022 Designated Use Support Summary for Maryland's Estuarine Waters.

Designated Use		Size of Estuarine Waters (square miles)				
		Not Supporting-Not Attaining WQ Standards	Insufficient Data and Information	Fully Supporting-Attaining WQ Standards	Total Assessed**	State Total
Aquatic Life and Wildlife		1,852.81	193.02	548.82	2,401.63	2,594.65
Fishing		789.55	11.44	315.73	1,105.28	1,116.72
Water Contact Sports	General Recreational Waters	14.67	0.19	1.47	16.14	16.33
Shellfishing		70.08	0	164.31	234.39	234.39
Seasonal Migratory Fish Spawning and Nursery Subcategory*		1,256.45	82.3	0	1,256.45	1,338.75
Seasonal Shallow-Water Submerged Aquatic Vegetation Subcategory*		443.42	139.57	92.47	535.89	675.46
Open-Water Fish and Shellfish Subcategory*		2,278.65	63.62	0	2,278.65	2,342.27
Seasonal Deep-Water Fish and Shellfish Subcategory*		1,402.11	0	0	1,402.11	1,402.11
Seasonal Deep-Channel Refuge Use*		1,329.72	0	0	1,329.72	1,329.72

*Chesapeake Bay specific uses. Note: Areas are based on total segment surface area. Surface area sizes for each specific designated use have not been defined.
**The Total Assessed column is the sum of the Not Supporting and Fully Supporting waters. Insufficient Data and Information waters are not included in the Total Assessed count since they include waters that are unassessed. The Insufficient Data and Information waters are included in the State Total calculations.

Table 17 shows the size of estuarine waters assigned to each category for each pollutant. For the 2020-2022 cycle, these numbers were calculated using ATTAINS reporting function. Please see section C.3.1 for more information on ATTAINS reporting calculations. ATTAINS reporting doesn't differentiate between the impairment Categories 4a, 4b, 4c, or 5. It groups all impaired waters together into a section labeled ‘Cause’. The section labeled ‘Meeting Criteria’ includes all Category 2 assessments while the section labeled ‘Insufficient Information’ includes all Category 3 assessments.

Table 17: Square mileage of estuarine waters assigned to categories according to the pollutant assessed.

Size of Estuarine Area (sq. miles) per Category according to Pollutant Type				
Parameter	**Cause** (Categories 4a, 4b, 4c, and 5)	**Meeting Criteria** (Category 2)	**Insufficient Information** (Category 3)	**TOTAL**
ARSENIC	0	35.43	0	35.43
BIOCHEMICAL OXYGEN DEMAND (BOD)	34.25	0	0	34.25
CADMIUM	0	85.68	0	85.68
CAUSE UNKNOWN	1,675.34	451.85	213.52	2,340.71
CHLORDANE	36.99	0.08	0	37.07
CHLORPYRIFOS	0	48.73	0	48.73
CHROMIUM IN SEDIMENT	0	2.9	0	2.9
CHROMIUM, TOTAL	0	76.1	0	76.1
COPPER	*1	94.83/*3	0	94.83*4
CYANIDE	*3	0	0	*3
ENTEROCOCCUS	5.17	0.36	0.19	5.72
FECAL COLIFORM	70.08	165.42	0	235.5
HEPTACHLOR EPOXIDE	0.08	6.25	0	6.33
LEAD	0	87.59	0	87.59
LEAD IN SEDIMENT	1.3	0	0	1.3
MERCURY IN FISH TISSUE	0	745.35	11.44	756.79
NICKEL	0	38.79/ *5	0	38.79/*5
NITROGEN, TOTAL	2,387.59	0	63.62	2,451.21
OIL SPILL - PAHS	1.04	0.3	0	1.34
PCBS IN FISH TISSUE	789.55	268.7	11.44	1,069.69
PERFLUOROOCTANE SULFONATE (PFOS) IN FISH TISSUE	1.43	0	0	1.43
PHOSPHORUS, TOTAL	2,387.59	0	63.62	2,451.21
POLYCHLORINATED BIPHENYLS (PCBS)	10.57	0	0	10.57
SELENIUM	0	34.5	0	34.5
SILVER	0	35.43	0	35.43
TOTAL SUSPENDED SOLIDS (TSS)	450.9	92.47	139.57	682.94
TOXICITY	2	0	0	2
TRASH	9.58	0	0	9.58
ZINC	0	47.89	0	47.89
ZINC IN SEDIMENT	17.59	0	0	17.59

*Point Source - These listings are remnants of the 304(L) list and were originally listed due to the presence of point sources. Thus these listings have no associated sizes and the values are the number of point sources.

Table 18: Size of Estuarine Waters Impaired by Various Sources.

Waterbody Type - Estuary	
Sources	**Water Size in Square Miles**
AGRICULTURE	470.88
ATMOSPHERIC DEPOSITION - TOXICS	45.77
CHANNEL EROSION/INCISION FROM UPSTREAM HYDROMODIFICATIONS	0.08
CONTAMINATED SEDIMENTS	143.26
CONTRIBUTION FROM DOWNSTREAM WATERS DUE TO TIDAL ACTION	16.06
DISCHARGES FROM MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4)	35.14
ILLEGAL DUMPS OR OTHER INAPPROPRIATE WASTE DISPOSAL	9.58
INDUSTRIAL POINT SOURCE DISCHARGE	*4
LIVESTOCK (GRAZING OR FEEDING OPERATIONS)	16.33
MANURE RUNOFF	16.19
MUNICIPAL POINT SOURCE DISCHARGES	42.45
NON-POINT SOURCE	22.56
ON-SITE TREATMENT SYSTEMS (SEPTIC SYSTEMS AND SIMILAR DECENTRALIZED SYSTEMS)	2.92
PIPELINE BREAKS	1.04
SOURCE UNKNOWN	2,784.14
UPSTREAM SOURCE	440.96
UPSTREAM/DOWNSTREAM SOURCE	10.72
URBAN RUNOFF/STORM SEWERS	47.53
WASTES FROM PETS	12.26
WILDLIFE OTHER THAN WATERFOWL	0.43

*These listings are remnants of the 304(L) list and were originally listed due to the presence of point sources. Thus these listings have no associated sizes and the values are the number of point sources.

The summary table provided below is submitted for consistency with EPA guidance and to allow for statewide biological condition estimates. Please note that this table is identical to that provided in Maryland’s 2014, 2016, and 2018 IR as new assessments have not been available since the 2014 IR.

Table 19: Attainment Results for the Chesapeake Bay Calculated Using a Probabilistic Monitoring Design.

Project Name	**Chesapeake Bay Benthic Assessment**
Owner of Data	**Chesapeake Bay Program and Versar Inc.**
Target Population	**Tidal waters of the Chesapeake Bay (reporting only the MD portion)**
Type of Waterbody	**Chesapeake Bay Estuary**
Size of Target Population	**2,342.3 (only the MD portion)**
Units of Measurement	**Square Miles**
Designated use	**Aquatic Life**
Percent Attaining	**40.1%**
Percent Not-Attaining	**50.8%**
Percent Nonresponse	**9.1%**
Indicator	**Biology - Estuarine Benthic macroinvertebrate IBI**
Assessment Date	**4/1/2014**
Precision	**unknown**

C.3.2.1 The Coastal Bays

Maryland's Coastal Bays, the shallow lagoons nestled behind Ocean City and Assateague Island, comprise a complex ecosystem. Like many estuaries, Maryland's Coastal Bays display differences in water quality ranging from generally degraded conditions near tributaries to better conditions in the more open, well-flushed bay regions.

For more information on the Coastal Bays, please refer to the 2019-2020 Coastal Bays Report Card (https://ian.umces.edu/site/assets/files/27612/2019-2020-maryland-coastal-bays-report-card.pdf). In addition the "Ecosystem Health Assessment of the Maryland Coastal Bays: 2007-2013" provides additional detail on the status of both the water quality and living resources of the Coastal Bays. (https://dnr.maryland.gov/waters/coastalbays/Pages/EHA.aspx). In addition, MDE completed and submitted nutrient TMDLs for all of the Coastal Bays in April 2014. EPA subsequently approved these TMDLs in August of 2014. To read the full text of these TMDLs please visit: https://mde.maryland.gov/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/TMDL_final_MD_Coastal_Bays_nutrients.aspx.

C.3.2.2 2007 National Estuary Program Coastal Condition Report

In spring of 2007, EPA released its third in a series of coastal environmental assessments which focused on conditions in the 28 National Estuary Program (NEP) estuaries (online at: https://water.epa.gov/type/oceb/nep/index.cfm). In this Coastal Condition Report (CCR), four estuarine condition indicators were rated for individual estuaries:

- water quality (e.g., dissolved inorganic nitrogen, dissolved inorganic phosphorus, chlorophyll a, water clarity, and dissolved oxygen);
- sediment quality (e.g., sediment toxicity, sediment contaminants, and sediment total organic carbon);
- benthic index and;
- fish tissue contaminants index

For each of these four key indicators, a score of good, fair, or poor was assigned to each estuary which were then averaged to create overall regional and national scores. Based on these calculations, the overall condition of the nation's NEP estuaries was generally fair. Specifically for the estuaries in the Northeast Coast region where Maryland's two NEP estuaries are located (Coastal Bays; Chesapeake Bay), the water quality index was rated as fair; sediment quality, benthic, and fish tissue contaminants indices were poor and the overall condition was rated as poor. However, considered altogether, the NEP estuaries showed the same or better estuarine condition than US coastal waters overall.

The report describes a number of major environmental concerns that affect some or all of the nation's 28 NEP estuaries. The goal of this report is to provide a benchmark for analyzing the progress and changing conditions of the NEPs over time. The top three issues, which also affect Maryland's estuaries include:

- Habitat loss and alteration (including dredging and dredge-disposal activities; construction of groins, seawalls, and other hardened structures; and hydrologic modifications);
- Declines in fish and wildlife populations (associated with habitat loss, fragmentation or alteration, water pollution from toxic chemicals and nutrients, overexploitation of natural resources, and introduction of invasive species); and

- Excessive nutrients (nitrogen and phosphorus runoff from agricultural and residentially applied fertilizers and animal wastes, discharges from wastewater treatment plants, leaching from malfunctioning septic systems, and discharges of sanitary wastes from recreational boats).

C.3.2.3 The National Coastal Condition Assessment (NCCA)

The National Coastal Condition Assessment is a statistical survey of the condition of the Nation's marine and Great Lakes Coasts.[3] This EPA-funded assessment program is implemented in cooperation with the States. The NCCA is designed to report on the water quality, ecological, and recreational health of the nation's waters. Another key goal is to use this survey to determine the key stressors that impact these uses. Field data collection for the NCCA, in its current form, occurred in 2010 and again in 2015. The sites are surveyed one time during the index period with a couple of sites being resampled. In both years, DNR participated in collecting and submitting data. This information is not generally used for IR assessment purposes; however it does help to inform regional comparisons in coastal conditions. For more information about this survey and to view available reports please visit: https://www.epa.gov/national-aquatic-resource-surveys/ncca.

[3] Much of this text was borrowed from EPA web pages on this survey https://www.epa.gov/national-aquatic-resource-surveys/what-national-coastal-condition-assessment .

C.3.3 Lakes Assessment- CWA §314 (Clean Lakes) Report

In the federal CWA, §314 addresses the Clean Lakes program, which was designed to identify publicly owned lakes, assess their water quality condition, implement in-lake and watershed restoration activities and develop programs to protect restored conditions. This section also required regular reporting of State efforts and results.

In Maryland, all significant (> 5 acres surface area), publicly-owned lakes are man-made impoundments. A number of specific assessment, planning and restoration activities in Maryland were funded by §314 as early as 1980 until Congress rescinded Clean Lakes funding in 1994. Section 314 has since been reauthorized (2000) under the Estuaries and CWA of 2000 but no funds have yet been appropriated to states. EPA currently encourages states to use funds in the §319 (Nonpoint Source Program) to address Clean Lakes priorities; however, no Clean Lake projects have been funded in Maryland through this program because of limited funding.

C.3.3.1 Lake Status and Trends

In the past, Maryland agencies didn't include lakes in their ambient monitoring programs, and monitoring was mainly used to address fish kills and algal bloom complaints (DNR, MDE) and some water sampling was done to provide input for pollutant loading models (TMDLs, MDE). More recently, MDE and DNR have recognized the need for continued lake monitoring and are partnering to address known sampling gaps in lakes and to coordinate sampling protocols. One of the primary goals is to monitor and assess all significant (>5 acres surface area), publicly-owned lakes in Maryland for impacts due to nutrients.

To inform current and future lake monitoring efforts, MDE and DNR have jointly developed a prioritization list to identify an order in which lakes will be sampled. MDE plans to sample 3-5 lakes per year according to the list and DNR will assist with other targeted sampling of State-owned Lakes. More information on the lake monitoring prioritization can be found here: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/Lake-Monitoring.aspx

MDE assessed new data for fifteen lakes in this IR cycle. The list of the lakes and years of monitoring data assessed for the combined 2020-2022 IR are provided in Table 20 below. Based on available data, a summary of the status of Maryland lakes and reservoirs is given in table 21 below. For the 2020-2022 cycle, these numbers were calculated using ATTAINS reporting function. Please see section C.3.1 for more information on ATTAINS reporting calculations.

Table 20: Lakes Assessed for the 2020-2022 Integrated Report

Lake Name	Monitoring Years
Adkins Pond	2014-2016
Broadford Lake	2016-2017
Centennial Lake	2014-2015 and 2017
Clopper Lake	2014-2017
Cunningham Lake	2017-2018
Hunting Creek Lake	2017-2018
Johnsons Pond	2014-2016
Lake Linganore	2014-2016
Lake Needwood	2019-2020
Lake Williston	2019-2020
Myrtle Grove	2019-2020
Smithville Lake	2019-2020
Tony Tank Lake	2014-2016
Urieville Lake	2016-2017
Wye Mills Community Lake	2016-2017

Table 21: Designated use support summary for Maryland's lakes and reservoirs (acres), 2020-2022.

Designated Use		Size of Impoundments (acres)				
		Not Supporting-Not Attaining WQ Standards	Insufficient Data and Information	Fully Supporting-Attaining WQ Standards	Total Assessed*	State Total
Aquatic Life and Wildlife		8,723.58	413.85	8,429.35	17,152.93	17,566.78
Fishing		8,690.92	0	10,586.25	19,277.17	19,277.17
Water Contact Recreation	General Recreational Waters	0	3,070.66	0	0	3,070.66
Public Water Supply		3,544.5	0	45.23	3,589.73	3,589.73

*The Total Assessed column is the sum of the Not Supporting and Fully Supporting waters. Insufficient Data and Information waters are not included in the Total Assessed count since they include waters that are unassessed. The Insufficient Data and Information waters are included in the State Total calculations.

C.3.3.1.1 Causes and sources of impairment

Since the water quality of lakes is largely dependent on the upstream watershed, there are numerous pollutants that can potentially impact a lake (Table 22). Overall, one of the principal lake problems is due to the accelerated eutrophication process that characterizes most reservoir systems. Upstream watershed sources, both natural and anthropogenic, supply nutrients and sediments to lakes on a continual basis which can lead to nuisance algal blooms, decreased dissolved oxygen levels (harmful to aquatic organisms), and loss of drinking water storage capacity. Currently, there are 18 lakes impaired for excess total phosphorus and 11 lakes impaired for excess sediment.

For the 2020-2022 cycle, these numbers were calculated using ATTAINS reporting function. Please see section C.3.1 for more information on ATTAINS reporting calculations. ATTAINS reporting doesn't differentiate between the impairment Categories 4a, 4b, 4c, or 5. It groups all impaired waters together into a section labeled 'Cause'. The section labeled 'Meeting Criteria' includes all Category 2 assessments while the section labeled 'Insufficient Information' includes all Category 3 assessments.

Table 22: Impoundment acreage assigned to Categories according to the pollutant assessed.

Size of Impoundments (acres) per Category according to Pollutant Type				
Parameter	**Cause** (Categories 4a, 4b, 4c, and 5)	**Meeting Criteria** (Category 2)	**Insufficient Information** (Category 3)	**TOTAL**
ARSENIC	0	3,707.09	0	3,707.09
CADMIUM	0	3,707.09	0	3,707.09
CHLORDANE	0	65.72	0	65.72
CHLOROPHYLL-A	474.04	45.23	0	519.27
CHROMIUM, HEXAVALENT	0	1,471.57	0	1,471.57
CHROMIUM, TOTAL	0	5,168.78	0	5,168.78
COPPER	0	3,707.09	0	3,707.09
ENTEROCOCCUS	0	0	0.2	0.2
FECAL COLIFORM	0	3,070.46	0	3,070.46
FLOATING DEBRIS	0	0	3070.46	3,070.46
LEAD	0	6,640.35	0	6,640.35
MERCURY IN FISH TISSUE	5,544.85	13,696.09	0	19,240.94
NICKEL	0	3,707.09	0	3,707.09
NITROGEN, TOTAL	0	29.6	0	29.6
PCBS IN FISH TISSUE	3,146.07	13,291.82	0	16,437.89
PHOSPHORUS, TOTAL	11,485.98	5,666.95	30.36	17,183.29
SEDIMENTATION/SILTATION	6,344.13	300.83	23.11	6,668.07
SELENIUM	0	3,707.09	0	3,707.09
ZINC	0	1,471.57	0	1,471.57

Table 23 shows the predominant sources of pollutants to impaired lakes.

Table 23: The total size of impoundments impaired by various sources, 2020-2022.

Waterbody Type - Impoundment	
Sources	**Water Size in Acres**
AGRICULTURE	4,367.5
ATMOSPHERIC DEPOSITION - TOXICS	5,544.85
CROP PRODUCTION (CROP LAND OR DRY LAND)	4,129.66
MUNICIPAL POINT SOURCE DISCHARGES	193.77
SOURCE UNKNOWN	3,500.37
UPSTREAM SOURCE	65.72
URBAN RUNOFF/STORM SEWERS	2,364.53

C.3.3.1.2 National Lake Survey

As part of a national effort to assess the quality of the nation's waters in a statistically-valid manner, every five years EPA randomly selects lakes in each state to be sampled using a nationally-consistent set of protocols (stratified by state, EPA Region and ecological region). So far, this lake survey has been completed in 2007, 2012, and 2017. See the table below for the names of the lakes sampled each year. In preparation for these sampling events, DNR biologists were trained by EPA to collect data on field water quality, biological community, habitat, and sediment conditions. Lakes were intensively sampled a single time during the summer with two additional lakes being sampled as a replicate for quality control purposes. Water, sediment and biological samples were sent to national labs for analysis and field data were submitted to EPA. Most recently, during the 2017 summer sampling season, 8 lakes were sampled in Maryland. More information on the national survey can be found at https://water.epa.gov/type/lakes/lakessurvey_index.cfm.

Table 24: Lakes Surveyed by the National Lake Survey

2007 National Lake Survey	2012 National Lake Survey	2017 National Lake Survey
Lake Habeeb	Lake Habeeb	Lake Habeeb
Lake Kittamaqundi	Lake Kittamaqundi	Lake Needwood
Johnson Pond	Johnsons Pond	Whetstone
Piney Run Reservoir	Lake Louise	Lake Louise
Savage River Reservoir	Unnamed Montgomery County Pond	Piney Run
	Lake Vista	Little Brown
	Leonard Pond	Lake Vista
	Unicorn Mill Pond	Stormwater pond Talbot CC

C.3.4 Non-tidal Rivers and Streams Assessment

The State of Maryland has two major monitoring programs for assessing non-tidal flowing waters. One is the probabilistic Maryland Biological Stream Survey (MBSS) and the other is the CORE/TREND program for assessing water quality trends at fixed locations (both conducted by DNR). The MBSS program uses fish and aquatic insects as indicators of aquatic health while the CORE/TREND program focuses on conventional water quality parameters (temperature, pH, etc.) and nutrient species. In addition to these two monitoring programs, Maryland also makes use of other ad-hoc stream monitoring data as well as data submitted by non-state organizations to assess state waters. Since the 2014 IR, Maryland has now also integrated biological stream data from specific counties (Baltimore and Frederick) to provide better sampling resolution for stream bioassessments. The summary tables below reflect the data supplied from this variety of sources.

The table below provides the most recent results from a statewide probabilistic biological assessment in first through fourth order streams. The reader will notice that this table has not changed since the 2014 IR. MDE generally conducts statewide biological assessments as resources permit as these assessments are extremely time intensive due to the level of quality control needed. The results shown below incorporate biological monitoring performed by the Maryland Biological Stream Survey (DNR), Baltimore County, and Frederick County.

Table 25: Statewide results for probabilistic biological sampling. This data assesses support of the aquatic life designated use.

Project Name	Maryland Biological Stream Survey and County Biological Data
Owner of Data	MD Dept. of Natural Resources (MANTA), Baltimore Co. Frederick Co.
Target Population	All 1st through 4th order non-tidal wadeable streams in MD
Type of Waterbody	1st through 4th Order Wadeable Streams
Size of Target Population	19,127.0
Units of Measurement	Miles
Designated use	Aquatic Life
Percent Attaining	56.55%
Percent Not-Attaining	42.99%
Percent Nonresponse	0.50%
Indicator	Biology - freshwater fish and benthic macroinvertebrate IBIs
Assessment Date	4/1/2014

Table 26 shows 8-digit watersheds which were previously listed as impaired (Category 5) based on a biological assessment but which now have a completed stressor identification analysis. Provided in this table is the attributable risk percentage for each identified stressor. For more information about this Biological Stressor Identification (BSID) process and how the attributable risk is calculated please visit the BSID website at: https://mde.maryland.gov/programs/Water/TMDL/Pages/bsid_studies.aspx.

Table 26: Watersheds previously listed as biologically impaired that have undergone BSID analysis. As a result of this analysis, the biological listings have been replaced by listings for the specific pollutants/stressors identified below.

8-digit watersheds that were previously in Category 5 based on impaired biological communities (cause unknown)	Stressors Identified through BSID Analysis	IR Category	Attributable Risk
Lower Pocomoke River	Sulfates	5	75%
	Lack of Riparian Buffer	4c	45%
	Channelization	4c	70%
Georges Creek*	Sulfates	5	22%

*The sulfate listing for Georges Creek was added on this IR (2020-2022) but the biological listing was actually addressed through the original BSID analysis in 2014.

The following tables present statewide assessment summaries on the wide range of pollutants and sources of pollutants to non-tidal flowing waters. Much of the data used for these assessments is from state-led monitoring efforts but increasingly more data from counties, non-profits, citizen groups and academia are also being used. These other data sources have helped to supplement the state-led programs and increase the overall spatial resolution at which certain parameters are measured. Tables 27-29 provide statewide assessment data for non-tidal rivers and streams. For the 2020-2022 cycle, these numbers were calculated using ATTAINS reporting function. Please see section C.3.1 for more information on ATTAINS reporting calculations. In table 28, ATTAINS reporting doesn't differentiate between the impairment Categories 4a, 4b, 4c, or 5. It groups all impaired waters together into a section labeled 'Cause'. The section labeled 'Meeting Criteria' includes all Category 2 assessments while the section labeled 'Insufficient Information' includes all Category 3 assessments.

Table 27: Designated Use Support Summary for Non-tidal Rivers and Streams.

Designated Use		Size of River/Stream Miles				
		Not Supporting-Not Attaining WQ Standards	Insufficient Data and Informatio n	Fully Supporting-Attaining WQ Standards	Total Assessed*	State Total
Aquatic Life and Wildlife		15,258.76	1,901.29	5,248.77	20,507.53	22,408.82
Fishing		270.24	1.00	570.54	840.78	841.78
Water Contact Recreation	**General Recreational Waters**	4,260.88	1,182.46	1,054.23	5,315.11	6,497.57
Public Water Supply		0	0	186.3	186.3	186.3

*The Total Assessed column is the sum of the Not Supporting and Fully Supporting waters. Insufficient Data and Information waters are not included in the Total Assessed count since they include waters that are unassessed. The Insufficient Data and Information waters are included in the State Total calculations.

Table 28: Extent of River/Stream Miles assigned to each category according to the pollutant assessed.

Size of River/Stream Miles per Category according to Pollutant Type				
Parameter	**Cause** (Categories 4a, 4b, 4c, and 5)	**Meeting Criteria** (Category 2)	**Insufficient Information** (Category 3)	**TOTAL**
ALUMINUM	26.2	160.1	0	186.3
AMMONIA, TOTAL	0	317.43	0	317.43
ARSENIC	0	663.7	0	663.7
BENZO[A]PYRENE	0	0	1	1
BIOCHEMICAL OXYGEN DEMAND (BOD)	277.52	132.17	0	409.69
BIOCHEMICAL OXYGEN DEMAND (BOD), CARBONACEOUS	72.08	447.14	0	519.22
BIOCHEMICAL OXYGEN DEMAND (BOD), NITROGENOUS	72.08	447.14	0	519.22
CADMIUM	0	1,235.53	0	1,235.53
CAUSE UNKNOWN	1,878.7	3,333.12	1,862.23	7,074.05
CHLORDANE	0	21.49	0	21.49
CHLORIDE	4,389.16	0	0	4,389.16
CHROMIUM, HEXAVALENT	0	266	0	266
CHROMIUM, TOTAL	0	292.42	0	292.42
CHROMIUM, TRIVALENT	0	105.28	0	105.28
COPPER	0	684.57	0	684.57
CYANIDE	0	98.39	0	98.39
ENTEROCOCCUS	451.25	6.78	0	458.03
ESCHERICHIA COLI (E. COLI)	3,441.4	491.23	613.33	4,545.96
FECAL COLIFORM	368.23	556.22	569.13	1,493.58
FLOW ALTERATION-CHANGES IN DEPTH AND FLOW VELOCITY	4.33	0	0	4.33
HABITAT ALTERATIONS	4,017.78	0	0	4,017.78
HEPTACHLOR EPOXIDE	21.49	0	0	21.49
IRON	58.51	126.14	0	184.65
LEAD	0	764.27	0	764.27
MANGANESE	0	186.3	0	186.3
MERCURY	0	477.4	0	477.4
MERCURY IN FISH TISSUE	49.21	607.59	5.03	661.83
NICKEL	0	663.7	0	663.7
NITROGEN, TOTAL	277.52	1,545.66	243.26	2,066.44
PCBS IN FISH TISSUE	175.65	537.22	0	712.87
PERFLUOROOCTANE SULFONATE (PFOS) IN FISH TISSUE	10.97	0	0	10.97
PH, HIGH	132.17	15.76	19.19	167.12
PH, LOW	683.69	1,187.86	14.34	1,885.89
PHOSPHORUS, TOTAL	4,209.48	4,031.18	245.84	8,486.5

Size of River/Stream Miles per Category according to Pollutant Type				
Parameter	**Cause** (Categories 4a, 4b, 4c, and 5)	**Meeting Criteria** (Category 2)	**Insufficient Information** (Category 3)	**TOTAL**
POLYCHLORINATED BIPHENYLS (PCBS)	39.5	0	0	39.5
RIPARIAN BUFFER, LACK OF	3,521.41	0	0	3,521.41
SELENIUM	0	663.7	0	663.7
SILVER	0	186.3	0	186.3
SULFATE	4,126.52	0	0	4,126.52
TEMPERATURE	179.4	48.13	1.33	228.86
TOTAL SUSPENDED SOLIDS (TSS)	9,931.98	852.38	0	10,784.36
TRASH	277.52	0	0	277.52
ZINC	0	910.11	0	910.11

Table 29: Summary of Sizes of Riverine Waters Impaired by Various Sources.

Waterbody Type - River	
Sources	**Water Size in Miles**
ACID MINE DRAINAGE	413.69
AGRICULTURE	5,601.72
ANTHROPOGENIC LAND USE CHANGES	847.27
ATMOSPHERIC DEPOSITION - ACIDITY	460.6
ATMOSPHERIC DEPOSITION - TOXICS	63.73
CHANNELIZATION	4,017.78
COMBINED SEWER OVERFLOWS	205.66
CONTAMINATED SEDIMENTS	118.88
CROP PRODUCTION (CROP LAND OR DRY LAND)	3,503.88
DAM OR IMPOUNDMENT	5.38
DISCHARGES FROM MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4)	383.94
ILLEGAL DUMPS OR OTHER INAPPROPRIATE WASTE DISPOSAL	277.52
LIVESTOCK (GRAZING OR FEEDING OPERATIONS)	1,927.02
LOSS OF RIPARIAN HABITAT	417.23
MANURE RUNOFF	481.08
MUNICIPAL (URBANIZED HIGH DENSITY AREA)	1,094.57
MUNICIPAL POINT SOURCE DISCHARGES	72.08
ON-SITE TREATMENT SYSTEMS (SEPTIC SYSTEMS AND SIMILAR DECENTRALIZED SYSTEMS)	71.67
POST-DEVELOPMENT EROSION AND SEDIMENTATION	53.1
SANITARY SEWER OVERFLOWS (COLLECTION SYSTEM FAILURES)	907.19
SOURCE UNKNOWN	3,031.92
UPSTREAM SOURCE	10.97
URBAN DEVELOPMENT IN RIPARIAN BUFFER	1,173.25
URBAN RUNOFF/STORM SEWERS	5,822.5
WASTES FROM PETS	879.76

C.3.4.1 National Rivers and Streams Assessment (NRSA)

The National Rivers and Streams Assessment is a national probability-based survey of rivers and streams that collects data on physical, chemical and biological parameters.[4] Similar to the other National Aquatic Resource Surveys, this survey is meant to report on the health of rivers and streams and provide information on the predominant stressors impacting their health. Additionally, this survey is used to compare the condition of streams to an earlier national survey. Field sampling for this survey was conducted in the 2008-2009 and 2013-2014 time-frames. Maryland DNR participated in both surveys. The next survey was planned for 2018-2019 and once the data is published, it will be reviewed by MDE. Though this information is not generally used for IR assessment purposes it does help to inform regional comparisons in stream conditions. For more information about this survey and to access reports, please visit: https://www.epa.gov/national-aquatic-resource-surveys/nrsa.

[4] Much of the text in this section was borrowed from EPA's web pages on this survey https://www.epa.gov/national-aquatic-resource-surveys/nrsa.

C.3.5 Beaches Assessment

In October 2000, the EPA passed the Beaches Environmental Assessment and Coastal Health (BEACH) Act and provided funding to improve beach monitoring in coastal states. The State Beaches program is administered by MDE; however, the responsibility of monitoring and public notification of beach information is delegated to the local health departments. Please see section C.6.7 for additional information on The BEACH Act.

The majority of the data used to assess Beaches for the Integrated Report is the same data collected by local health departments for use in the (BEACH) Act monitoring. However, the assessment methodology for the public health notifications by the State Beaches Program is different from the methodology for use in the Integrated Report. For more information, please see the Listing Methodology for Identifying Waters Impaired by Bacteria in Maryland's Integrated Report at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Bacteria_Listing_Methodology_Final_2_23_2021.pdf .

Tables 30-31 provide statewide assessment data for Beaches. For the 2020-2022 cycle, these numbers were calculated using ATTAINS reporting function. Please see section C.3.1 for more information on ATTAINS reporting calculations. For table 31, ATTAINS reporting doesn't differentiate between the impairment Categories 4a, 4b, 4c, or 5. It groups all impaired waters together into a section labeled 'Cause'. The section labeled 'Meeting Criteria' includes all Category 2 assessments while the section labeled 'Insufficient Information' includes all Category 3 assessments. Please note, the table summarizing the size of waters impaired by various sources is not applicable to beaches since none of the beaches are impaired, and therefore, do not have a source of impairment. The sources table has been excluded from this section.

Table 30: Designated Use Support Summary for Beaches.

Designated Use		Number of Beaches				
		Not Supporting-Not Attaining WQ Standards	Insufficient Data and Information	Fully Supporting-Attaining WQ Standards	Total Assessed**	State Total
Water Contact Recreation	Public Beaches*	0	5	45	45	50

*Public beaches are reported as the number of beaches in each category rather than providing a size.
**The Total Assessed column is the sum of the Not Supporting and Fully Supporting waters. Insufficient Data and Information waters are not included in the Total Assessed count since they include waters that are unassessed. The Insufficient Data and Information waters are included in the State Total calculations.

Table 31: Number of Beaches assigned to each category according to the pollutant assessed.

Number of Beaches per Category according to Pollutant Type				
Parameter	**Cause** (Categories 4a, 4b, 4c, and 5)	**Meeting Criteria** (Category 2)	**Insufficient Information** (Category 3)	**TOTAL**
ENTEROCOCCUS*	0	43	5	48
ESCHERICHIA COLI (E. COLI)*	0	2	0	2

*Public beaches are reported as the number of beaches in each category rather than providing a size.

C.3.6 Total Maximum Daily Loads

Maryland continues to make progress completing TMDLs for waters listed as impaired on Category 5 of the IR. TMDLs determine the sources of pollution for an identified impairment as well as the estimated reductions necessary to bring the water body back into compliance with WQS. Once Maryland completes a TMDL for a water body-pollutant combination, it must then be approved by EPA, in order for it to take force. When this has occurred, the water body-pollutant combination will get moved to Category 4a on the IR. MDE has completed sixteen TMDLs since the 2018 IR. Table 32 lists the water bodies with TMDLs completed since the last IR cycle.

Table 32: Recently Approved TMDLs in Category 4a of the Integrated Report. This list does not include any TMDLs that were captured on the 2018 Integrated Report.

Cycle First Listed	Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant	Sources
2010	MD-PAXMH-Battle_Creek-2	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform	Livestock (Grazing or Feeding Operations)
2014	MD-PAXMH-Battle_Creek-3	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform	Livestock (Grazing or Feeding Operations)
2012	MD-PAXMH-BUZZARD_ISLAND_CREEK	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform	Livestock (Grazing or Feeding Operations)
2014	MD-PAXMH-HogNeck_Creek	PAXMH - Lower Patuxent River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform	Livestock (Grazing or Feeding Operations)
2014	MD-WICMH-Ellis_Bay	WICMH - Wicomico River Mesohaline	ESTUARY	Shellfishing	Fecal Coliform	Source Unknown
2002	MD-BSHOH	BSHOH - Bush River Oligohaline	ESTUARY	Fishing	PCBs in Fish Tissue	Contaminated Sediments
2014	MD-MATTF	Mattawoman Creek	ESTUARY	Fishing	PCBs in Fish Tissue	Atmospheric Deposition - Toxics
2014	MD-PISTF	Piscataway Creek Tidal Fresh	ESTUARY	Fishing	PCBs in Fish Tissue	Atmospheric Deposition - Toxics
2012	MD-02130404	Upper Choptank River	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Agriculture
2012	MD-02130510	Upper Chester River	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Crop Production (Crop Land or Dry Land)
2012	MD-02131004	West River	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Urban Runoff/Storm Sewers
2014	MD-02131101	Patuxent River lower	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Crop Production (Crop Land or Dry Land)

Cycle First Listed	Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Pollutant	Sources
2014	MD-02131102	Patuxent River Middle	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Crop Production (Crop Land or Dry Land)
2016	MD-02140109	Port Tobacco River	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Anthropogenic Land Use Changes
2016	MD-02140203	Piscataway Creek	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Anthropogenic Land Use Changes
2016	MD-02140503	Marsh Run	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Urban Runoff/Storm Sewers

Tables 33 and 34 list those waters for which TMDLs will likely be initiated over the next two years.

Table 33: Anticipated Submissions to Address Category 5 Integrated Report Listings in FFY 2022.

Submission Date	Listing Year	Listed Waterbody	Impairing Substance	2018 303(d) List Count
September 2022				
	1996	Aberdeen Proving Ground	Toxics	1
*	2014	Baltimore Harbor	Sediment	1
*	2010	Baltimore Harbor	Bacteria	1
*	1998	Baltimore Harbor – Middle Harbor and Curtis Bay	Zinc	2
*	2014	Catoctin Creek	Temperature	4
*	2014	Conococheague Creek	Mercury	1
*	2002	Conococheague Creek	pH	1
*	2014	Gwynns Falls	Temperature	3
*	2014	Jones Falls	Temperature	3
*	2014	Lower North Branch Potomac River	Mercury	1
*	2002	Lower Susquehanna River	PCBs	1
*	2006	Middle River	PCBs	1
*	1998	Northwest Branch, Inner Harbor	Zinc and Lead	2
*	2008	Potomac River Montgomery County	PCBs	1
*	2008	Susquehanna River/Conowingo Dam	PCBs	1
*	2014	Upper North Branch Potomac River – Jennings Randolph Reservoir	Mercury	1
		Total Listings Addressed from 2018 303(d) List		25

* Identified as a priority under USEPA's prioritization known as WQ-27.

Table 34: Anticipated Submissions to Address Category 5 Integrated Report Listings in FFY 2023.

Submission Date	Listing Year	Listed Waterbody	Impairing Substance	2018 303(d) List Count
September 2023				
*	2012	Baltimore Harbor, Stansbury Pond	PCBs	1
*	1998	Bear Creek	Zinc	1
*	1998	Clopper Lake (revisit)	Nutrients	1
*	2012	Deep Creek Lake	Sediments	1
*	2014	Liberty Reservoir	Temperature	12
*	2014	Lower Potomac River Mesohaline – Neale Sound	Bacteria	1
*	2006	Port Tobacco River	Bacteria	4
*	2014	Potomac River Frederick County	Mercury	1
*	2014	Potomac River Frederick County	PCBs	1
*	2014	Potomac River Washington County (Dam #4 - Dam #5)	Mercury	1
*	2010	Youghiogheny River Lake	Mercury	1
*	2006	Port Tobacco River	Bacteria	4

Submission Date	Listing Year	Listed Waterbody	Impairing Substance	2018 303(d) List Count
		Total Listings Addressed from 2018 303(d) List		**29**

* Identified as a priority under USEPA's prioritization known as WQ-27

In an effort to continue to make progress in developing TMDLs for waters and pollutants where they are most needed, Maryland has developed a prioritization of impairments for TMDL development. This prioritization methodology describes Maryland's ongoing work on the Chesapeake Bay TMDLs and WIP and lays out the different high priority pollutants that will be addressed between now and 2022. Documentation describing this prioritization was incorporated as part of Maryland's 2016 IR and can be accessed at:
https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2016IR.aspx.

C.4 Wetlands Program

C.4.1 Wetland Monitoring Strategy

MDE developed a wetland monitoring strategy in 2010. Wetland monitoring and assessment is undertaken in Maryland to meet various objectives. The strategy includes recommendations and tasks for two options: those that can be done with existing resources, and those that are recommended, but will need additional resources. Recommendations were prepared for monitoring and assessment related to Maryland's wetland permit programs; voluntary restoration, large scale landscape assessments; preservation; and CWA requirements.

Deliverables from the strategy development effort include literature reviews of existing GIS-based landscape assessments (Level 1); rapid field assessments (Level 2); and more intensive field assessments (Level 3). In addition, the work group also prepared a template for an intensive long-term Level 3 monitoring approach and a conceptual framework for WQS specific to wetlands. The final Maryland Wetland Monitoring Strategy was completed in September of 2010 (https://mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Documents/www.mde.state.md.us/assets/document/wetlandswaterways/Final%20Strategy%20Report%20commentsNRCSaddr2.pdf). More details on Maryland's wetlands strategy can be found on MDE's web site at https://mde.maryland.gov/programs/Water/WetlandsandWaterways/Pages/index.aspx.

C.4.2 National Wetland Condition Assessment

As a participant in the National Aquatic Resources Survey program, in 2016, Maryland completed the field work for the National Wetland Condition Assessment. MDE and its subcontractor, Riparia, at Pennsylvania State University, sampled fifteen sites with broader distribution across Maryland than what was previously sampled in 2011. Additional information about the National Wetland Condition Assessment can be found at: https://www.epa.gov/national-aquatic-resource-surveys/nwca.

C.4.3 Mitigation

MDE's Wetlands and Waterways Program has included a nontidal wetland mitigation section since the program's inception in 1991. Maryland's Nontidal Wetlands Act requires a "no net loss" of wetland acreage and function. In order to achieve the goal of "no net loss," compensatory mitigation is required when wetland impacts are unavoidable. The mitigation section is tasked with ensuring that the compensatory mitigation is successfully completed. Additional information about wetland mitigation can be found at:
https://mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Pages/mitigation_report.aspx

C.5 Trend Monitoring

Although water quality trend analysis results are not used in the state's water quality assessment methodologies or listing process, they can be useful metrics for quantifying the amount of pollutants in our waterways and tracking progress of restoration efforts. Typically, water quality information must be collected over sufficiently long temporal periods so as not to draw conclusions from changes caused by natural variability.

Most trend analyses applicable to Maryland waters come from three sources, the United States Geological Survey (USGS), DNR, and the Chesapeake Bay Program (CBP).

C.5.1 USGS Water Quality Trends

The USGS monitoring program includes stations in all 7 of the Chesapeake Bay jurisdictions (Delaware, D.C., Maryland, New York, Pennsylvania, Virginia, and West Virginia). The primary purpose of this monitoring program is to assess the trends in loads that are delivered downstream to the Bay. The Non-Tidal Network (NTN) program began in 2004 and now has 123 stations spread throughout the Bay watershed. 23 of the NTN stations are in Maryland. The analysis for the NTN stations only includes short term trends (2007-2018) since most stations have only been monitored since 2007. The 123 NTN stations include 9 River Input Monitoring (RIM) stations that have been in place since 1985, 4 of which are in MD. Located in non-tidal waters along the fall line, the RIM stations are used to determine trends in loads delivered from the watershed to the tidal waters. USGS conducts 10-year trend analyses for all 27 Maryland stations.

For more information on the Water- Quality Loads and Trends at Nontidal Monitoring Stations in the Chesapeake Bay Watershed please see USGS Trends webpage here: https://cbrim.er.usgs.gov/index.html

USGS has published their Summary of Nitrogen, Phosphorus, and Suspended-Sediment Loads and Trends Measured at the Chesapeake Bay Nontidal Network Stations for Water Years 2009-2018. The summary report can be found here: https://cbrim.er.usgs.gov/summary.html. There is also a story map with additional information that accompanies the 2018 report that can be found here: https://cbrim.er.usgs.gov/data/RIM%20Load%20and%20Trend%20Summary%202020.pdf

USGS has also published a summary of load and trend results from the 9 River Input Monitoring Stations for the period of 1985-2020 here: https://cbrim.er.usgs.gov/data/RIM%20Load%20and%20Trend%20Summary%202020.pdf

C.5.2 DNR Trends

DNR analyzes trends for a variety of water quality parameters in both the tidal and non-tidal waters of Maryland. These data are used to calculate trends both for the purpose of tracking progress with Chesapeake Bay restoration efforts (mainly concerning nutrient and sediment reductions) and for tracking changes in the health of non-tidal river systems. DNR regularly monitors non-tidal waters at 53 CORE/TREND sites and also analyzes trends for 72 tidal stations (125 total stations). These monitoring data provide highly accurate information on the amount of pollutants in our waterways today and in the past.

For more information on DNR's Core/Trend monitoring, please visit DNR's webpage here: https://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/metadata/MDDNR_CORETrendsSummaryThrough2019.pdf

For more information on DNR's Tidal Water Quality Status and Trends please visit their Eyes on the Bay Webpage here: https://eyesonthebay.dnr.maryland.gov/eyesonthebay/status_trends_methods.cfm

C.5.3 The Chesapeake Bay Program Integrated Trends Analysis Team

Recently, the Chesapeake Bay Program developed The Integrated Trends Analysis Team (ITAT) for tidal monitoring in the Chesapeake Bay. The ITAT aims to combine the efforts of the Chesapeake Bay Program analysts with those of investigators in governmental, academic, and non-profit organizations to identify potential research synergies and collaborations that will enhance our understanding of spatial and temporal patterns in water quality.

For more information on the ITAT or to see maps of 2019 Tidal Water Quality Changes, please

visit https://www.chesapeakebay.net/who/group/integrated_trends_analysis_team.

C.5.4 Summary of Trends

MDE analyzed DNR and USGS' Maryland trend reports and found a few important trends of note. Nutrient trends are improving in Maryland, and restoration efforts display measurable positive impacts on water quality. According to DNR, statistical analysis of monitoring data collected at DNR CORE/TREND stations from 1999 through 2019 demonstrates that the current impact of historical Chesapeake Bay restoration spending has resulted in significant reductions in nitrogen concentrations at 49% of stations, phosphorus concentrations at 70% of stations, and sediment concentrations at 38% of stations. However, contributing streams to the Chesapeake Bay continue to warm in the mid-Atlantic region, as previously detected by Rice and Jastram (2014). Currently, temperature shows a degrading trend at 66% of stations (Figure 7).

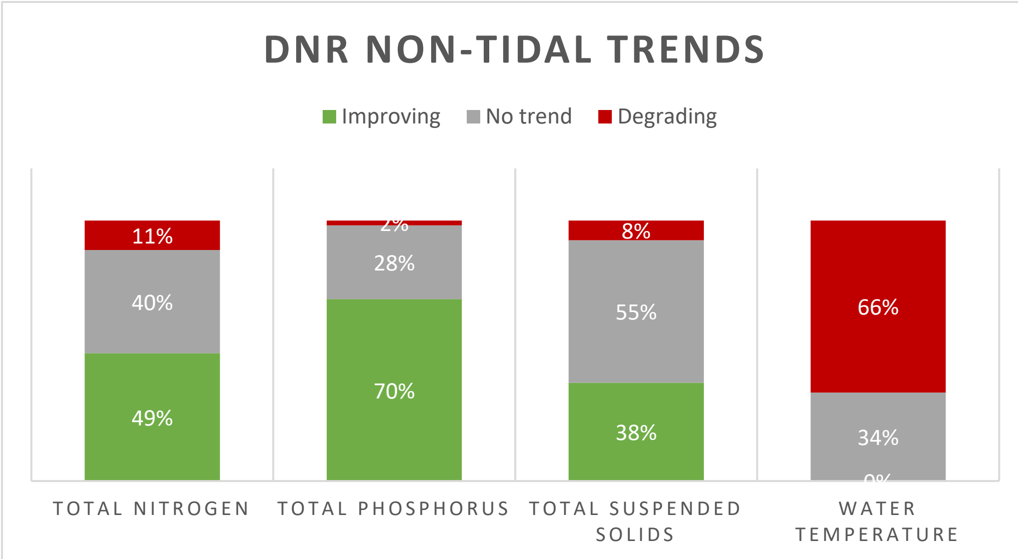

Figure 7: DNR non-tidal trend results in flow adjusted total nitrogen, total phosphorus, total suspended sediment concentrations, and water temperature from 1999 to 2019.

US Geological Service (USGS, 2020) conducted a trend analysis using the Chesapeake Bay nontidal network (NTN) which currently consists of 123 monitoring sites throughout the Chesapeake Bay. In this study they identified a mixed water quality response in the Chesapeake Bay Watershed. However, the same analysis indicates that from the 23 NTN stations and 4 RIM stations in Maryland, total nitrogen trends improved at 66% of the sites and total phosphorus improved at 50% of the sites (Figure 8). USGS analysis corroborates DNR findings on improving nutrient trends in the State of Maryland particularly on the Western Shore of Maryland.

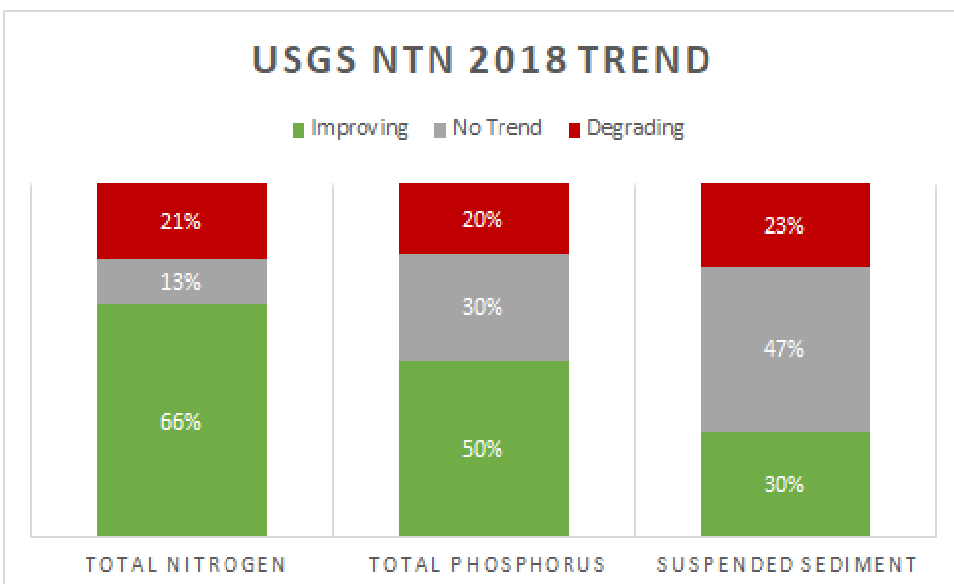

Figure 8: USGS NTN trend results in flow-normalized nutrient and sediment loads from the 27 USGS stations in MD.

DNR (2021) also monitors water quality at 72 stations in the Chesapeake Bay and conducts trend analyses applying the Generalized Additive Models (GAMs) technique developed by Murphy and Perry (2018). The estuary water quality is responding in ways consistent with the watershed (Figures 9 and 10). DO is improving at 27% of stations but showing no trend at 59% of stations. Despite positive trends in nutrients, chlorophyll-a shows improvements at only 13% of tidal stations. Scientists suggest that despite reductions, the current nutrient levels may not be low enough to limit algae growth, and that expectations need to be reevaluated to rethink water quality endpoints (Wardrop and Stephenson, 2021). Temperature shows a degrading trend at 71% of tidal stations. Future warming of contributing streams and the Chesapeake Bay estuary will present new challenges for restoration programs.

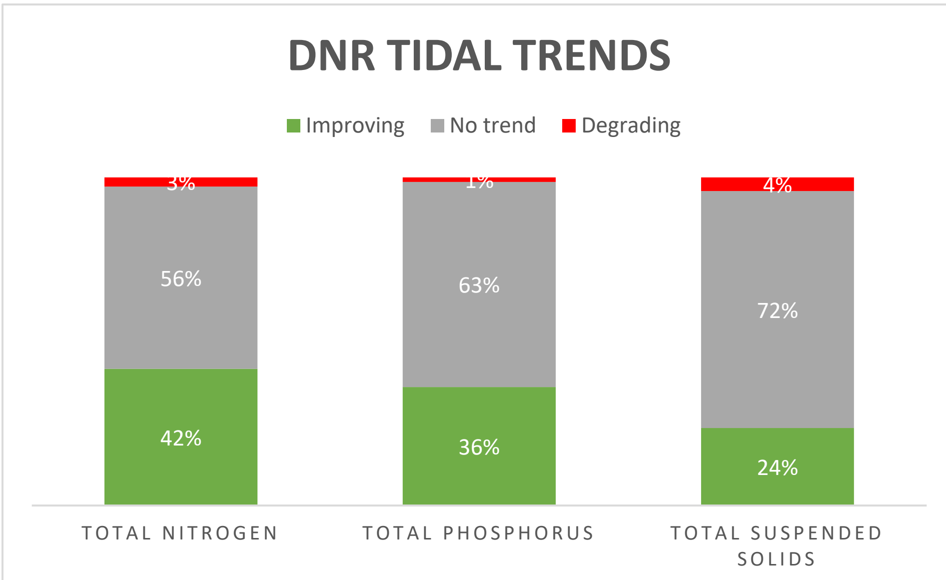

Figure 9: DNR tidal trend results in flow adjusted total nitrogen, total phosphorus, and total suspended sediment concentrations from 1999 to 2019.

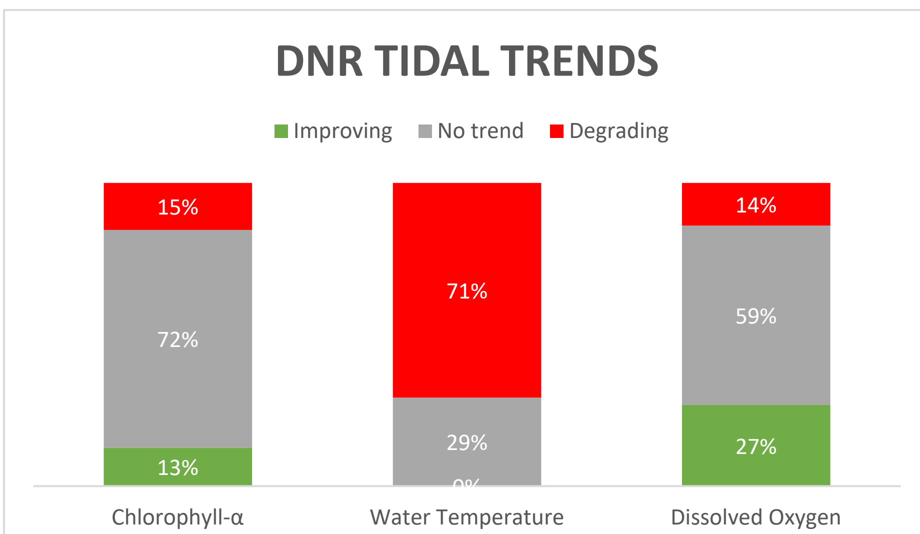

Figure 10: DNR tidal trend results in flow adjusted chlorophyll-a, water temperature, and summer bottom dissolved oxygen concentrations from 1999 to 2019.

References for the Trend Section

ITAT. 2021. Chesapeake Bay Watershed Tributary Summaries. Water Quality Goal Implementation Team September 27, 2021. Online at: https://www.chesapeakebay.net/channel_files/42029/trib_summaries_wqgit_overview_2021-09-27.pdf

Maryland Department of Natural Resources. 2021. Quality Assurance Project Plan for the Maryland Department of Natural Resources Chesapeake Bay Tidal Monitoring Programs Data Management and Analysis for the period July 1, 2019 - June 30, 2020.

Maryland Department of Natural Resources. Karrh, R. 2021. Personal communications (e-mail) – Summary of Tidal Trends. 14 September 2021. Maryland Department of Natural Resources, Annapolis MD.

Maryland Department of Natural Resources. Keppel, A. 2021. Personal communications (e-mail) - CORE/TREND trends results through 2019. 9 June 2021. Maryland Department of Natural Resources, Annapolis MD.

Murphy, R., and E. Perry. 2018. Methods for Application of Generalized Additive Models (GAMs) for Water Quality Trends in Tidal Waters of Chesapeake Bay. Online at: https://www.chesapeakebay.net/channel_files/26076/draft-gam_method_for_chesapeake_5-10-18.pdf

Rice K. and J. Jastram. 2014. Rising air and stream-water temperatures in Chesapeake Bay region, USA. Online at: https://link.springer.com/article/10.1007/s10584-014-1295-9

USGS. 2020. Chesapeake Bay Nontidal Network 1985-2018: Short- and long-term trends. Online at: https://www.sciencebase.gov/catalog/item/5e222083e4b014c853040582

USGS. 2020. Loads and trends in the Chesapeake Bay nontidal monitoring network: results through Water Year 2018. Online at: https://va.water.usgs.gov/storymap/NTN/

Wardrop, D. and K. Stephenson. 2021. Comprehensive Evaluation of System Response. Online at: https://www.chesapeakebay.net/channel_files/43868/cesrtowqgit10-26-2021_final.pdf

C.6 Public Health Issues

C.6.1 Waterborne Disease

The 1996 Safe Drinking Water Act Amendments mandated that EPA and the US Centers for Disease Control (CDC) and Prevention conduct five waterborne disease studies and develop a national estimate of waterborne disease. Additional information on national estimates and waterborne diseases can be found on CDC's website at https://www.cdc.gov/healthywater/burden/.

C.6.2 Drinking Water

MDE is charged with ensuring that all Marylanders have a safe and adequate supply of drinking water. MDE's programs oversee both public water supplies, which serve about 84 percent of the population's residential needs, and individual water supply wells, which serve citizens in most rural areas of the State. Marylanders use both surface water and ground water sources to obtain their water supplies. Surface water sources such as rivers, streams, and reservoirs serve approximately two-thirds of the State's 5.8 million citizens. The remaining one-third of the State's population obtains their water from underground sources. For more details on the State's drinking water program, go to https://mde.maryland.gov/programs/water/water_supply/Pages/index.aspx. For specific information regarding annual consumer confidence reports provided by water systems for their customers please see: https://mde.maryland.gov/programs/Water/water_supply/ConsumerConfidenceReports/Pages/index.aspx.

For information on Maryland's water well construction program, which is the primary regulatory mechanism for protecting new individual water supplies please see: https://mde.maryland.gov/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Pages/WellConstruction.aspx. County Environmental Health Departments implement the State's well construction program and respond to water quality concerns of individual well owners. MDE's regional consultants assist County Environmental Health Departments in addressing water quality issues from individual well owners.

C.6.3 Shellfish Harvesting Area Closures

Maryland's Chesapeake Bay waters have long been known for their plentiful shellfish. MDE is responsible for regulating shellfish harvesting waters so as to safeguard public health. This effort has three parts: 1) identifying and eliminating pollution sources, 2) collecting water samples for bacteriological examination; and 3) examining shellstock samples for bacteriological contamination and chemical toxicants.

Information about which shellfish harvesting areas have conditional closures is updated daily on the web and via a phone message. Click https://mde.maryland.gov/programs/Marylander/fishandshellfish/Pages/shellfishadvisory.aspx to find out which conditional closures are in effect or call 1-800-541-1210. MDE has also created an online interactive map that provides timely information showing approved shellfish harvesting areas, conditionally approved areas, and closed or restricted areas. This map can be accessed at: https://mde.maryland.gov/programs/Marylander/fishandshellfish/Pages/shellfishmaps.aspx.

C.6.4 Toxic Contaminants Fish Consumption Advisories

MDE is responsible for monitoring and evaluating contaminant levels in recreationally-caught fish (includes fish, shellfish and crabs) in Maryland waters. The tissues of interest for human health include the edible portions of fish (fillet), crab (crabmeat and "mustard"), and shellfish ("meats"). Such monitoring enables MDE to determine whether the specific contaminant levels in these species are within safe limits for human consumption. Results of such studies are used to issue consumption guidelines for fish, shellfish, and crab species in Maryland https://mde.maryland.gov/programs/water/FishandShellfish/Pages/index.aspx. Additionally, since fish, shellfish, and crabs have the potential to accumulate inorganic and organic chemicals in their tissues (even when these materials are not detected in water), monitoring of these species becomes a valuable indicator of environmental pollution in a given water body.

C.6.4.1 Fish Tissue Monitoring

MDE has monitored chemical contaminant levels in Maryland's fish since the early 1970s. The current regional sampling areas divide the State waters into five regions:

- Eastern Shore water bodies,
- Harbors and Bay,
- Baltimore/Washington urban waters,
- Western Bay tributaries, and
- Western Maryland water bodies.

Maryland routinely monitors watersheds within these five zones on a 5-year cycle. When routine monitoring indicates potential hazards to the public and environment, additional monitoring of the affected area may be conducted to verify the initial findings and identify the appropriate species and size classes associated with harmful contaminant levels. Findings from such studies are the basis for the fish consumption guidelines found at: https://mde.maryland.gov/programs/Marylander/fishandshellfish/Pages/fishconsumptionadvisory.aspx.

C.6.4.2 Shellfish Monitoring

In the 1960s, MDE began surveying metal and pesticide levels in oysters and clams from the Chesapeake Bay and its tributaries. Prior to 1990, this effort was conducted every one or two years. In response to low levels of contaminants found and very little change from year to year, shellfish are not monitored routinely for chemical contaminants. This allows MDE to devote its limited resources toward intensive surveys in areas where contamination is more likely.

While monitoring has shown no chemical contaminants at levels of concern in any of the oysters sampled, recreational harvesters should still be aware of possible bacterial contamination and avoid shell-fishing in areas that are closed to commercial shellfish harvesting.

C.6.4.3 Crab Monitoring

Between 2001 and 2003 a study of blue crab (Callinectes sapidus) tissue revealed elevated levels of polychlorinated biphenyls and other contaminants in the “mustard” (hepatopancreas) of crabs caught from the following locations:

- Cedar Point,
- Fairlee Creek,
- Hart-Miller Island,
- Middle River, and
- Patapsco River/Baltimore Harbor.

Crabmeat was found to be low in contaminants. Specific recommendations for crab “mustard” have not been developed for all locations. However, in general, it is advised that the “mustard” from crabs taken from the Northern Chesapeake Bay (above Magothy River) should be consumed in moderation, while “mustard” from the previously mentioned locations should be eaten sparingly and avoided for the crabs from the Patapsco River/Baltimore Harbor area.

C.6.5 Harmful Algal Blooms

Algae are a natural and critical part of our Chesapeake and Coastal Bays ecosystems. Algae may become harmful if they occur in an unnaturally high abundance or if they produce a toxin. In Maryland, the Department of Health (MDH), DNR, and MDE collaborate to manage a state-wide harmful algae bloom (HAB) surveillance program which includes issuing health advisories as warranted. MDE and DNR conduct algal bloom complaint response and monitoring that provides useful water quality data, a priori data related to fish kills, and protection for recreational water users and shellfish consumers. MDE also employs ELISA technology to test water and shellfish tissue for ambient and bio-accumulated toxins in support of this effort.

From 2015-2018, the State identified and investigated 34 potential Harmful Algae Bloom (HAB) events where significant risk to human health from contacting or ingesting water existed and 15 Contact advisories were initiated. Both MDE and DNR will continue to work with the Bay Program and MDH to develop, where appropriate, standards or other measures to protect both human health and aquatic life from harmful algal blooms.

Table 35: Number of water samples tested for microcystin, number with microcystin above 10 ppb and number of no-contact advisories issued to protect human health from over the most recent 5-year period (source: MDE unpublished data).

Year	Number of Samples Tested	Number of Samples with Elevated Toxins	Number of Advisories Issued
2015	3	3	3
2016	53	26	5
2017	15	8	2
2018	34	5	5
Total	**105**	**42**	**15**

For more information on the science of HABs and how they are managed in Maryland please visit the following websites:

MDE HAB page
https://mde.maryland.gov/programs/Water/HAB/Pages/index.aspx

MDH HAB page
https://phpa.health.maryland.gov/OEHFP/EH/Pages/harmful-algae-blooms.aspx

DNR HAB pages
https://dnr.maryland.gov/waters/bay/Pages/algal_blooms/Ecosystem-Disruptive-HABs.aspx

C.6.6 Fish Kills

Fish kills occur for a variety of reasons such as natural water chemistry, biological changes, chemical pollution or miscellaneous human activity. MDE is the lead agency with the responsibility for investigating, responding, and reporting on fish kills throughout the state. DNR jointly investigates when fish kills are the result of disease and provides other support as needed. MDE releases an annual summary report of fish kills that can be found here:
https://mde.maryland.gov/programs/Water/FishandShellfish/Documents/2019_FK_ANNUAL_REPORT_final.pdf

For more information on fish kills, please visit MDE's website:
https://mde.maryland.gov/programs/water/fishandshellfish/pages/mdfishkills.aspx

C.6.7 Bathing Beach Closures

In October 2000, EPA passed the BEACH Act and provided funding to improve beach monitoring in coastal states. The BEACH Act allows states to define and designate marine coastal waters (including estuaries) for use for swimming, bathing, surfing, or similar water contact activities. The State of Maryland defines beaches in the Code of Maryland Regulations (COMAR, https://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.09.01.htm) as "natural waters, including points of access, used by the public for swimming, surfing, or other similar water contact activities." Beaches are places where people engage in, or are likely to engage in, activities that could result in the accidental ingestion of water. In Maryland, the beach season is designated from Memorial Day to Labor Day. Maryland's WQS and regulations for beaches are published in COMAR 26.08.09 and 26.08.02.03. Some important points are:

1. *E. coli* and Enterococci are the bacteriological indicators for beach monitoring;
2. Prioritization of monitoring of beaches is based on risk; and
3. All beaches, whether permitted or not, now receive protection.

MDE works with local health departments to enhance beach water quality monitoring and improve the public notification process to protect the health of Marylanders at public bathing beaches. The State

Beaches program is administered by MDE; however, the responsibility of monitoring and public notification of beach information is delegated to the local health departments (https://www.mde.maryland.gov/programs/Water/Beaches/Pages/beaches_healthdepts.aspx).

To protect the health of citizens visiting beaches across Maryland, MDE's Beaches Program is working to standardize and improve recreational water quality monitoring. In addition, MDE provides access to timely information to inform the public of beach closures, advisories, and algal blooms before they head to the beach. This information is accessible through the web at: (https://mde.maryland.gov/programs/Water/MHB/Pages/Current-Conditions.aspx).

C.6.8 Combined and Sanitary Sewer Overflows

MDE has been tracking reports of sewage overflows by owners and operators of sewage systems in the State. MDE is concerned that there are still a significant number of overflows that occur across the State. These sewage overflows adversely impact State waters and pose a risk to public health from raw or partially treated sewage containing elevated levels of bacteria and disease-causing pathogens. MDE maintains an online database of reported sanitary sewer overflows, combined sewer overflows, and bypasses.
See https://mde.maryland.gov/programs/water/Compliance/Pages/ReportedSewerOverflow.aspx .

C.7 Invasive aquatic species

'New' species are being introduced at an increasing rate into Maryland. Since colonization, new species have been introduced through a variety of pathways, including ship ballast, in packing materials, and through deliberate import for various uses. While most of these introduced species are beneficial or benign, about 15 percent become invasive - showing a tremendous capacity for reproduction and distribution throughout its new environment. These invasive species can have a negative impact on environmental, economic, or public welfare priorities.

Many introduced species once thought to be beneficial have demonstrated invasive characteristics and are proving difficult to control - out-competing native species (species of plants and animals that have evolved in the State and have developed mutually-sustaining relationships to each other over geologic time) for food, shelter, water or other resources, as well as affecting economic interests and human welfare.

Additional information about invasive species are available online from DNR (https://dnr.maryland.gov/invasives/Pages/default.aspx), the Smithsonian Environmental Research Center (https://serc.si.edu/invasive-species), and the US Department of Interior's Fish and Wildlife Service (https://www.fws.gov/invasives/).

PART D: GROUND WATER MONITORING AND ASSESSMENT

Groundwater is a finite natural resource that sustains Maryland's natural ecosystems in addition to supporting significant and growing human water supply demands. Approximately one third of Maryland's population currently depends on groundwater for drinking water. As the population in Maryland continues to grow, the demand for groundwater for drinking, irrigation, industry, and other uses is increasing, while threats to groundwater quality related to that development increase as well.

Senate Joint Resolution No. 25 of 1985 requires the MDE to provide an annual report on the development and implementation of a Comprehensive Ground Water Protection Strategy in the State and on the coordinated efforts by state agencies to protect and manage groundwater. Since the development of the original strategy, a variety of state programs at MDE, the Maryland Department of Agriculture (MDA) and (DNR) have endeavored to protect ground water resources and characterize the quality and quantity of these resources.

The most recently approved groundwater protection report provides an overview of the FY13 activities and accomplishments of state programs that are designed to implement Maryland's Comprehensive Ground Water Protection Strategy. Stakeholders interested in reading the full FY13 groundwater report can visit:
https://mde.maryland.gov/programs/Water/water_supply/Source_Water_Assessment_Program/Documents/FINAL_GWR%20report_1__2013%20_3_.pdf.

PART E: PUBLIC PARTICIPATION

MDE utilizes a public participation process for the IR similar to that used for promulgation of new regulations. The Administrative Procedures Act mandates that a minimum of 30 days from the date of publication in the Maryland Register must be allowed for public review and comment. MDE granted 42 days for public review of the draft Combined 2020-2022 IR of Surface Water Quality which began on December 6, 2021 and ended on January 17, 2022. Besides posting an announcement on the Department's home web page, MDE also posted announcements through the following outlets:

- MDE's IR web page,
- Several of MDE's social media outlets (e.g. Facebook),
- The Maryland Water Monitoring Council Announcement web page (https://dnr.maryland.gov/streams/Pages/MWMC/BulletinBoard.aspx), and
- Targeted emails to the TMDL contact list (approximately 500+ contacts) which includes representatives of federal, state, and local government, academia, and other non-government organizations.

The draft IR was made available in electronic format to the public via MDE's IR webpage https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/Combined_2020_2022IR.aspx and in hard copy format by special request to Becky Monahan at becky.monahan@maryland.gov or 410-537-3947. *Please note that MDE charges a fee (36¢/page) for printing and shipping hard-copy reports.*

During the open comment period for the IR, an informational public meeting was held virtually at 5pm on January 5, 2022 to facilitate dialogue between MDE and stakeholders concerning the format, structure, and content of the draft IR. This meeting was recorded and shared with stakeholders that weren't able to attend the virtual public meeting.

E.1 Informational Public Meeting Announcement

Maryland
Department of
the Environment

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

Ben Grumbles, Secretary
Horacio Tablada, Deputy Secretary

Department of the Environment
Informational Public Meeting Announcement:
Maryland's Draft Combined 2020-2022 Integrated Report of Surface Water Quality

The Federal Clean Water Act requires that States assess the quality of their waters every two years and publish a list of waters not meeting the water quality standards set for them. This list of impaired waters is included in the State's biennial Integrated Report (IR) of Surface Water Quality. Waters identified in Category 5 of the IR are impaired and may require the development of Total Maximum Daily Loads (TMDLs). The Maryland Department of the Environment (MDE) is announcing the availability of the Draft Combined 2020-2022 IR for public review and comment. Maryland's combined Integrated Report covers the 2020 and 2022 reporting cycles and incorporates assessments using all data that normally would have been included for the 2020 and 2022 cycles into one report. The public review period will run until **January 17, 2022**. The Draft IR is being posted on MDE's website at http://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/Combined_2020_2022IR.aspx. Hard copies of the Draft IR may be requested by calling Becky Monahan at (410) 537-3947. *Please note that the Department charges a fee to cover printing and shipping costs.*

The Department is hosting a virtual informational public meeting at 5 pm on January 5, 2022. Please register for the virtual meeting at https://attendee.gotowebinar.com/register/3651118994985642256. Any hearing impaired person may request a closed caption option for the meeting by contacting Becky Monahan at Becky.Monahan@maryland.gov or by calling (410) 537- 3947 in advance. The meeting will be recorded and a copy can be requested by contacting Matthew Stover at Matthew.Stover@maryland.gov. Comments or questions may be directed in writing to Matthew Stover, MDE, Water and Science Administration, 1800 Washington Blvd., Baltimore, Maryland 21230, or emailed to Matthew.Stover@maryland.gov, on or before **January 17, 2022**. After addressing all comments received during the public review period, a final IR will be prepared and submitted to the U.S. Environmental Protection Agency for approval.

Public Meeting Announcement
Date: January 5, 2022.
Start Time: 5:00 p.m.
Virtual Registration: https://attendee.gotowebinar.com/register/3651118994985642256
Webinar ID: 811-985-427
Audio: United States 1 866 901 6455
Attendee- Pin: 584-629-042

E.2 Attendance List from Virtual Informational Public Meeting

Attendee Report:	**Virtual Informational Public Meeting for the Draft Combined 2020-2022 Integrated Report (IR) of Surface Water Quality**			
Report Generated: 01/06/2022 08:43 AM EST				
Webinar ID	**Actual Start Date/Time**	**Duration**	**# Registered**	**# Attended**
811-985-427	01/05/2022 04:21 PM EST	1 hour 33 minutes	28	17
Attendee Details				
Attended	**Last Name**	**First Name**	**Email Address**	
Yes	Abbott	Doug	dabbott@eucmail.com	
Yes	Dalmasy	Dinorah	dinorah.dalmasy@maryland.gov	
Yes	Fogel	Daniel	dan.fogel@stmarysmd.com	
Yes	Grossweiler	Sophia	sophia.grossweiler@maryand.gov	
Yes	Hamilton	Amy	amy.hamilton@maryland.gov	
Yes	Kasko	Anna	anna.kasko@maryland.gov	
Yes	Martin	Kathy	kjm2@aol.com	
Yes	Martinez da Matta	Maria Izabel	maria.martinezdamatta@maryland.gov	
Yes	Pates	Hunter	pates.hunter@epa.gov	
Yes	Shin	Jin	jin.shin@wsscwater.com	
Yes	Stecker	Kathy	kathy.stecker@maryland.gov	
Yes	Wagner	Kevin	kevin.wagner@maryland.gov	
Yes	Wazniak	Catherine	catherine.wazniak@maryland.gov	
Yes	White	Jeff	Jeff.White@Maryland.gov	
Yes	Wiggen	Karen	wiggenk@charlescountymd.gov	
Yes	Willoughby	Jenny	jwilloughby@cityoffrederickmd.gov	
Yes	Zitta	Peter	pzitta@amtengineering.com	
No	Coleman	Tracy	tcoleman@cityoffrederickmd.gov	
No	Cooke	Travis	tcooke@res.us	
No	Lewandowski	Mark	mark.lewandowski@maryland.gov	
No	MacLeod	Chip	cmacleod@mlg-lawyers.com	
No	Mariscal	Phillip	phillip.mariscal@gmail.com	
No	Musegaas	Phillip	phillip@prknetwork.org	
No	Reed	Alexander	areed@washco-md.net	
No	Sanchez de Boado	Alexi	aboado@clean-streams.com	
No	Silvia	Jami	Jami.everton@maryland.gov	
No	Wojahn	Patrick	pwojahn@collegeparkmd.gov	
No	Zeff	Marjorie	marjorie.zeff@aecom.com	

E.3 Comment-Response for the Combined 2020-2022 Integrated Report

Table 36: List of Commenters

Author	Affiliation	Date Received	Comment Numbers
Gregory Voigt	Environmental Protection Agency (Region 3)	January 13, 2022	1-2

United States Environmental Protection Agency Region III (EPA), 1650 Arch Street, Philadelphia, Pennsylvania 19103-2029, Gregory Voigt, Section Chief, Standards and TMDLs Section.

EPA Comment 1: MDE should explain if there are any updates to the existing 4b listings, including whether further investigations were conducted and if any recent data is available from permittees or elsewhere to assess whether water quality has improved. Furthermore, if MDE has any additional plans for monitoring at these sites, please describe.

MDE Response: Maryland has a total of ten Category 4B assessment records in the 2020-2022 IR including: 5 water segments in the tidal Patuxent River caused by an oil spill that occurred in 2000, 4 assessment records for areas around Sparrows Point for cyanide and copper impairments, and 1 record for a pH impairment to Georges Creek due to issues with acid mine drainage.

The assessment records for oil impacted waters describe portions of the Patuxent River watershed where clean-up was not an effective option. Instead, EPA and the Natural Resources Trustees determined that these waters be addressed using a Qualitative Long Term Monitoring (QLTM) plan to characterize the spatial extent of natural attenuation (of oil presence) over time. The QLTM plan consists of "visual inspections of oil and is based on modified Shoreline Clean-up Assessment Technique (SCAT) procedures. Each shoreline zone is required to pass two levels of clean-up criteria before being signed-off by the trustees and approved by the Unified Command (consisting of EPA, MDE, and PEPCO)" (Summary of 2013 Qualitative Long-Term Monitoring Activities: Swanson Creek and Patuxent River). The remaining waters impacted by the historical oil spill now undergo sampling every 3 years to determine if residual oil is still impacting aquatic resources. This area was sampled in 2019 and MDE will review the data in preparation for the 2024 Integrated Report.

The four assessment records related to cyanide and copper in waters near Sparrows Point were monitored in 2015 and found to be in violation of, or potentially in violation of water quality criteria. Since it is highly likely that these water quality issues resulted from legacy industrial contamination in this area, and efforts are currently underway (through a consent decree) to remediate that contamination, the Department is planning to reassess these waters after significant remediation has completed.

The Category 4B assessment record for pH impairment in Georges Creek is being addressed through ongoing efforts by MDE's Abandoned Mine Land Division to remediate acid mine drainage at a variety of points along the Creek. Modifications to help with treatment were made in 2014. All flow from the mine opening was directed though a lime doser via a ditch which aerates the flow and works to off gas much of the Carbon Dioxide and assist in treatment. Prior to this modification, only a portion of the flow was piped from the mine opening to the doser. In addition, since 2011 the pH has been gradually increasing requiring less treatment from the doser. MDE plans to reassess these waters during the next IR cycle.

EPA Comment 2: MD-02140205-Northwest_Branch/HEPTACHLOR EPOXIDE, listed in Category 5, is associated with the Anacostia River Toxics TMDLs, which have been made available for public notice and comment (in July 2021); therefore, MDE may consider changing the TMDL priority ranking from low to high to ensure that the TMDLs are finalized.

MDE Response: MD-02140205-Northwest_Branch for HEPTACHLOR EPOXIDE listed in Category 5 has been updated with a high TMDL priority ranking.

PART F: THE 2020-2022 INTEGRATED REPORT

What follows is the Combined 2020-2022 IR sorted by attainment status or category of the IR upon which a water body-designated use-pollution assessment is placed. Seven categories are used in the current report (Categories 2, 3, 4a, 4b, 4c, 5, and 5s). Section F.2 of the list represents Category 2 waters meeting the standards for which they have been assessed. Section F.3 captures Category 3 waters that have insufficient data or information to determine whether any water quality standard is being attained. Section F.4 reports surface waters listed on Category 4a that are still impaired but have a TMDL developed that establishes pollutant loading limits designed to bring the water body back into compliance. Section F.5 reports surface waters on Category 4b that are impaired but for which a technological remedy should correct the impairment. Section F.6 reports surface waters on Category 4c that are impaired but not for a conventional pollutant. This includes pollution caused by habitat alteration or flow alteration. Section F.7 reports surface waters listed on Category 5 of the Integrated List and is the section of the List that has been historically known as the 303(d) List. Category 5 of the IR includes water bodies that may require a TMDL. Lastly, Section F.8 reports surface waters listed in Subcategory 5s where the waterbody impairment is caused by chloride from road salt. These are still impaired waters that are part of the 303(d) List.

F.1 Report Format and Structure

The 2020-2022 IR format provided in this report is different from the 2018 IR since Maryland utilized EPA's Assessment, TMDL Tracking and Implementation System (ATTAINS) for the Combined 2020-2022 Integrated Report. Displaying the information from ATTAINS supports greater consistency between information the public can access through the EPA tools like How's My Waterway and the Integrated Report. The report header indicates the listing Category for that section of the report as well as the information provided for each assessment unit or water body. Each row of the table represents each individual assessment unit or water body in the report. The other information provided includes the assessment unit ID, the assessment unit name, the location description, the waterbody type, the designated use of the waterbody, the attainment status of the designated use, the parameter or pollutant name, the cycle first listed if impaired, the attainment status of the parameter, the overall status of the parameter, the EPA Category, the MDE Category, the TMDL development priority ranking if impaired, and a comment field. Please note that the EPA Category and the MDE Category will differ for Category 5s waters since EPA doesn't specifically designate any State subcategories.

Since ATTAINS reporting is a newer requirement, MDE also wanted to provide the information in the same format that was presented in previous IRs. MDE is making the Department's IR Database available in a query-able excel format on the MDE webpage: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/Combined_2020_2022IR.aspx. MDE's database includes columns and information that are not found in ATTAINS such as the percent impaired, percent attributable risk, or MD's 8-digit basin information. MDE feels that this is valuable information that the public may want to access. This excel table includes a data dictionary tab that provides a description of the headings and information in the database.

For more information on ATTAINS please see https://www.epa.gov/waterdata/attains.
To access How's My Waterway please see https://www.epa.gov/waterdata/hows-my-waterway.

F.2 Category 2 Waters

F.3 Category 3 Waters

F.4 Category 4a Waters

F.5 Category 4b Waters

F.6 Category 4c Waters

F.7 Category 5 Waters

F.8 Category 5s Waters

PART G: SPECIAL ASSESSMENTS

G.1 Conococheague Creek High pH Assessment

Introduction

Conococheague Creek segments (2016 Integrated Report of Surface Water Quality in Maryland Assessment Unit IDs: MD-02140504-Multiple_segments_1 and MD-02140504-Multiple_segments_2) were originally listed in Category 5 for high pH on the 2002 303(d) list, based on data from the 2001 305(b) report. The threshold used to determine impairment, as indicated in MD's IR, is defined as greater than 10% of measurements exceeding a pH of 8.5 during the most recent five year period. Data used for listing was from the DNR CORE/Trend program, which collected monthly pH data from the mainstem Conococheague Creek at two stations, CON0180 and CON0005. The impairment listing was refined in 2012 defining the impaired portion as only the portion downstream of CON0180, since newer data showed that this station was not impaired.

Then, in 2014, an intensive review of studies completed in the Conococheague Creek relating to pH was conducted in order to determine if the high pH was being caused by karst, a natural condition. The Conococheague Creek in Washington County, MD, is located in a region with prevalent karst (limestone) geology. Karst geology is formed by the slow dissolution of calcium and magnesium oxides in limestone, dolomite, or marble bedrock, which leads to increased alkalinity and ultimately pH (Sherwood 2004). Maryland's IR Assessment Methodology for pH stipulates that, "it is undesirable to incorrectly identify a water body as impaired when the observed condition is of a natural origin." Furthermore, it also states that, "certain conditions in close proximity to limestone springs may also have natural pH values outside of the standards." (MDE 2012). The 2014 review included Biological Stressor Identification, a synoptic pH monitoring survey, ion concentration analyses, and karst formation mapping. The conclusion of the review was that the observed high pH measurements were likely due to natural karst conditions.

Based on the intensive study of Conococheague Creek (Assessment Unit: MD-02140504-Multiple_segments_1), in the Draft 2018 IR that was released for public comment, MDE proposed that the local geological conditions (i.e. karst formations) caused the pH for this stream system to frequently go above the upper bound of Maryland's pH criteria (8.5). MDE intended to move this pH listing from Category 5 (impaired waters for which a TMDL is required) to Category 2 (waters attaining some standards) due to the impairment being caused by the natural geology of the area. However, upon further review and discussion with EPA, MDE decided that additional follow-up monitoring and assessment was needed to further evaluate if the high pH levels were caused by the natural geology of the area or another factor like nutrients. Therefore, MD-02140504- Multiple_segments_1 remained on Category 5 for high pH for the 2018 IR.

In response to the conversation with EPA, MDE developed a study in 2019-2020 to further investigate the cause of the high pH impairment in the Conococheague Creek Watershed. This report provides a brief summary of the 2014 review, details on the 2018 IR category change proposal, and new information on the 2019-2020 Conococheague Creek study investigating the high pH.

Summary of 2014 Intensive Review

Figure 1 shows the location of the Conococheague Creek watershed and the monitoring stations evaluated in the 2014 Intensive Review.

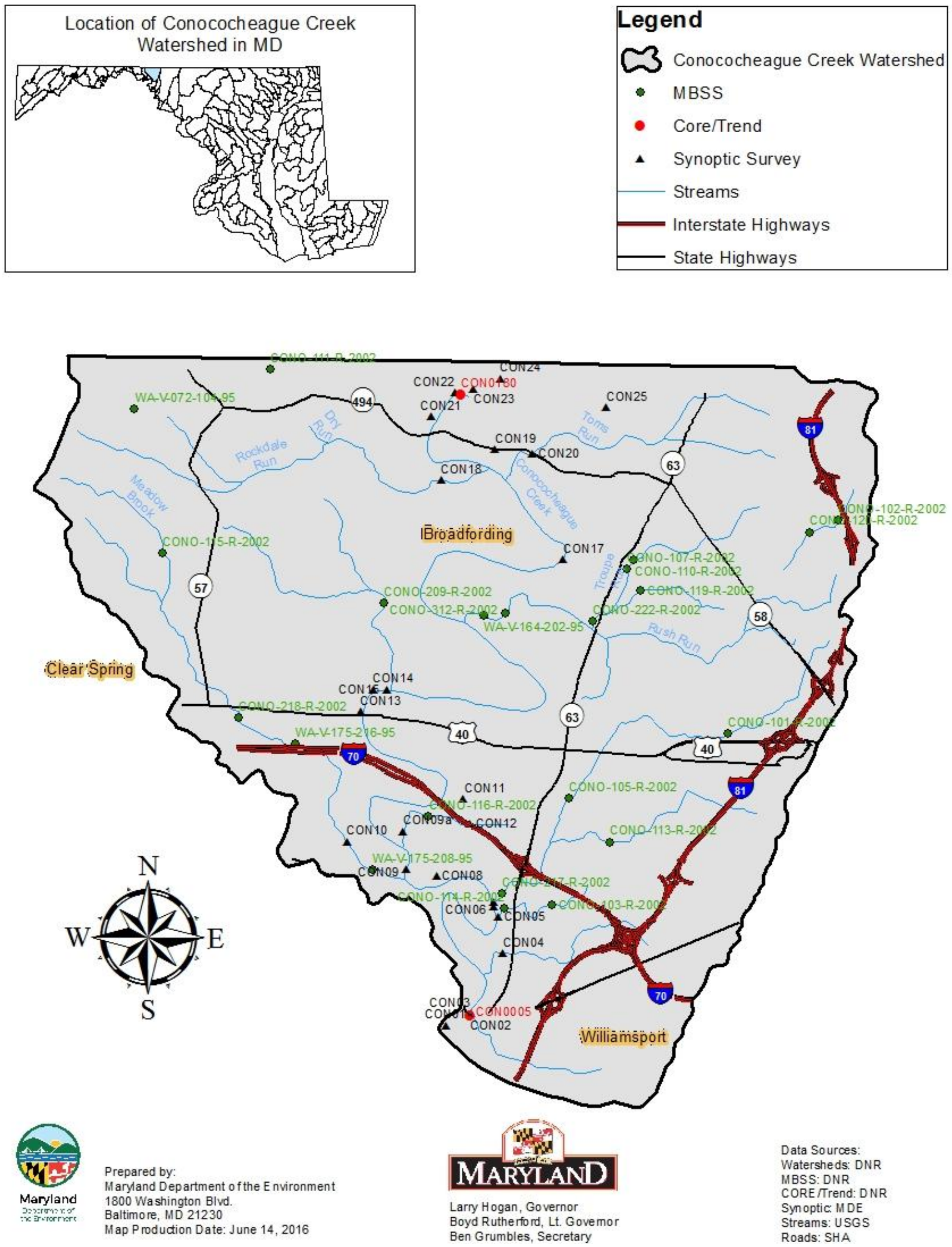

Figure 1: Location of Conococheague Creek Watershed, with pH Sampling Stations

The 2014 intensive review included evaluating the entirety of the CORE/Trend data (1986 – 2019) at both CON005 and CON080 to determine the presence of any seasonal or inter-annual trends as to when exceedances occurred. Over the 31 years, most exceedances occurred in the spring (March-April) and the fall (September – November), which suggested either a bi-modal exceedances pattern or no seasonal pattern at all. A Biological Stressor Identification (BSID) Analysis was also conducted for Conococheague Creek in 2013 since it was listed as impaired for impacts to biological communities in 2004. The BSID analysis did not identify high pH as a cause for biological impairment in the Conococheague Creek. The BSID analysis did identify sediment, nutrients, chlorides, and sulfates as causes of impairment (MDE 2013). A synoptic survey was also conducted given the differing results of the Integrated Report listing analysis and the BSID analysis. In addition, the karst geology of the area was evaluated through maps produced by US Geological Survey, Maryland Geological Survey, Natural Resources Conservation Service, and Western Maryland Resource Conservation & Development Council, Inc. The counties in Maryland most affected by karst are Washington, Carroll, Frederick, and Baltimore, with less extensive areas in Allegany County (Sherwood 2004). Alkalinity and ionic variance were also assessed through water quality samples in Conococheague Creek and the predominant cation was calcium and the predominant anion was bicarbonate, which indicated significant interaction with the limestone bedrock.

Finally, a spatial comparison was performed relating the results from the ion study to mapped karst geology (based on an ongoing survey by MGS) within the state. The analysis compared calcium, alkalinity, and pH, to the prevalence of karst geology in the catchment upstream of the study sites. The results showed a significant correlation between those catchments with greater than 50% karst to high calcium and alkalinity, and higher pH. There were five sites from the ion study in the Conococheague Creek. Of the five, one had no upstream karst, one had 56% karst upstream, and the other three had >85% karst upstream. Based on the information found during this 2014 review, it was determined that the occasionally high pH observations in the mainstem of Conococheague Creek were most likely due to natural conditions, and specifically the karst geology of the watershed. Therefore, it was recommended that the high pH listing for Conococheague Creek should be delisted and moved to Category 2 on the 2018 IR due to the karst geology being a natural condition of the watershed.

Draft 2018 IR

The draft 2018 IR was released for public comment on February 16, 2018 and included a Special Assessment section detailing the results of the 2014 intensive study of Conococheague Creek (Assessment Unit: MD-02140504-Multiple_segments_1) and proposed moving the listing from Category 5 to Category 2 due to local geological conditions (i.e. karst formations) that caused the pH for this stream system to frequently go above the upper bound of Maryland's pH criteria (8.5). EPA commented on the listing change during the 2018 public comment period.

EPA's comment on the 2018 IR: "G.1: The non-tidal Conococheague Creek is listed as impaired for total phosphorus and pH as well as other parameters. MDE proposes to move the pH listing for Conococheague Creek from Category 5 to Category 2 due to the impairment being caused by the natural geology of the area. In addition to geology, other water quality factors can influence pH. For instance, seasonal patterns of high pH during spring and fall may arise from high levels of photosynthesis, which in some cases, is a result of excessive nutrients. MDE's pH assessment method states "Another natural condition which should not be used to identify a water body as pH impaired is an abundance of algae or aquatic plans that elevate pH levels about 8.5 as a result of photosynthetic-drive chemical reaction, unless the condition is being caused by a defined nutrient enrichment source." The BSID analysis identified nutrients as a stressor impacting aquatic life in the Conococheague Creek watershed. To the extent the pH levels may be associated with the identified nutrient enrichment, it may be useful for MDE to explain this link as an additional causative factor, particularly as the phosphorus impairment remains in Category 5. It also may be useful for MDE to compare observed pH and alkalinity values in a biologically unimpaired, reference watershed with 75 to 100 percent karst coverage with observed pH and alkalinity values in the Conococheague Creek."

After further review and discussion with EPA, MDE agreed that additional follow-up monitoring and assessment was needed to further evaluate if the high pH levels were caused by the natural geology of the area or another factor like nutrients. MDE decided to conduct a follow up monitoring study in the Conococheague Creek watershed and kept the MD-02140504- Multiple_segments_1 assessment on Category 5 for high pH for the 2018 IR.

2019-2020 Conococheague Monitoring Project

Based on EPA's comment on the 2018 Draft IR, it was agreed to create a joint (EPA/MDE) monitoring project to determine if the reason for high pH readings in the Conococheague Creek Watershed were more likely geological or eutrophication-related. The project team included members from both EPA and MDE and the project team determined that the project should include a water quality study collecting diel pH and nutrient values in the Conococheague Creek and surrounding watersheds, comparisons of the water quality study data with other literature values for evaluating impacts from nutrients, consultations with local geology experts to determine what is unique about the geology and surface water interaction in the Conococheague, a semi-quantitative or qualitative algae survey in the Conococheague Creek Watershed to determine whether algae are present and persistent in the watershed, and research and documentation on the presence of quarries or other significant concentrated sources of alkalinity to the Conococheague Creek Watershed.

Water Quality Study

The main effort of the project was to conduct a water quality monitoring study to collect diel pH data at sites in the Conococheague Creek and surrounding watersheds to determine pH flux and evaluate the impact from nutrients. Ten stations were chosen within the Conococheague Creek, Antietam Creek, and Little Conococheague Creek Watersheds (figure 2) and monitoring began in January 2019. Monitoring was conducted by the MDE Annapolis Field Office. Little Conococheague Creek and Antietam Creek were chosen because of their proximity and similar karst geology/agricultural land use to that of Conococheague Creek. The team was especially interested in learning why the pH in the Conococheague was so much higher than the other two similar watersheds.

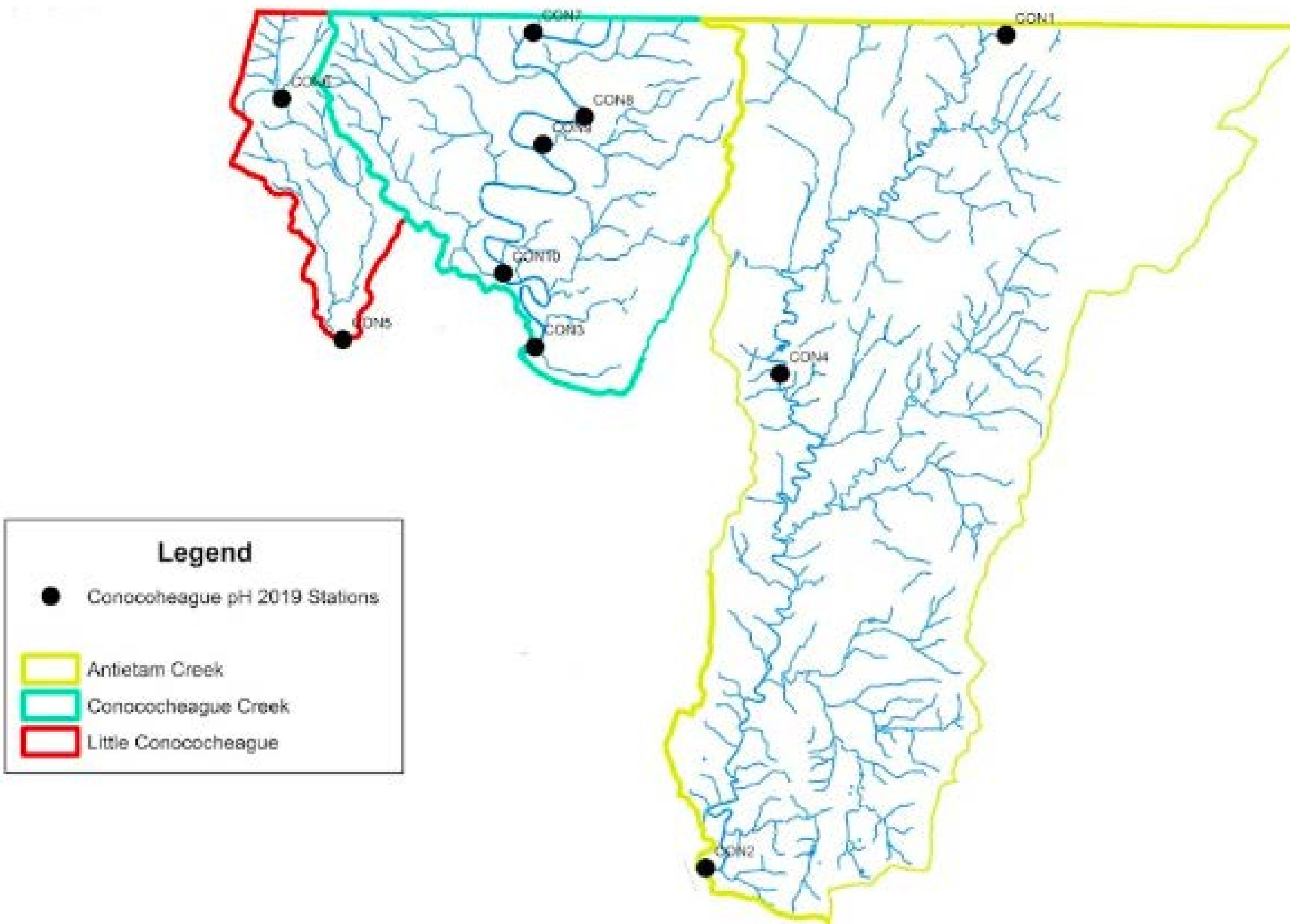

Figure 2: 2019-2020 Monitoring stations

pH Loggers were deployed in January 2019 and set to record pH and temperature every hour. The dates that each logger was deployed are as follows:

- CON1: January 2019 – January 2020
- CON2: January 2019 – January 2020
- CON3: January 2019 – April 2020
- CON4: January 2019 – November 2020
- CON5: January 2019 – January 2020
- CON6: January 2019 – November 2020
- CON7: January 2019 – January 2020
- CON8: January 2019 – January 2020
- CON9: January 2019 – January 2020
- CON10: January 2019 – April 2020

Nutrient samples were also collected monthly at stations CON1 – CON10 from March through November of 2019 for a total of 8 samples per station. Samples were analyzed for total ammonium, nitrate + nitrite, phosphate, total nitrogen and phosphorus, chlorophyll-a (spectrophotometric), phaeophytin (spectrophotometric), alkalinity, and hardness. In addition, a water quality sonde was rotated between 4 sites during the summer months to collect dissolved oxygen. Each sonde was deployed for a full week at CON3, CON8, CON9, and CON10.

In November 2019, 10 months of data was analyzed and CON3 (DNR CORE/Trend station CON005) and CON10 were the only two stations with pH exceedances greater than 10% of the time. Based on this analysis, monitoring stations were changed to more closely focus efforts near CON10 and CON3. CON4 in Antietam Creek and CON6 in Little Conococheague were both dropped since they didn't have any exceedances. Two new stations, CON11 and CON12, were added in the Conococheague Creek, one downstream of CON3 and one in between CON3 and CON10 (Figure 3). pH data was collected at these stations between November 2019 and April 2020.

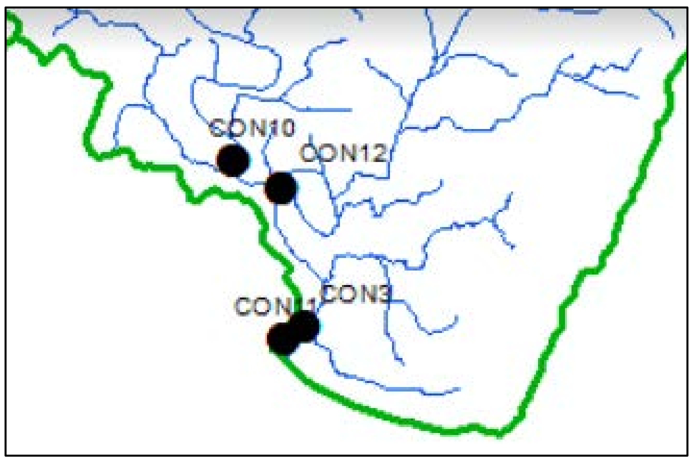

Figure 3: Additional 2019-2020 Monitoring stations

Geological Research

MDE consulted with a geochemist, Chris Gammons, in Montana that has many published studies on pH in streams. He maintained that a karst stream that is in equilibrium with calcium carbonate would have a "resting" pH of about 8.3. In addition, if the stream is even moderately productive, with low turbidity the stream could have a pH swing of one unit. In karst streams the diel pH would range from 7.8 to 8.8, which is a similar range to what was observed in the Conococheague pH logger data.

Additionally, several abiotic factors can limit the pH swing and cause the instream pH to only exceed 8.5 pH criteria for a relatively short period of time. For example, higher flow and gradient areas in streams will have more rapids and riffles. This will reduce the pH swing because the dissolved CO_2 and oxygen would equilibrate with the air more rapidly. Lower flow streams are expected to have large pH swings. Turbidity is also a factor and clearer areas of streams are expected to have larger pH swings because the macrophytes have a greater access to sunlight and therefore can absorb more CO_2 during the day. More turbid streams will have smaller pH swings.

Furthermore, bicarbonate data from the Maryland Biological Stream Survey strongly suggests that the Conococheague mainstem is saturated in calcium carbonate, and this is pushing the pH to around 8.1 to 8.3. The time series data seems to show that photosynthesis was pushing the pH over the 8.5 criteria exactly at the expected time.

Additional geological information was provided by the MDE Field Office. Based on GIS analysis, there is a large amount of crop agriculture with very little tree buffer in the Conococheague Creek Watershed. While it seems that the karst geology is a large factor in the pH exceedances, there is also a nutrient factor, due to the amount of agricultural land. The nutrients increase algae production which in turn pushes a higher pH in an already elevated system. Additionally, the entire creek is a slow run with very little riffle/rapid areas that could counteract the other factors driving the high pH. There is also a dam below station CON10 that causes the river to be very wide and slow moving above station CON10 and may be a contributing source to the pH exceedances around CON10.

Algae Research

MDE field office staff did not observe a significant amount of algae at any of the water quality monitoring stations. Therefore, a standardized algae survey was not completed. The field office staff took qualitative notes on any algae present when they calibrated the logger sensors or collected samples. Chlorophyll-a and periphyton were also analyzed with the nutrient samples.

Concentrated Sources of Alkalinity

MDE staff also researched the presence of quarries and permitted point sources that might contribute to the high pH impairment in the Conococheague Creek Watershed. The MDE Water Permits Interactive Search Portal and ICIS were used to identify locations and possible pH data. There is one quarry near monitoring station CON8 and two WWTPs located near CON1 (Waynesboro WWTP) and CON4 (Funkstown WWTP). Funkstown WWTP had two pH exceedances, one in 1996 and one in 2004. No other point source pH exceedances were found.

Water Quality Data Analysis

Due to resource constraints at MDE, EPA offered assistance with a more robust analysis of the monitoring data through their Wheeling, WV office, led by Leah Ettema and Greg Pond. Their analysis focused on the diel fluctuations in pH to determine if nutrients were a driving force. The team provided a comprehensive analysis of the nutrients, DO, and other parameters collected in a station by station format. Based on their analysis, the Wheeling EPA office concluded that the elevated pH in the Conococheague is primarily due to nutrients. The highest pH levels of all the monitored sites are in the Conococheague Creek mainstem sites (see Table 1 and Figure 4). EPA agreed that the Karst geography does create naturally high levels of pH, so that there is low assimilative capacity. However, alkalinity and hardness are not higher in the Conococheague Creek compared to Antietam Creek. The site with the highest alkalinity and hardness was a tributary to Conococheague Creek mainstem (CON9), and it had lower pH than the Conococheague mainstem (see Figure 5). They also determined that chlorophyll a and phaeophyton are elevated in the Conococheague Creek Watershed; the increased primary production and decomposition amplify pH (and DO) diel fluxes and maximum values (See figure 6). In addition, there is a dam just below CON10. The dam coupled with high nutrient inputs are likely causing the highest levels of primary production on Conococheague (and therefore highest pH and pH daily flux values) to occur directly upstream of the dam at CON10. However, other sites on the Conococheague mainstem exhibit similar pH fluxes, indicating that the issue is not isolated to the area upstream of the dam, just amplified at CON10 (See figure 7, 8, and 9). Finally, all Conococheague Creek sites with DO monitoring had DO saturation levels above the BSID threshold of 115%, resulting from increased primary productivity and decomposition from elevated nutrient levels (See Figure 10). DO saturation was greater than 180% at CON10.

Table 1: Site Summary of pH Metrics

Site	Watershed	n	Max pH	Max pHFlux	% of all pH points >8.5	CDF percentile at 8.5 pH	% of days with pH values >8.5
CON-10	Conococheague Creek	9141	9.05	1.15	14.9%	84.3	44%
CON-3	Conococheague Creek	8619	8.85	0.9	10.2%	89.3	23%
CON-8	Conococheague Creek	8493	8.95	0.89	8.3%	91.4	25%
CON-12	Conococheague Creek	2169	8.77	0.9	7.4%	92.3	17%
CON-11	Conococheague Creek	2563	8.73	1.31	7.3%	92	19%
CON-7	Conococheague Creek	8726	8.93	0.91	5.6%	94.1	21%
CON-1	Antietam Creek	8031	8.9	0.99	2%	97.8	15%
CON-9	Rush Run	8276	8.72	0.67	1.9%	97.8	7%
CON-5	Little Conococheague Creek	8622	8.73	0.95	0.2%	99.8	1%
CON-2	Antietam Creek	8837	8.58	0.82	0.1%	99.8	1%
CON-4	Antietam Creek	7383	8.26	0.51	0%	100	0
CON-6	Little Conococheague Creek	7303	7.67	0.7	0%	100	0

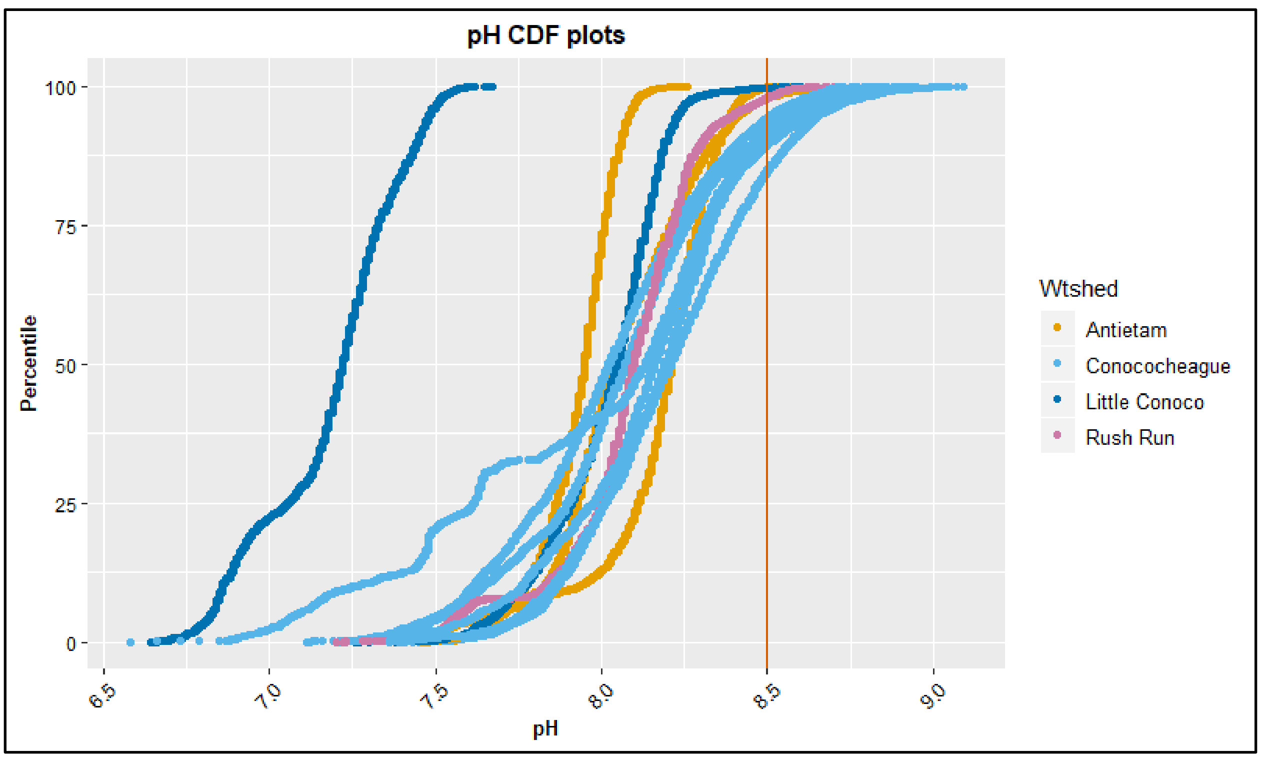

Figure 4: Cumulative Distribution Function plot of pH data

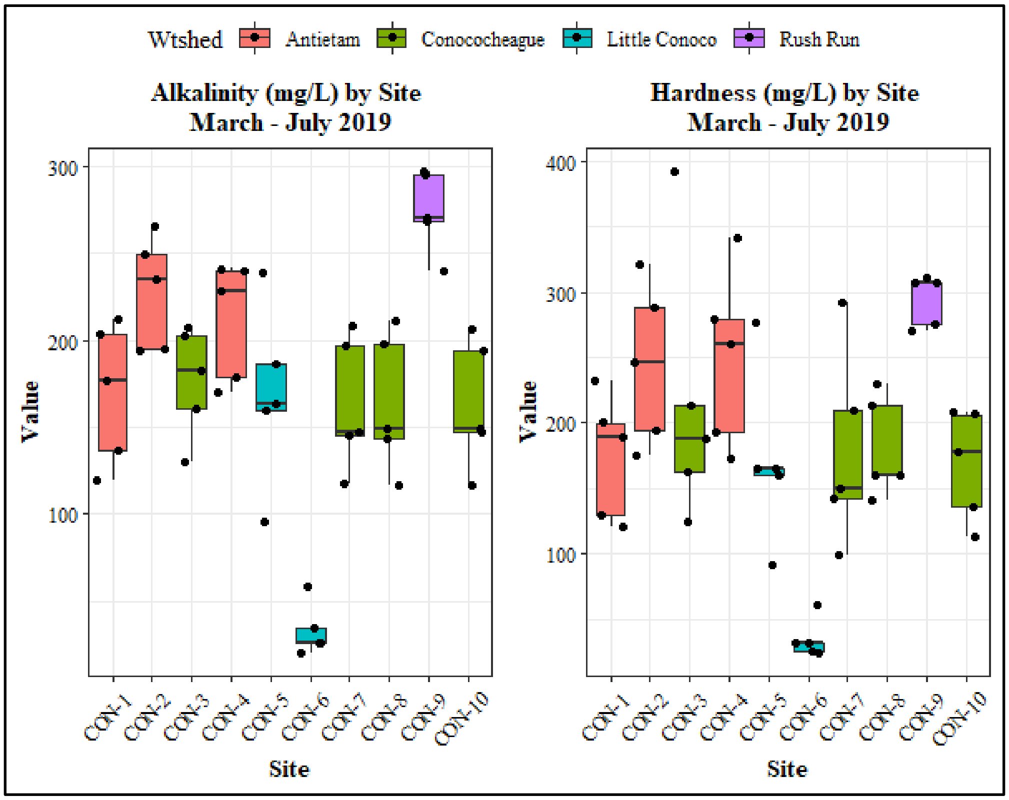

Figure 5: Hardness and Alkalinity Box Plots

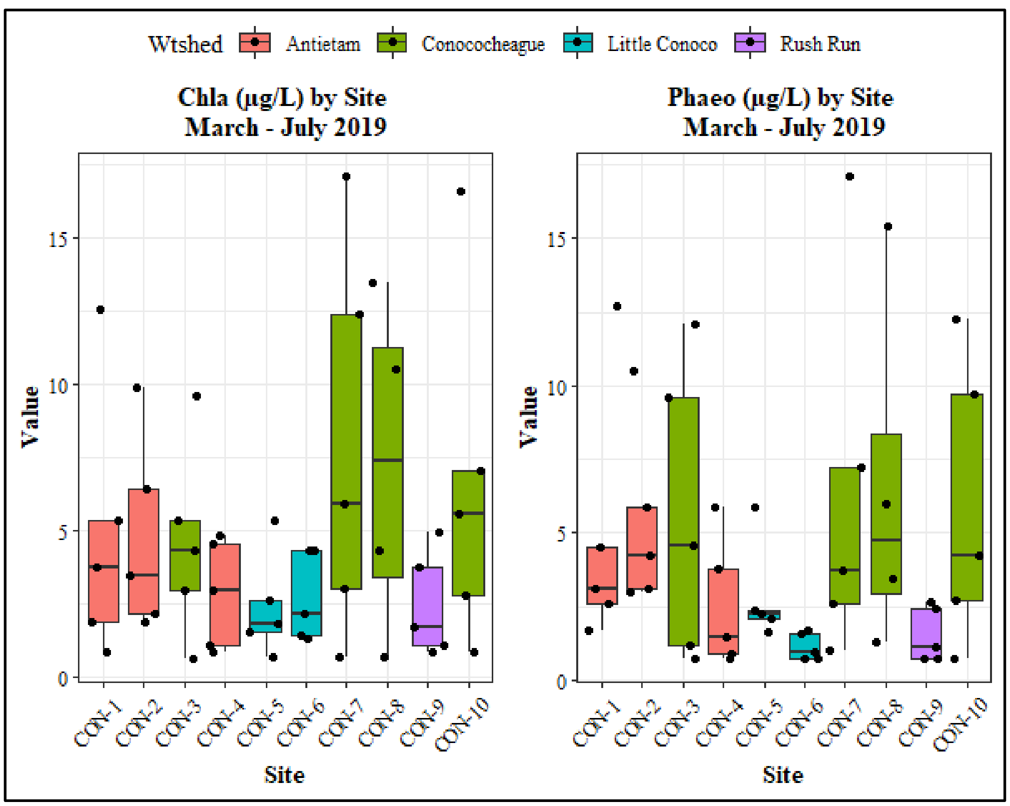

Figure 6: Chlorophyll a and Phaeophyton Box Plots

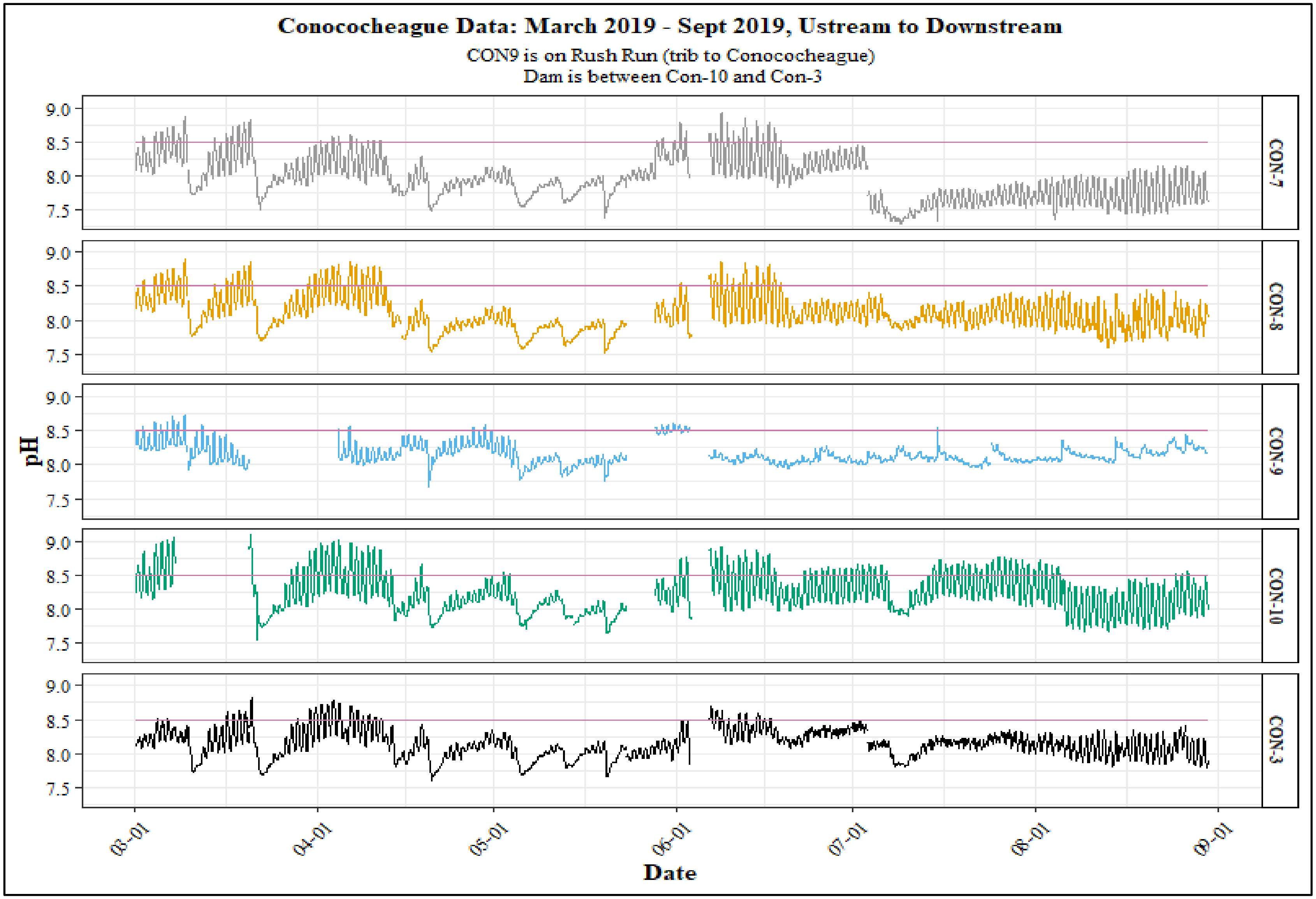

Figure 7: Summer Conococheague Creek pH Data

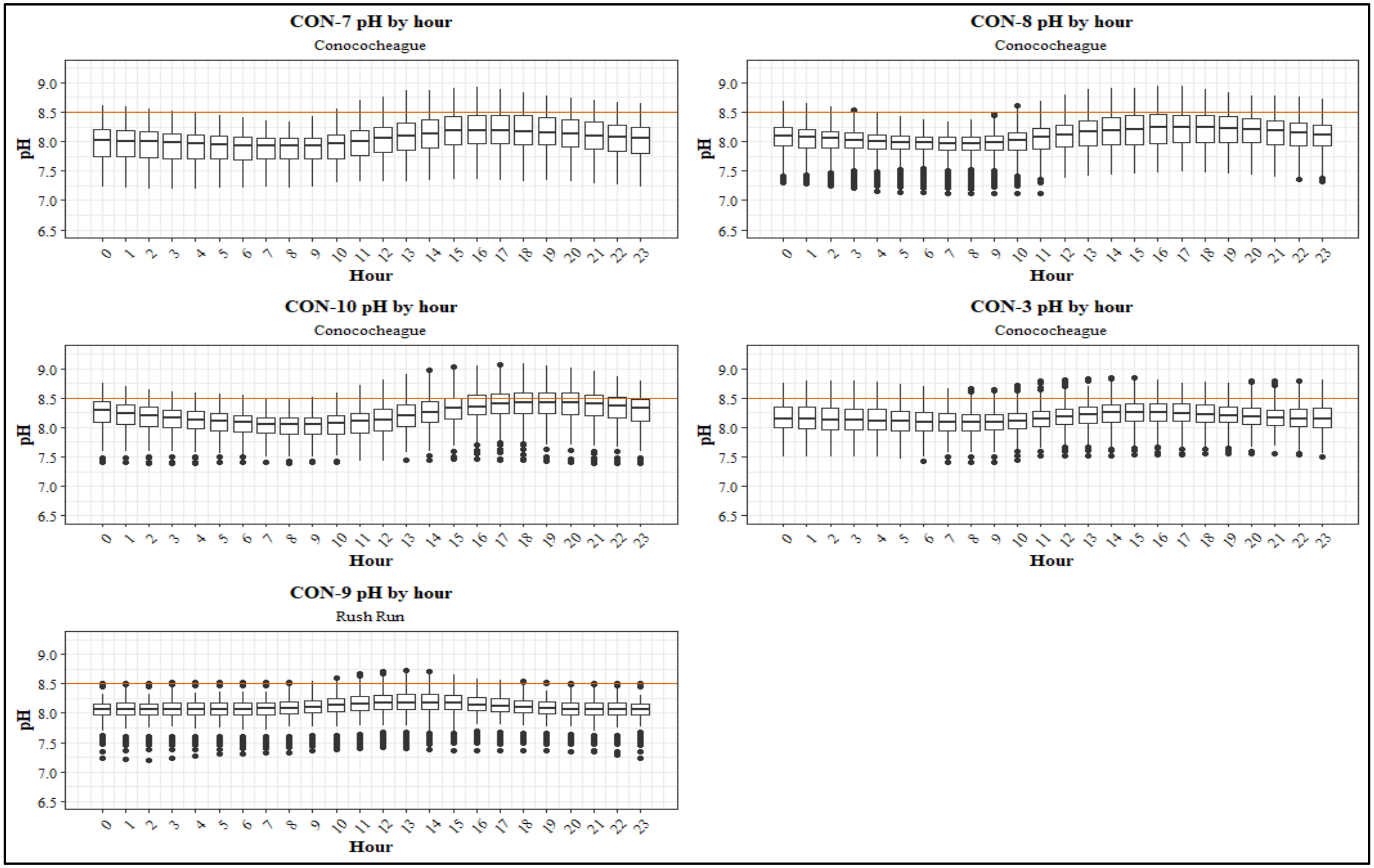

Figure 8: Conococheague Creek pH Data by Hour

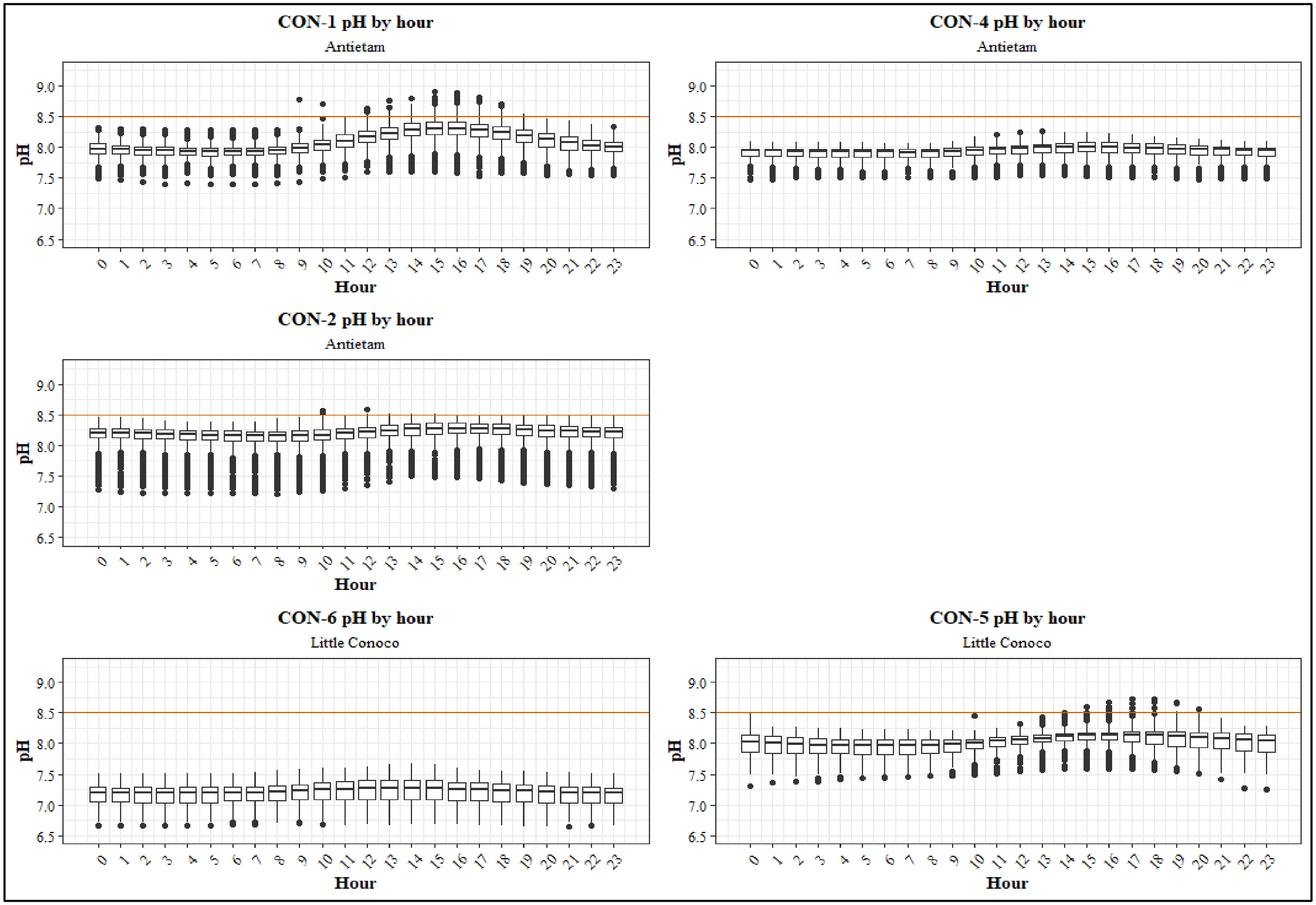

Figure 9: Antietam Creek and Little Conococheague pH Data by Hour

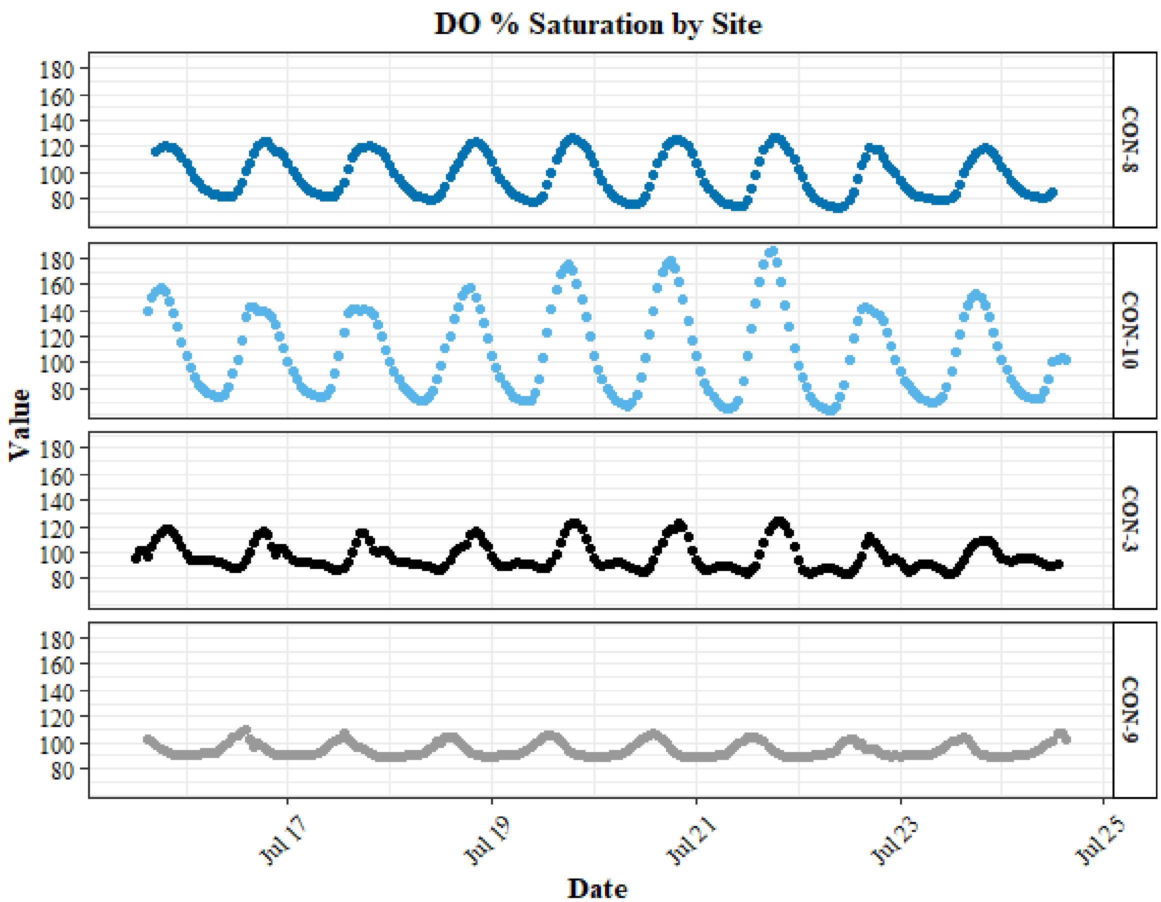

Figure 10: DO Percent (%) Saturation per Site

Water Quality Monitoring Conclusion

EPA and MDE discussed the results provided by the Wheeling team, with a focus on the geographic extent of the high pH problem in the Conococheague Creek Watershed since the main exceedances were shown around CON10. Based on the analysis, the pH exceedances were concentrated at CON10 because of the dam below the station that causes the river to be very wide and slow moving. However, the daily pH fluxes that occurred throughout the Conococheague Creek Watershed indicate that the nutrient input and pH increases were not isolated to the area around CON10 and existed throughout the entire watershed.

In summary, MDE and EPA agree that the high pH in the Conococheague Watershed is due to a combination of the Karst geography, the high nutrient input, and the dam around CON10. Since the entire 8-digit watershed MD-02140504 was already listed for Phosphorus, and the nutrients and pH are linked, along with karst and the dam, the entire MD-02140504 Conococheague Creek watershed should remain on Category 5 for phosphorus and also be placed on Category 5 for pH. When the TMDL is completed for phosphorus, it will also include the high pH listing for the same 8-digit watershed and both can be moved to Category 4a together.

2020-2022 IR Listing

Because the entire Conococheague Creek Watershed has new data showing daily pH fluxes in all sites, and the entire watershed is already listed for phosphorus, MDE proposes combining MD-01240504_Multiple_segments_1 and MD-02140504_Multiple_segments_2 as MD-02140504 and placing it in Category 5 for high pH for the combined 2020-2022 IR. The data also shows that the high pH is linked to the high nutrients and both Category 5 listings for the Conococheague Creek Watershed, for phosphorus and high pH, will be incorporated together when a TMDL is completed for phosphorus. The changes between the 2018 listing and the proposed 2020-2022 listings are shown in Tables 2 and 3 below.

Table 2: Summary of 2018 IR Listing

Assessment Unit	Size	Units	Listing Category	Cause	Indicator	Cause Grouping
MD-02140504	132.17	Miles	5	Phosphorus, Total	Fish and Benthic IBIs	Nutrients
MD-02140504-Multiple_segments_1	127.46	Miles	5	pH, High	Direct Measurement	pH
MD-02140504-Multiple_segments_2	4.7	Miles	2	pH, High	Direct Measurement	pH

Table 3: Proposed 2020-2022 IR Listing

Assessment Unit	Size	Units	Listing Category	Cause	Indicator	Cause Grouping
MD-02140504	132.17	Miles	5	Phosphorus, Total	Fish and Benthic IBIs	Nutrients
MD-02140504	132.17	Miles	5	pH, High	Direct Measurement	pH

The note associated with the proposed 2020-2022 listing specifically says "MD-02140504-Multiple_segments_1 and MD-02140504-Multiple_segments_2 were merged in 2020. A 2020 study showed that the entire watershed is impaired for pH due to high nutrient input and natural karst geology. This listing will be incorporated into a future nutrient TMDL for phosphorus."

G.2 Piscataway Creek Elevated PFOS Listing

MDE's WSA recommends listing the Piscataway Creek (tidal and non-tidal waters) as impaired in Maryland's Combined 2020-2022 Integrated Report of Surface Water Quality for elevated levels of PFOS in fish tissue. This memo describes the rationale for the proposed listing.

Background

PFAS are a family of thousands of human-made chemicals that are found in a wide range of products used by consumers and industry since the 1940's. PFAS have been used in a variety of applications including in stain- and water-resistant fabrics and carpeting, cleaning products, paints, and fire-fighting foams due to their resistance to grease, oil, water and heat. Due to the strength of the carbon-fluorine bond, many PFAS may bioaccumulate in the food chain and remain persistent in the environment. Understanding the occurrence of PFAS compounds in various environmental compartments (e.g., air, surface water, groundwater, and land) and the routes of human exposure (e.g., in drinking water or in foods such as seafood) is a growing area of science, as environmental and public health professionals seek to better understand the risks to human health posed by PFAS.

In fall 2020, MDE began its effort to sample fish tissue for PFAS by including PFAS analytes in its fish tissue sampling program, which at the time was focused on sampling of fish tissue in the Eastern Shore Region. In late 2020 and early 2021, MDE also initiated a targeted study of the occurrence of PFAS compounds in surface water and fish tissue in the Piscataway Creek area since there were two potential PFAS sources upstream. The Piscataway Creek PFAS study included monitoring for PFAS in surface waters and fish tissue in the tidal and non-tidal waters of Piscataway Creek. Nanjemoy Creek was also sampled and was used as a reference site with tidal and non-tidal sampling locations similar to and south of Piscataway Creek with no known PFAS sources. MDE determined that it would be beneficial to sample PFAS levels in surface water and fish tissue in Piscataway Creek in order to better understand human health risk and potential sources of PFAS. MDE was also aware of a discharge of firefighting foam and the resulting fish kill investigation (on July 31, 2020, from Joint Base Andrews) and data concerning PFAS releases to surface water discussed in the 2018 Site IR of the Fire Fighting Foam usage at Joint Base Andrews, Prince George's County, Maryland (https://mde.maryland.gov/Documents/PFC%20Final%20Joint%20Base%20Andrews%20SI%20Report%2007%20May%202018.pdf).

Piscataway Creek Location

Piscataway Creek is located off the Potomac River in Prince George's County. There are two potential PFAS sources upstream from Piscataway Creek. The first is Joint Base Andrews (JBA) that has two tributaries on the southwest side that join to form Tinkers Creek, the major tributary to Piscataway Creek. The second source is Prince George's County Multi Agency Training Center which is located directly adjacent to Piscataway Creek. Please see Figure 1 below.

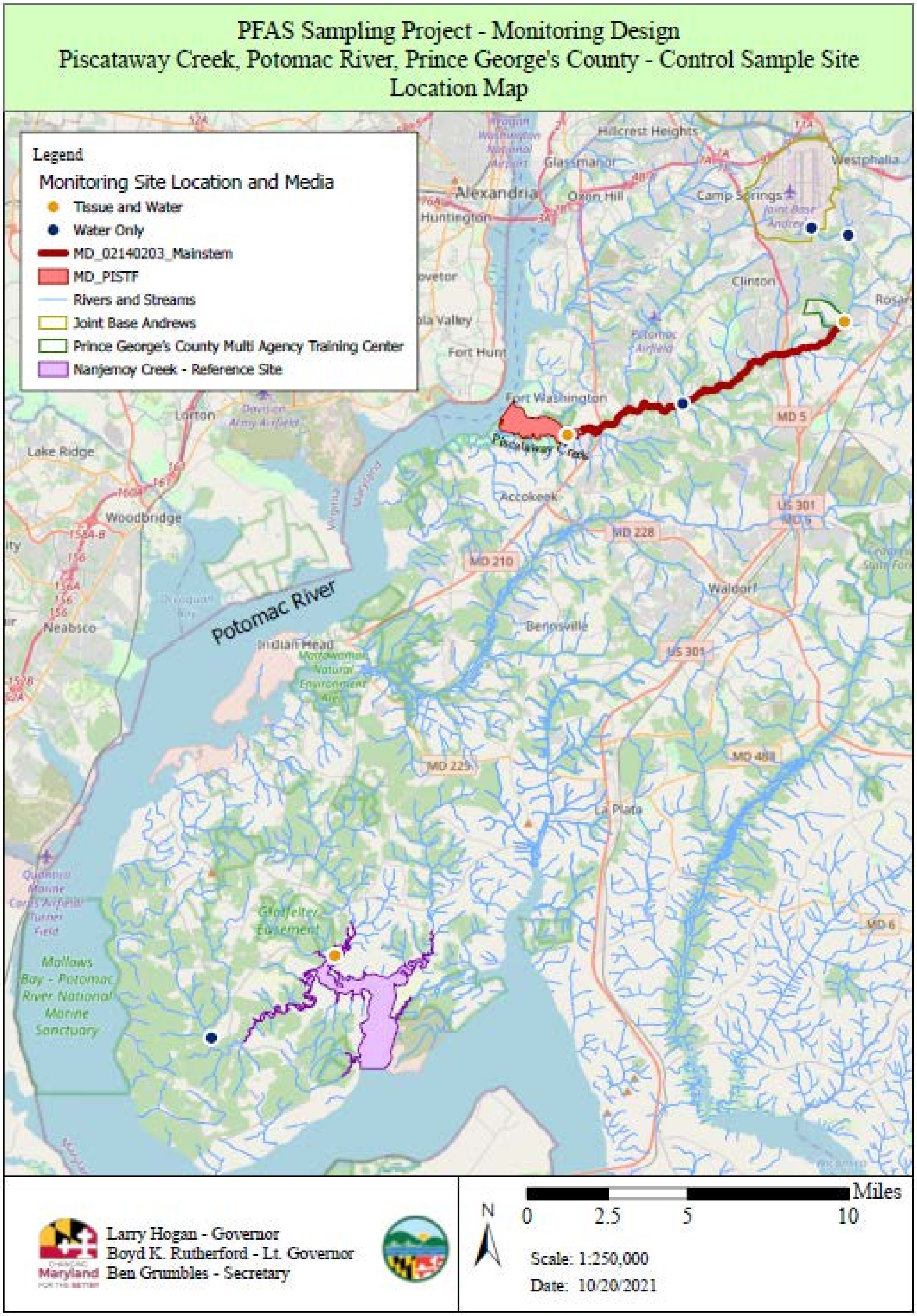

Figure 1: Piscataway Creek Sampling Area Locator Map

The Piscataway Creek watershed encompasses 69 square miles in Prince George's County. Headwaters originate to the west and east of JBA (in the vicinity of Camp Springs, Clinton and Woodyard). On the southwest side of JBA two branches join to form Tinkers Creek, the major tributary to Piscataway Creek. Surface water runoff flows into Tinkers Creek, to Piscataway Creek, and eventually into the Potomac River. From the southeast of JBA, the mainstem receives drainage from nearly 1,500 acres of the base and is partially redirected to a man-made lake (Base Lake) on base.

The northern region of the Piscataway Creek between JBA and Louise F. Cosca Regional Park is more developed. The major land use in this region is JBA. The base sits atop a north-south drainage divide, in the vicinity of the runways, that separates the Potomac River Basin to the west and the Patuxent River Basin to the east. The area surrounding JBA to the east is residential, commercial, light and heavy industrial, agricultural and some open land. The land used to the west is residential, commercial, and industrial. The area to the north is commercial and light industrial. The population density here is high.

The southern region comprises the area between Louise F. Cosca Regional Park to Piscataway Creek drainage. The land use to the south is mostly forested, some open and row-crop agricultural land, residential, commercial, and light industrial. Butler Branch (tributary to Piscataway Creek) flows through Louise F. Cosca Regional Park, and it forms a lake within the park. This Park has extensive facilities: shelters, grills, restrooms, athletic fields, tennis courts, and nature trails. To the south the land is more forested and agricultural with the encroachment of rural development and many new home estates. Along Accokeek Road (Route 373) between Dyson Road and Bealle Road there are older homes with septic systems. To the south along Indian Head Highway (Route 210) there is extensive urban development and homes with septic systems.

PFAS Fish Tissue and Ambient Water Quality Monitoring in the Piscataway Creek

In late 2020 and early 2021, MDE initiated the targeted study of the occurrence of PFAS compounds in surface water and fish tissue in the Piscataway Creek area. The Piscataway Creek was selected in part based on findings in the 2018 JBA Site Investigation report. The report indicates that "groundwater generally flows radially outward from these areas toward the streams and base boundaries." Also, the report states that "The relationship between groundwater and surface water drainage suggests that a portion of the groundwater discharges as base flow to six streams discharging from JBA. Finally, there are a number of places in the report under the various areas investigated where the report indicates that recreational fishing occurs in one or more of these streams and that there is a potentially complete pathway for human exposure to surface water from discharges from PFAS in groundwater. The Report includes the following statement: "Piscataway Creek is used for recreational fishing by residents of nearby communities and could provide an exposure pathway to humans through dermal contact and ingestion of fish". MDE was also aware of a discharge of firefighting foam and the resulting fish kill investigation (on July 31, 2020, from JBA).

On October 26, 2020, MDE collected fish tissue samples at Commo road in the Piscataway Creek to determine the occurrence and levels of 14 PFAS analytes, including PFOA and PFOS. Yellow-bullhead catfish and redbreast sunfish were collected in the non-tidal portion of Piscataway Creek, west of Rt. 210, off Commo Road. The results indicated elevated concentrations of PFOS in redbreast sunfish, compared to similar species collected and analyzed for PFAS during the annual fish tissue core station collection. Yellow-bullhead catfish were also collected at the same location but the results were not as elevated as redbreast sunfish. The elevated levels of PFOS in redbreast sunfish suggested that further investigation was warranted.

MDE completed a more detailed study of the Piscataway in May 2021, including the collection of surface water samples, an additional fish tissue collection in the Piscataway Creek tidal waters, and a tidal and non-tidal water and fish collection at reference locations in Nanjemoy Creek (a reference site with tidal and non-tidal sampling locations similar to and south of Piscataway Creek with no known PFAS sources). Water samples were collected at five locations along the Piscataway Creek downstream to the tidal headwaters. Fish tissue samples were collected at two locations, one in tidal headwaters of Piscataway Creek and the other in the non- tidal portion of Piscataway Creek off of Commo Road. Figure 2 shows the location of the Piscataway Creek sampling area and the monitoring stations evaluated in the 2020-2021 Intensive Review.   Figure 3 shows the location of the Nanjemoy Creek Reference Site sampling area and the monitoring stations evaluated in the 2021 portion of the Piscataway Creek Intensive Review.

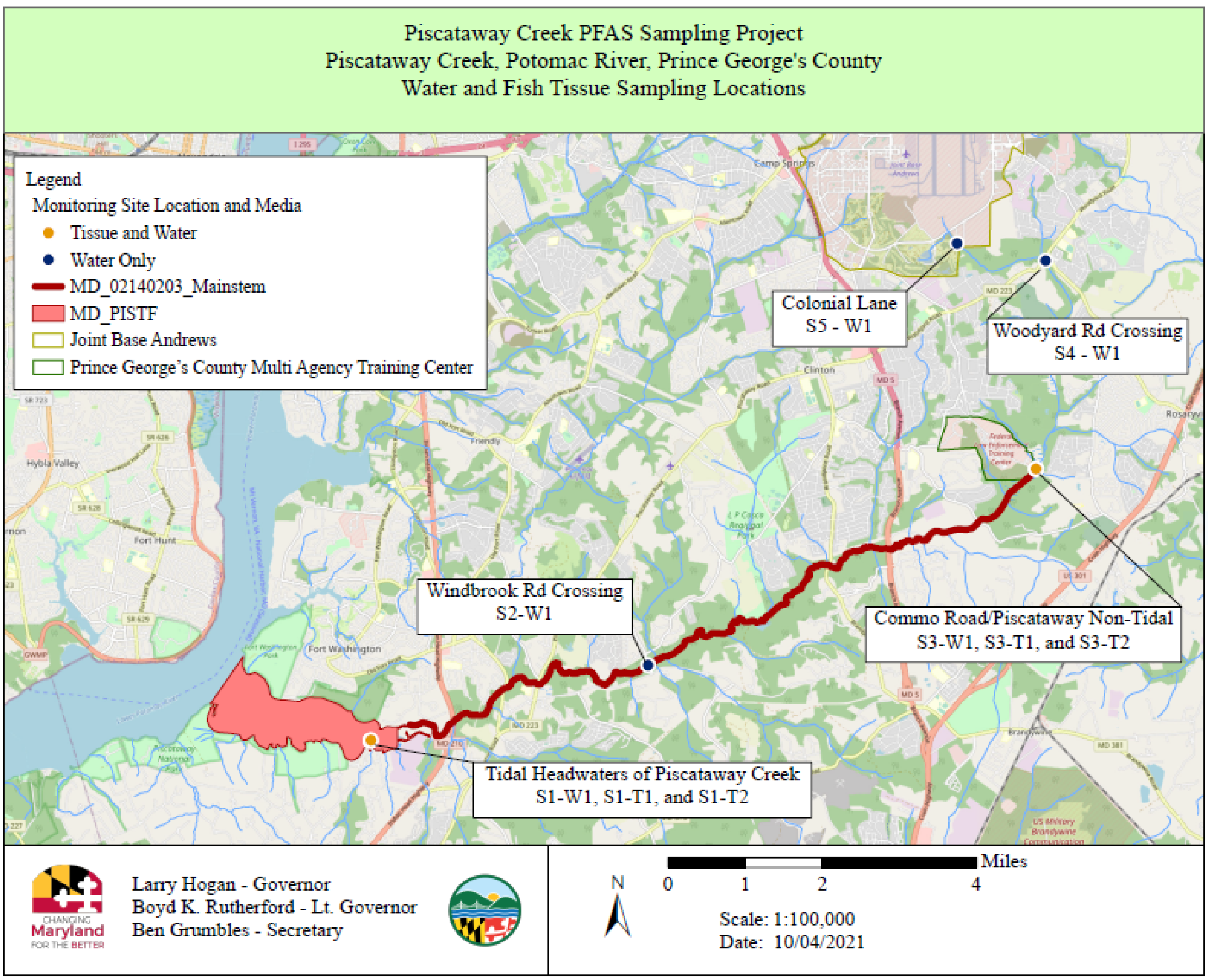

Figure 2: Piscataway Creek Sampling Area Monitoring Stations evaluated in the 2020-2021 Intensive Review

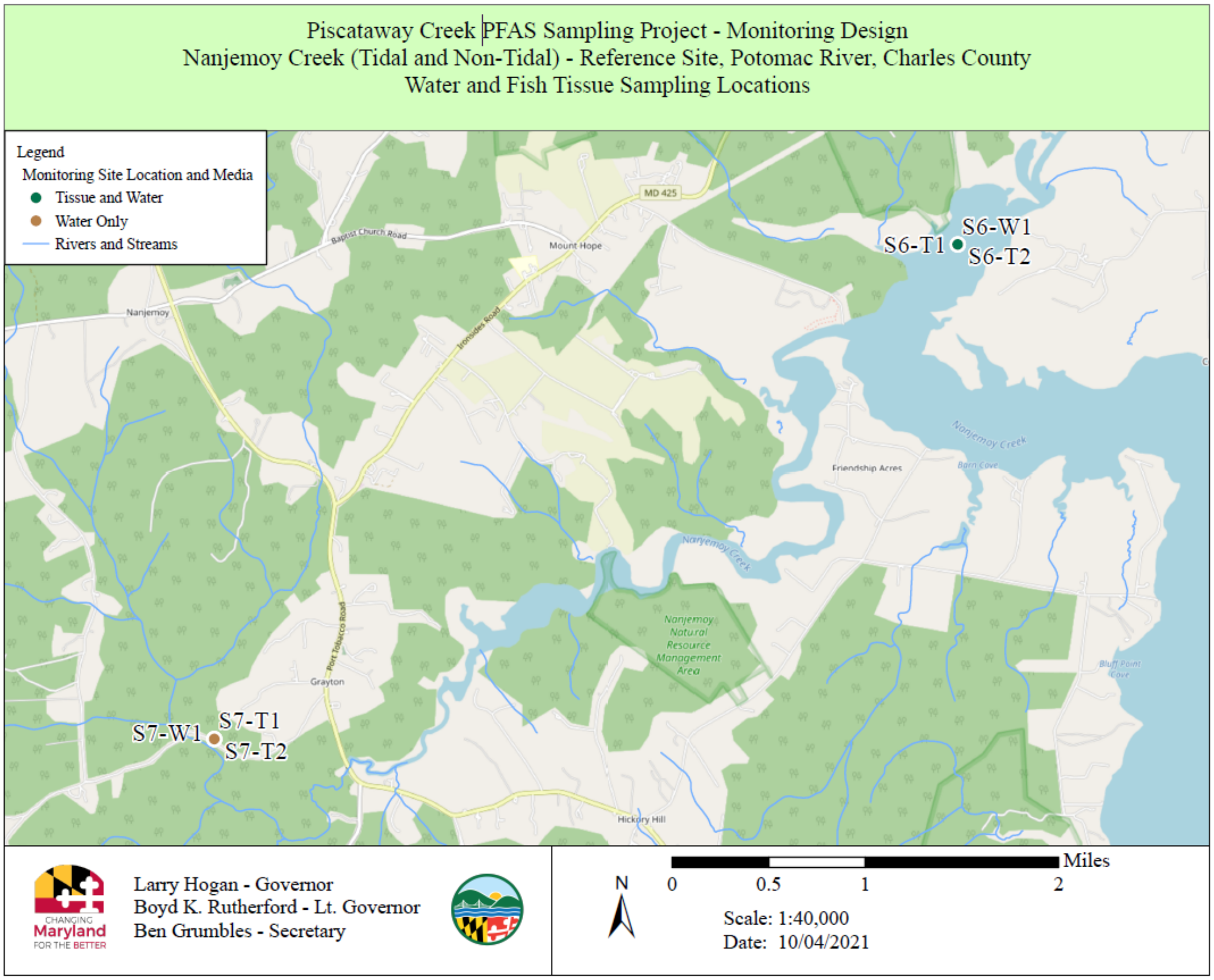

Figure 3: Nanjemoy Creek - Reference Site Sampling Area Monitoring Stations evaluated in the 2021 Intensive Review

PFAS Threshold

MDE developed risk-based swimming criteria for Perfluorooctanoic Acid (PFOA), Perfluorooctanesulfonic Acid (PFOS) and Perfluorobutanesulfonic Acid (PFBS) and risk-based fish tissue screening criteria for PFOA and PFOS in order to interpret the sampling results from the perspective of potential risk to human health. Both PFOA and PFOS have EPA-established reference doses (i.e. toxicity values) which were used by EPA to develop EPA's 2016 PFAS Health Advisory for PFOA and PFOS in drinking water. PFOA and PFOS currently have the same EPA reference doses and MDE used these reference doses and the EPA PFBS reference dose to develop its risk-based screening criteria for use in interpreting surface water and fish tissue sampling results.

Maryland, as well as most states, do not have numeric PFAS water quality criteria. EPA is developing human health as well as aquatic life criteria and is expected to release draft criteria for review in the next 1-2 years.

Maryland regulations addressing narrative criteria to protect aquatic life and human health from toxic materials in toxic amounts are addressed in the Code of Maryland Regulations:
26.08.01.01B. (93)
26.08.02.03B. General Water Quality Criteria
26.08.08.03-3
(7) Toxic Substance Criteria. All toxic substance criteria to protect:
(a) Freshwater aquatic organisms apply in waters designated as fresh water in Regulation .03-1B;
(b) Estuarine or saltwater aquatic organisms apply in waters designated as estuarine or salt waters as specified in Regulation .03-1B; and
(c) The wholesomeness of fish for human consumption apply in fresh, estuarine, and salt waters.

EPA advocates that both numeric and narrative criteria are useful in WQS, because they help protect a water body from the effects of specific chemicals as well as from the effects of pollutants that are not easily measured, such as chemical mixtures and floatable debris. Narrative criteria are also helpful when numeric criteria are not available or are under development, but the substance is known to be toxic. Most importantly, narrative criteria should be adopted based on biological monitoring and assessment methods to supplement numerical criteria. In accordance with 40 CFR 131.11(b)(2), in adopting water quality criteria, states and authorized tribes should "establish narrative criteria or criteria based on biomonitoring methods where numeric criteria cannot be established or to supplement numeric criteria." In the case of PFAS compounds, fish tissue and water column PFAS levels will be compared to health endpoint recommendations provided by EPA.

PFAS "Standards", Toxicity Values and Uncertainty Analyses

Health-based guidance values in specific environmental media for some PFAS have been developed by federal, state, and international agencies using a variety of critical studies, endpoints, methods, and policy choices. This study focuses specifically on assessing human health risk associated with measured levels of PFOA, PFOS and PFBS in surface water, and PFOS in fish taken from Piscataway Creek. PFOS was the predominant PFAS detected in fish tissue and the only detected PFAS with peer reviewed toxicity values, therefore, fish tissue consumption risks were evaluated only for PFOS. MDE used peer reviewed reference doses (RfDs) for PFOA and PFOS which were developed by EPA (and used by EPA in developing its 2016 Drinking Water Health Advisory Levels) and an MDE estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (with uncertainty factors generally applied to reflect limitations of the data used). The PFBS RfD was a Provisional Peer-Reviewed Toxicity Value (PPRTV) primarily derived for use in EPA's Superfund Program. RfDs are generally used in noncancer health assessments and the RfDs utilized in this assessment are approved by EPA and detailed within the Regional Screening Level User's Guide, (May, 2021), https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide. The MDE-developed health based guidance values for swimming and for fish consumption are estimates of a daily exposure dose that is not expected to lead to a non-cancer health risk over a set period of time. These guidance values are used to identify exposures (and levels in surface water and fish) that could potentially pose an unacceptable risk to human health. However, exposure above a guidance value does not mean that health problems will occur. MDEs quantitative assessment addresses only PFOA, PFOS, and PFBS, three of the most studied PFAS which both have RfDs.

The MDE risk threshold for noncarcinogens is set at a hazard quotient of 1 which is the ratio of the potential exposure to a substance and the level at which no adverse effects are expected (calculated as the exposure divided by the appropriate chronic or acute value) which means adverse noncancer effects are unlikely at this level, and thus can be considered to have negligible risk. For hazard quotients greater than 1, the potential for adverse effects increases, but we do not know by how much. For toxins that affect the same target organ or organ systems that can cause similar adverse health effects, combining hazard quotients from different toxics is often appropriate. The sum of hazard quotients is a hazard index (HI) which was utilized for PFOA, PFOS and PFBS in this evaluation. An HI of 1 or lower means toxics are unlikely to cause adverse noncancer health effects over a lifetime of exposure. However, an HI greater than 1 doesn't necessarily mean adverse effects are likely.

As stated previously, PFAS compounds have been in use since the 1940s and PFAS are found in a wide array of consumer and industrial products. Other than for PFOA, PFOS and PFBS, the vast majority of PFAS compounds in the marketplace have little to no toxicity information or RfDs. As greater knowledge of the toxicity of other PFAS compounds advances, MDE will re-visit prior assessments to ensure that appropriate actions are taken to address any unacceptable human health risk. Currently, MDE, EPA and other organizations are collaborating to generate and review research and consider new scientific information as it becomes available on the bioaccumulation potential and toxicity of additional PFAS. Developing toxicity values or oral reference doses, RfDs, for other PFAS, including GenX chemicals are a priority for EPA and will be considered by MDE as the research becomes available.

Surface Water Results

Surface water samples were collected on May 14th and 18th of 2021 in and around the non-tidal and tidal waters of Piscataway creek and the reference sites in the tidal and non-tidal waters of Nanjemoy Creek south of Piscataway Creek. A total of 10 field blanks containing PFAS-free water supplied by the contract laboratory were utilized during sampling. The number of samples, sample locations and quality control samples are detailed in Tables 1 and 2.

Table 1: Piscataway Creek Intensive Survey Sampling Information

Location	Position	Collection Reference	Site Reference	Sample ID	Sample Type	Field Blanks	Avg Length (cm)	Avg Weight (g/lbs.)	Collection Date	Deliver to Lab
Tidal headwaters of Piscataway Creek	38.69522, -77.00623	Water Sample		S1-W1	Water	S1-FB1			5/14/2021	5/21/2021
Tidal headwaters of Piscataway Creek	38.69522, -77.00623	Composite Species 1 - Largemouth Bass		S1-T1	Tissue	S1-FB1	39.9	910.8	5/14/2021	5/21/2021
Tidal headwaters of Piscataway Creek	38.69522, -77.00623	Composite Species 2 - Blue Catfish		S1-T2	Tissue	S1-FB1	47.38	1081	5/14/2021	5/21/2021
Windbrook Road Crossing	38.70933, -76.93954	Water Sample		S2-W1	Water	S2-FB1				5/21/2021
Commo Road - Non Tidal	38.74618, -76.84636	Composite Species 1 - Redbreast Sunfish		S3-T1	Tissue	S3-FB1	15.5	72.8	5/17/2021	5/21/2021
Commo Road - Non Tidal	38.74618, -76.84636	Composite Species 2 - Yellow Bullhead Catfish		S3-T2	Tissue	S3-FB1	17.7	75.8	5/17/2021	5/21/2021
Commo Road - Non Tidal	38.74618, -76.84636	Water Sample		S3-W1	Water	S3-FB1			5/17/2021	5/21/2021
Woodyard Road Crossing	38.78536, -76.84388	Water Sample		S4-W1	Water	S4-FB1			5/18/2021	5/21/2021
Colonial Lane	38.78866, -76.86529	Water Sample		S5-W1	Water	S5-FB1			5/18/2021	5/21/2021
Tidal headwaters of Nanjemoy Creek	38.44992, -77.15417	Water Sample	Control	S6-W1	Water	S6-FB1			5/20/2021	5/21/2021
Tidal headwaters of Nanjemoy Creek	38.44992, -77.15417	Composite Species 1 - Bluegill	Control	S6-T1	Tissue	S6-FB1	16.7	107.4	5/20/2021	5/21/2021
Tidal headwaters of Nanjemoy Creek	38.44992, -77.15417	Composite Species 2 - Blue Catfish	Control	S6-T2	Tissue	S6-FB1	48.4	1073.2	5/20/2021	5/21/2021
Non Tidal waters of Nanjemoy Creek	38.42201, -77.21040	Water Sample	Control	S7-W1	Water	S7-FB1			5/26/2021	5/28/2021
Non Tidal waters of Nanjemoy Creek	38.42201, -77.21040	Composite Species 1 - Redbreast Sunfish	Control	S7-T1	Tissue	S7-FB1	14.9	60.2	5/26/2021	5/28/2021
Non Tidal waters of Nanjemoy Creek	38.42201, -77.21040	Composite Species 2 - Yellow Bullhead Catfish	Control	S7-T2	Tissue	S7-FB1	21.1	142.2	5/26/2021	5/28/2021

Field Blanks	One with each site collected	S1-FB1,S2-FB1,S3-FB1,S4-FB1,S5-FB1,S6-FB1,S7-FB1			Water	7
Trip Blanks	One with each "trip"	TB-1,TB-2,TB-3,TB-4			Water	4
Replicates	Done in Lab	Water Sample	Lab Sample		Water	1
Replicates	Done in Lab	Tissue Replicate	Lab Sample		Tissue	1
NIST Water Sample	Done in Lab	Water Sample	Lab Sample		Water	1
NIST Tissue Sample	Done in Lab	Tissue Replicate	Lab Sample		Tissue	1

Media	Count
Tissue	10
Water	20

Table 2: Piscataway Creek Fall 2020 PFAS Sampling

Location	Position	Collection Reference	Site Reference	Sample ID	Sample Type	Field Blanks	Avg Length (cm)	Avg Weight (g/lbs.)	Collection Date
Commo Road - Non Tidal	38.74776, -76.84507	Composite Species 1 - Yellow Bullhead Catfish	PIS0134	2020FTC_PISC_A	Tissue	FB_2020FTC_PISC	20.2	102.2	10/26/2020
Commo Road - Non Tidal	38.74776, -76.84507	Composite Species 2 - Redbreast Sunfish	PIS0134	2020FTC_PISC_B	Tissue	FB_2020FTC_PISC	15.16	54.4	10/26/2020

Surface water concentrations of PFOS ranged from not detected in Nanjemoy Creek to 1.5040 ug/L (parts per billion (ppb)) in the mainstem of Piscataway Creek. All PFOS plus PFOA surface water concentrations were below recreational swimming screening criteria (based on incidental ingestion). Concentrations of PFOS compounds in the nontidal headwaters and tidal headwaters of Piscataway Creek were significantly greater than PFOS surface water concentrations in comparable locations in the Nanjemoy Creek reference site. PFOS surface water concentrations in Piscataway Creek and comparisons to a similar reference site, Nanjemoy Creek, indicate significant ongoing sources of PFOS exist within the Piscataway Creek watershed.

Table 3: Surface Water Results for Piscataway Creek Intensive Survey Spring 2021 with MDE-calculated risk-based screening criteria for PFOA, PFOS, and PFBS for Recreational Swimming.

Site Description	ID	Collection Date	PFOS + PFOA (ug/L)	Recreational Screening Criteria PFOS+PFOA (ug/L)		PFBS (ug/L)	Recreational Screening Criteria PFBS (ug/L)	
				Moderate	Intensive		Moderate	Intensive
Tidal headwaters of Piscataway Creek	S1-W1	5/14/2021	0.1007	17.5	8.77	0.00689	26.2	13.1
Windbrook Road Crossing	S2-W1	5/18/2021	0.1469	17.5	8.77	0.01060	26.2	13.1
Commo Road - Non-Tidal	S3-W1	5/18/2021	0.6250	17.5	8.77	0.03940	26.2	13.1
Woodyard Road Crossing	S4-W1	5/18/2021	1.2860	17.5	8.77	0.08080	26.2	13.1
Colonial Lane	S5-W1	5/18/2021	1.5040	17.5	8.77	0.10800	26.2	13.1
Tidal Headwaters of Nanjemoy Creek	S6-W1	5/18/2021	0.00453	17.5	8.77	ND	26.2	13.1
Non-Tidal Headwaters of Nanjemoy Creek	S7-W1	5/18/2021	ND	17.5	8.77	ND	26.2	13.1

*Note that PFOS levels at S3, S4, and S5 are a magnitude over 500 times higher than the reference sites (stations S6 and S7).

Fish Tissue Results

MDE collected fish tissue samples at two locations in the tidal and non-tidal waters of Piscataway Creek. Additionally, fish tissue samples were collected from two locations in the tidal and non-tidal waters of the Nanjemoy Creek reference site. On May 14, 2021, May 17, 2021, May 20, 2021, and May 26, 2021, MDE collected fish tissue samples at four sampling locations: the tidal headwaters of Piscataway Creek (5/14/2021), the non-tidal waters of Piscataway Creek at Commo Road (05/17/2021), the tidal headwaters of Nanjemoy Creek (05/20/2021), and the non-tidal waters of Nanjemoy Creek (05/26/2021). All samples were collected according to MDE's fish tissue methodology and were submitted for analysis to determine the levels of 14 PFAS (Table 4).

Table 4: PFAS Parameters

Parameter	Acronym	CAS Number
Perfluorobutanesulfonic Acid	PFBS	375-73-5
Perfluorohexanoic Acid	PFHx A	307-24-4
Perfluoroheptanoic Acid	PFHpA	375-85-9
Perfluorohexanesulfonic Acid	PFHxS	355-46-4
Perfluorooctanoic Acid	PFOA	335-67-1
Perfluorononanoic Acid	PFNA	375-95-1
Perfluorooctanesulfonic Acid	PFOS	1763-23-1
Perfluorodecanoic Acid	PFDA	335-76-2
N-Methyl Perfluorooctanesulfonamidoacetic Acid	NMeFOSAA	31506-32-8
PerfluorouND1ecanoic Acid	PFUnA	2058-94-8
N-Ethyl Perfluorooctanesulfonamidoacetic Acid	NEtFOSAA	1691-99-2
Perfluorododecanoic Acid	PFDoA	16517-11-6
Perfluorotridecanoic Acid	PFTrDA	72629-94-8
Perfluorotetradecanoic Acid	PFTA	376-06-7

MDE's evaluation of the fish tissue samples from Piscataway Creek includes a comparison of measured PFOS fish tissue concentrations to measured concentrations at the reference site and to a range of MDE-calculated risk-based site-specific fish consumption screening concentrations. These human health-based screening concentrations for PFOS assume that all fish are consumed from the same harvesting location. MDE found that fish tissue concentrations in redbreast sunfish in the non-tidal portion of Piscataway Creek off Commo Road were in excess of the PFOS screening criteria and that fish tissue PFOS concentrations in largemouth bass were in excess of screening criteria in the tidal portion of Piscataway Creek. Fish tissue PFOS concentrations from fish sampled from the Nanjemoy Creek control sites were significantly lower than fish tissue PFOS concentrations in fish sampled from Piscataway Creek. Results of the fish tissue consumption evaluation for PFOS indicated consumption of fish tissue within non-tidal and tidal portions of the Piscataway Creek study area are in excess of the MDE site-specific fish consumption screening criteria.

Table 5: Fish Tissue Sample Results from Piscataway Creek Intensive Survey Fall 2020 - Spring 2021 with MDE-calculated risk-based screening criteria for PFOA, and PFOS for Fish Consumption

Site Description	ID	Collection Date	Species Common Name	PFOS (ug/kg)	Fish Tissue (cooked) Screening Concentration (ug/kg)		
					General Population (76 kg)	Women Child-bearing Age (67 kg)	Children (14.5 kg)
Piscataway - Commo Road	2020FTC_PISC_A	10/26/2020	Yellow Bullhead Catfish	20.0	73	64	37
Piscataway - Commo Road	2020FTC_PISC_B	10/26/2020	Redbreast Sunfish	233.0	73	64	37
Tidal headwaters of Piscataway Creek	S1-T1	5/14/2021	Largemouth Bass	94.2	73	64	37
Tidal headwaters of Piscataway Creek	S1-T2	5/14/2021	Blue Catfish	2.5	73	64	37
Commo Road - Non Tidal	S3-T1	5/17/2021	Redbreast Sunfish	231.0	73	64	37
Commo Road - Non Tidal	S3-T2	5/17/2021	Yellow Bullhead Catfish	24.7	73	64	37
Tidal headwaters of Nanjemoy Creek	S6-T1	5/20/2021	Bluegill	5.2	73	64	37
Tidal headwaters of Nanjemoy Creek	S6-T2	5/20/2021	Blue Catfish	1.4	73	64	37
Non tidal waters of Nanjemoy Creek	S7-T1	5/26/2021	Redbreast Sunfish	5.2	73	64	37
Non tidal waters of Nanjemoy Creek	S7-T2	5/26/2021	Yellow Bullhead Catfish	3.3	73	64	37
Consumption Rate (mg-day)					**29,825**	**29,825**	**11,185**
Approximate Meals per Month (8-ounce meal adult, 3-ounce meal child)					**4**	**4**	**4**

*PFOA and PFBS were not detected in any fish tissue samples, therefore, all fish tissue risk-based values are for PFOS.

Results Summary

The study concludes that PFOA and PFOS are present in the non-tidal and tidal waters of Piscataway Creek at concentrations below risk-based recreational use swimming screening criteria. However, PFAS surface water concentrations in both the non-tidal and tidal portions of Piscataway Creek are significantly greater than PFAS concentrations at the Nanjemoy Creek reference sites. PFOA and PFOS are present in fish tissue at levels that exceed human consumption-based screening criteria and fish consumption advisories and additional assessments are warranted in both the tidal and non-tidal waters of Piscataway Creek.

Table 6: Summary of Total PFAS and PFOS Sampling Results for Surface Water

Location	Media	Concentration Range (PFAS) (ug/kg)	Maximum Concentration PFAS (ug/kg)	Maximum Concentration PFOS (ug/kg)
Nanjemoy Creek non-tidal	fish tissue	4 - 10	10	5
Nanjemoy Creek tidal	fish tissue	1 - 6	6	5
Piscataway Creek non-tidal	fish tissue	29 - 247	247	231
Piscataway Creek tidal	fish tissue	4 - 101	101	94

Table 7: Summary of Total PFAS and PFOS Sampling Results for Fish Tissue

Location	Media	Concentration Range (PFAS) (ng/L)	Maximum Concentration PFAS (ng/L)	Maximum Concentration PFOS (ng/L)
Nanjemoy Creek non-tidal	surface water	ND	ND	ND
Nanjemoy Creek tidal	surface water	7	7	3
Piscataway Creek non-tidal	surface water	310 - 3,193	3,193	1,100
Piscataway Creek tidal	surface water	207	207	74

Rationale for Integrated Report/303(d) PFAS Impairment Listing

Following the Assessment Methodology for Determining Impaired Waters by Chemical Contaminants for Maryland's Integrated Report of Surface Water Quality: Fish Tissue Data Use for Integrated Report Listings, when a fish consumption advisory is issued for a waterbody, the designated use of that waterbody is not being supported and usually results in listing a waterbody as impaired for the specific contaminant. According to the methodology, the risk-based screening criteria for PFOS can be used as a listing threshold, and a 4 meals per month advisory of a common recreational fish species for a 76 kg individual (general population) is the threshold used for an impairment listing. Both the tidal and nontidal portions of Piscataway Creek show elevated PFOS levels above the listing threshold and have an advisory at 4 meals per month and therefore, should be listed as impaired (Category 5) on the

Combined 2020-2022 IR of Surface Water Quality. Since the number of meals does not meet the goal of at least four meals per month, MDE has determined that the narrative criterion that provides for the "wholesomeness of fish for human consumption" is not met. The geographic scale of the assessment was shown in figure 2 of this narrative, and the summary of the impairment listings are in Table 8 below.

Table 8: Summary of the 2020-2022 IR Impairment Listings

Assessment Unit	Basin Name	Designated Use	Listing Category	Cause	Sources
MD-02140203-Mainstem	Piscataway Creek	Fishing	5	PERFLUOROOCTANE SULFONATE (PFOS) IN FISH TISSUE	Upstream Source
MD-PISTF	PISTF - Piscataway Creek tidal Fresh	Fishing	5	PERFLUOROOCTANE SULFONATE (PFOS) IN FISH TISSUE	Upstream Source

References

EPA, Regional Screening Levels (RSLs) User's Guide, May 2020, https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide.

EPA (2000a). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1. Fish Sampling and Analysis. In (doi: EPA 823-B-00-0073rd ed.

EPA (2000b). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits. In (doi: EPA 823- B-00-0083rd ed.

MDE (2006) Total Maximum Daily Loads of Fecal Bacteria for the Non-Tidal Piscataway Creek Basin in Prince George's County, Maryland. Document Version: May 10, 2006

USGS current conditions for USGS 01653600 PISCATAWAY Creek AT PISCATAWAY, MD, https://waterdata.usgs.gov/nwis/uv?site_no=01653600. 09/27/2021

PART H: ASSESSMENT METHODOLOGIES

H.1 Updated Assessment Methodologies

H.1.1 The Listing Methodology for Identifying Waters Impaired by Bacteria in Maryland's Integrated Report

Section III of this methodology, The Interpretation of Bacteria Data for Water Contact Recreation Use, was updated with the 2012 EPA Recreational Water Quality Criteria and the assessment process was modified to support the new criteria, including the addition of a weekly sampling requirement. Appendix A. Considerations for Bacteria Sampling at Non-Beach Areas was also added. The updated Bacteria assessment methodology can be found online at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Bacteria_Listing_Methodology_Final_2_23_2021.pdf

H.1.2 The Fish Tissue Assessment Methodology section which is part of the Methodology for Determining Impaired Waters by Chemical Contaminants for Maryland's Integrated Report of Surface Water Quality

The Fish Tissue section of this methodology was updated with modifications to the data used for Integrated Report listings including a minimum data requirement of 5 fish, a data assessment period of ten years, and information concerning the use of best professional judgment. The updates on best professional judgement apply to reviewing data outside of the ten-year period and determining if a species identified from older data is still representative of the current common recreational fish species for that waterbody. The updated Fish Tissue assessment methodology can be found online at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Toxics_Assessment_Methodology_06-28-2019.pdf

H.1.3 The Temperature Assessment Methodology for Use III(-P) Streams in Maryland

The Temperature Assessment Methodology was updated to include a decision diagram and assessment process that supports the policy of independent applicability by only using temperature data and applicable criteria for the impairment listing decisions. The presence or absence of any cold-water obligate taxa has been excluded from the process. The updated Temperature assessment methodology can be found online at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Temp_AM_UCIII_2019.pdf

H.2 New Assessment Methodologies

H.2.1 The Delisting Methodology for Biological Assessments

A new assessment methodology, The Delisting Methodology for Biological Assessments in Maryland's Integrated Report is intended to be part of the Biological Assessment Methodology for Non-Tidal Wadeable Streams. The purpose of the delisting methodology is to refine the spatial scale of biological impairment listings in order to demonstrate progress and identify areas that are attaining biocriteria. The delisting methodology utilizes a targeted standardized approach that is complementary to the large scale probabilistic design of the current biological assessment methodology. The new Delisting Methodology can be found at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Final_Draft_Delisting_Methodology_10_20_21.pdf

The rest of Maryland's assessment methodologies remain unchanged for this IR cycle and are available on MDE's website at: https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/ir_listing_methodologies.aspx. The public is invited to review and comment on any of these methodologies during the public review period for the Integrated Report. Comments should be submitted in writing to Matthew Stover at matthew.stover@maryland.gov.

PART I: REPORT SECTIONS AND ASSESSMENTS THAT WERE MODIFIED DURING THE PUBLIC COMMENT PERIOD

The public comment period for the combined 2020-2022 Integrated Report (IR) began on December 6, 2021 and concluded on January 17, 2022. This section summarizes the changes that were made to Maryland's combined 2020-2022 Integrated Report and assessment records during the public comment period.

I.1 Report Section Changes

1. Figure 6: Federal nonpoint source total budget allocation including the Maryland totals was updated. Changed both y-axis to use a similar scale so that the MD 319 match of the EPA budget can be more easily determined.

2. Added Table 20: Lakes Assessed for the 2020-2022 Integrated Report was added to document the list of lakes and monitoring years assessed for the combined 2020-2022 IR.

3. Section C.5.4 Summary of Trends was updated. Figures 7 and 8 were combined into a new Figure 7 to highlight the increasing non-tidal temperature trends adjacent to the decreasing nutrient trends. The non-tidal chlorophyll-a and dissolved oxygen levels are no longer presented in this report since the relationships in non-tidal waters are complex and further exploration is warranted. The DNR tidal trends figures (previously figures 10 and 11 and now figures 9 and 10) were also updated based on new information. The data remains the same, but the p value was updated to a more stringent significance range of $p<0.05$ rather than the previous less stringent value of $p<0.25$ originally presented. This change was implemented to ensure consistency with the DNR non-tidal trends analysis referenced in this IR as well as other external DNR reports that use $p<0.05$.

4. Created Section C.3.1.5 Assessments with Insufficient Information and added Table 15: Assessments placed in Category 3 for the 2020-2022 Integrated Report in order to provide a rationale for assessments on Category 3.

I.2 Assessments/Listings

1. Notes were updated for the twelve Category 3 assessments established in the 2020-2022 Cycle to provide a rationale for their placement on Category 3. This information is captured in Table 15.

2. Per EPA's comment- MD-02140205-Northwest_Branch Heptachlor Epoxide is associated with a TMDL that has been made available for public notice. Therefore, MDE changed the TMDL priority ranking from low to high.

REFERENCES

Association of Clean Water Administrators (ACWA). (2018, February 12). *FUNDING LEVELS FOR KEY WATER APPROPRIATIONS (Dollars in Millions)* [Chart]. In *Www.acwa-us.org*. Retrieved June 7, 2019, from https://www.acwa-us.org/wp-content/uploads/2018/02/Funding-Chart-2.12.18_FY19Pres_proposal_budget-1.pdf

Baltimore Metropolitan Council. (2018, June 1). *Progress Report for 2016 and 2017 on the Implementation of the 2005 Reservoir Watershed Action Strategy* (Rep.). Retrieved June 6, 2019, from Baltimore Metropolitan Council website: https://www.baltometro.org/sites/default/files/bmc_documents/general/environment/reservoir/RWSM_2018_reservoir-watershed-action-strategy_progress-report.pdf

Band, L., Dillaha, T., Duffy, C., Reckhow, K., & Welty, C. (2008). *Chesapeake Bay Watershed Model Phase V Review* (pp. 1-13, Tech. No. 08-003). Edgewater, MD: Scientific and Technical Advisory Committee. Retrieved June 10, 2019, from https://www.chesapeake.org/pubs/2ndphasevreportfinal.pdf

Bingham, Tayler H., Timothy R. Bondelid, Brooks M. Depro, Ruth C. Figueroa, A. Brett Hauber, Suzanne J. Unger, George L. Van Houtven. (2000, January). *A Benefits Assessment of Water Pollution Control Programs Since 1972: Part 1, The Benefits of Point Source Controls for Conventional Pollutants in Rivers and Streams* (Rep. No. Ee-0429-01). Retrieved June 7, 2019, from EPA website: https://archive.epa.gov/aed/lakesecoservices/web/pdf/ee-0429-01.pdf

Bricker, S., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of Nutrient Enrichment In the Nation's Estuaries: A Decade of Change. NOAA Technical Memorandum NOS NCCOS Coastal Ocean Program Decision Analysis Series 26. Silver Spring, MD. 328 pp.

Brohawn, Kathy. 2007. Personal communications. MD Dept. Environment, Environmental Risk Assessment Program (Shellfish Sanitation Program), Baltimore.

Cardno ENTRIX. 2014. Summary of 2013 Qualitative Long-Term Monitoring Activities: Swanson Creek and Patuxent River. Potomac Electric Power Company, NW, Washington, DC. Introduction 1-1.

Centers for Disease Control and Prevention. 2016. Vibrio (Vibriosis): Frequently Asked Questions. US Department of Health and Human Services. Atlanta, GA. Accessed on June 7, 2016 at: https://www.cdc.gov/vibrio/faq.html).

Chanat, J.G., Moyer, D.L., Blomquist, J.D., Hyer, K.E., and Langland, M.J., 2016, Application of a Weighted Regression Model for Reporting Nutrient and Sediment Concentrations, Fluxes, and Trends in Concentration and Flux for the Chesapeake Bay Nontidal Water-Quality Monitoring Network, Results Through Water Year 2012: U.S. Geological Survey Scientific Investigations Report 2015-5133, 76 p., Online at: https://pubs.er.usgs.gov/publication/sir20155133

Clean Water Action Plan Technical Workgroup. (1998, December 31). *Maryland Clean Water Action Plan: Final 1998 report on unified watershed assessment, watershed prioritization and plans for restoration action strategies*. Dept. Natural Resources, Annapolis. 68p. Online at <URL: https://msa.maryland.gov/megafile/msa/speccol/sc5300/sc5339/000113/000000/000385/unrestricted/20040775e.pdf

Code of Maryland Regulations (COMAR). 2001 (and periodic updates). §26.08 - MD Dept. Environment. Office of the Secretary of State, Div. of State Documents, Annapolis. Online at: https://www.dsd.state.md.us/COMAR/subtitle_chapters/26_Chapters.aspx

Colwell, R. R. (2004). Infectious disease and environment: Cholera as a paradigm for waterborne disease. *International Microbiology, 7*, 285-289. Retrieved June 7, 2019, from https://scielo.isciii.es/scielo.php?pid=S1139-67092004000400008&script=sci_arttext&tlng=pt

Cronin, W. B. (1971). *Volumetric, areal and tidal statistics of the Chesapeake Bay estuary and its tributaries* (71-2). Baltimore, MD: Chesapeake Bay Institute.

Curriero, F. C., Patz, J. A., Rose, J. B., & Lele, S. (2001). The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948–1994. *American Journal of Public Health*, *91*(8), 1194-1199. Retrieved June 7, 2019, from https://www.ncbi.nlm.nih.gov/pubmed/11499103.

Cutler, D., & Miller, G. (2005). The Role of Public Health Improvements in Health Advances: The Twentieth-Century United States. *Demography, 42*(1), 1-22. Retrieved June 7, 2019, from https://link.springer.com/article/10.1353/dem.2005.0002.

Dillow, J. J., & Greene, E. A. (1999). *Ground Water Discharge and Nitrate Loadings to the Coastal Bays of Maryland* (Rep. No. 99-4167). Retrieved from https://pubs.usgs.gov/wri/wri99-4167/

Eskin, Richard, J. Ellen Lathrop-Davis and Tim C. Rule. (2000). *Report of the Biological Criteria Advisory Committee to the Maryland Department of the Environment on the Interim Framework for the Regulatory Application of Biological Assessments*. Dept. of the Environment, Technical and Regulatory Services Admin., Baltimore.

Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. (2012). *A Function-Based Framework for Stream Assessment and Restoration Projects*. US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006.

Heicher, David. 2007. Personal communications (e-mail) - update on invasive mussels in Susquehanna River basin. 21 December 2007. Susquehanna River Basin Commission, Harrisburg, PA.

Hirsch, R. M., Moyer, D. L., & Archfield, S. A. (2010). Weighted Regression On Time, Discharge, and Season (WRTDS),With An Application to Chesapeake Bay River Inputs. *Journal of the*

American Water Resources Association, 46(5), 857-880. Retrieved June 7, 2019, from https://onlinelibrary.wiley.com/doi/full/10.1111/j.1752-1688.2010.00482.x

Hirsch, R. M., Archfield, S. A., & De Cicco, L. A. (2015). A bootstrap method for estimating uncertainty of water quality trends. *Environmental Modeling and Software, 73*, 148-166. Retrieved June 7, 2019, from https://www.sciencedirect.com/science/article/pii/S1364815215300220.

Hlavsa, M. C., Roberts, V. A., Kahler, A. M., Hilborn, E. D., Mecher, T. R., Beach, M. J., . . . Joder, J. S. (2015, June 26). *Morbidity and Mortality Weekly Report: Outbreaks of Illness Associated with Recreational Water — United States, 2011–2012* (Rep. No. 64(24);668-672). Retrieved June 7, 2019, from Centers for Disease Control and Prevention website: https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6424a4.htm

Jacobs, A.D. and D.F. Bleil. 2008. Condition of nontidal wetlands in the Nanticoke River Watershed, Maryland and Delaware. Delaware Department of Natural Resources and Environmental Control, Watershed Assessment Section, Dover, DE 78pp.

Karrh, R. 2021. Personal communications (e-mail) – Summary of Tidal Trends. 14 September 2021. Maryland Department of Natural Resources, Annapolis MD.

Keisman, J., & Shenk, G. (2013). Total Maximum Daily Load Criteria Assessment Using Monitoring and Modeling Data. *Journal of the American Water Resources Association, 49*(5), 1134-1149. Retrieved October 22, 2021, from https://www.chesapeakebay.net/documents/WQ_Criteria_Assessment_Using_Monitoring_and_Modleling_Data_10-13.pdf

Keppel, A. 2021. Personal communications (e-mail) - Core/Trend trend results through 2019. 9 June 2021. Maryland Department of Natural Resources, Annapolis MD.

Leschine, T. M., Wellman, K. F., & Green, T. H. (1997). *The Economic Value of Wetlands Wetlands' Role in Flood Protection in Western Washington* (pp. 1-53, Rep. No. 97-100). Bellevue, WA: Washington State Department of Ecology.

Llanso, Roberto J., Lisa C. Scott and Frederick S. Kelley 2005. Assessment of 2000 through 2004 Chesapeake Bay estuarine benthic communities protocol and summary of results for MD and VA 2006 Integrated 305b/303d reports. 30 September. Prepared for VA Dept. Environmental Quality by Versar, Inc., Columbia, MD. 10p.

Luckett, C. N. (2015). *2015 Fish Kill Summary* (pp. 1-17, Rep.). Annapolis, MD: Maryland Department of the Environment, Fish Kill Investigations Section.

Maryland Coastal Bays Program. Accessed 2011. Ocean City. 2010 Coastal Bays Report Card. Online at: https://mdcoastalbays.org/

Maryland Department of Agriculture a. (2016, March 14). Agriculture Department Releases Preliminary Data on Soil Phosphorus Levels; Soil Data Collected for First Time Statewide as a Result of PMT Regulations. Retrieved June 10, 2019, from https://news.maryland.gov/mda/press-release/2016/03/14/agriculture-department-releases-preliminary-data-on-soil-phosphorus-levels-soil-data-collected-for-first-time-statewide-as-a-result-of-pmt-regulations/

Maryland Department of Agriculture b. (2016, August 24). Maryland Department of Agriculture Announces Record Cover Crop Sign-up. Retrieved June 10, 2019, from https://news.maryland.gov/mda/press-release/2016/08/17/maryland-department-of-agriculture-announces-record-cover-crop-sign-up

Maryland Department of the Environment. 1993. Maryland Lake Water Quality Assessment. Water Quality Monitoring Div., Annapolis.

Maryland Department of the Environment. 1995. Maryland Lake Water Quality Assessment. Water Quality Monitoring Pgm., Annapolis.

Maryland Department of the Environment. 2006 303(d) Listing. Baltimore. Online at https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2006_303d_list_final.aspx

Maryland Department of the Environment. 2008 Integrated Report. Baltimore. Online at https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2008_final_303d_list.aspx

Maryland Department of the Environment. 2009. Safe Drinking Water Act annual compliance report for calendar year 2008. Water Supply Pgm., Baltimore, MD. 29p. Online at: https://mde.maryland.gov/programs/Water/water_supply/Documents/www.mde.state.md.us/assets/document/WSP-ACR2009for2008.pdf

Maryland Department of the Environment. 2010 Integrated Report. Baltimore. Online at https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/Final_approved_2010_ir.aspx

Maryland Department of the Environment. 2011. Maryland nonpoint source program 2010 annual report. Science Services Admin., Baltimore, MD 41p. + appendices. Online at: https://mde.maryland.gov/programs/Water/319NonPointSource/Documents/AnnualReports/2010%20MD%20Annual%20Rpt%2020110224.pdf

Maryland Department of the Environment. 2012 Integrated Report. Baltimore. Online at https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2012_IR.aspx

Maryland Department of the Environment. July 2013. FY13 Groundwater Protection Program: Annual Report to the Maryland General Assembly. Baltimore, MD. Online at: https://mde.maryland.gov/programs/Water/water_supply/Source_Water_Assessment_Program/Documents/FINAL_GWR%20report_1__2013%20_3_.pdf

Maryland Department of the Environment. 2014. Maryland 319 Nonpoint Source Program 2013 Annual Report. Science Services Admin., Baltimore, MD 37p. + appendices. Online at: https://mde.maryland.gov/programs/Water/319NonPointSource/Documents/AnnualReports/2014_MD_Annual_Rpt_FINAL_20150513.pdf

Maryland Department of the Environment. 2014 Integrated Report. Baltimore. Online at https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2014IR.aspx.

Maryland Department of the Environment. 2016 The Heron: Maryland Department of the Environment's Monthly Newsletter. March 2016 Issue. Baltimore.

Maryland Department of the Environment. 2016 Bay Restoration Fund. Baltimore. Accessed on October 3, 2016. Online at: https://mde.maryland.gov/programs/Water/BayRestorationFund/Pages/Index.aspx.

Maryland Department of the Environment. 2016 Bay Restoration Fund: Wastewater Treatment Plants Enhanced Nutrient Removal Upgrade. Baltimore. Accessed on October 3, 2016. Online at: https://mde.maryland.gov/programs/Water/BayRestorationFund/Pages/wwtp_enr_upgrade.aspx.

Maryland Department of the Environment. Dec 2016. Historical and Projected Chesapeake Bay Restoration Spending: A Report to the Maryland General Assembly pursuant to the 2016 Join Chairman's Report- Page 184. Online at https://mde.maryland.gov/programs/Water/TMDL/TMDLImplementation/Documents/Webinars/April_25_2017/MD_Section_38_Cover_Letter-Complete_Report_12.2.16.pdf

Maryland Department of the Environment. 2016 Integrated Report. Baltimore. Online at https://mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2016IR.aspx.

Maryland Department of the Environment. 2017. Safe Drinking Water Act Annual Compliance Report for Calendar Year 2017. Water Supply Pgm., Baltimore. 22p. Online at: https://mde.maryland.gov/programs/Water/water_supply/Documents/PWS/ACRs/WSP-ACR-CY2017.pdf

Maryland Department of the Environment. 2018. Fish consumption advisories. Online at: https://mde.maryland.gov/programs/Marylander/fishandshellfish/Pages/fishconsumptionadvisory.aspx.

Maryland Department of the Environment. 2018. Water Programs. Baltimore. Online at: https://mde.maryland.gov/programs/Water/Pages/index.aspx.

Maryland Department of the Environment. 2019. Maryland's 2019 Chesapeake Bay Annual Progress. Online at: https://storymaps.arcgis.com/stories/234759335b7249d88442a7bff53a8784

Maryland Department of Natural Resources (DNR). 1987. The quantity and natural quality of ground water in Maryland. 2nd. ed. Water Resources Admin., Annapolis. 150 p.

Maryland Department of Natural Resources (DNR). 1998. 1998 Maryland Section 305(b) water quality report. Resource Assessment Service, Annapolis. 108 p.

Maryland Department of Natural Resources (DNR). 2000. 2000 Maryland 305(b) report. Resource Assessment Serv., Annapolis. 200p. + appendix.

Maryland Department of Natural Resources (DNR). 2001. Land areas, inland-water areas, and length of shorelines of Maryland's counties. MD Geological Survey, Baltimore. Fact sheet series FS-2. Online at: https://www.mgs.md.gov/geology/areas_and_lengths.html

Maryland Department of Natural Resources (DNR). 2004. State of the Maryland Coastal Bays, Annapolis. 48p. Online at: https://ian.umces.edu/press/reports/publication/48/state_of_the_maryland_coastal_bays_2004_2004-08-16/

Maryland Department of Natural Resources (DNR). 2014. Chesapeake and Atlantic Coastal Bays Trust

Maryland Department of Natural Resources (DNR). 2016. Chesapeake and Atlantic Coastal Bays Trust Fund: 2016 Annual Report. Annapolis, Maryland. Publication Date: January 2016. https://dnr.maryland.gov/ccs/Publication/TrustFund_WP2015-YearSeven_FY15_FY16.pdf

Maryland Smart, Green, and Growing. Accessed April 2014. BayStat: Tracking Chesapeake Bay Restoration. Online at: https://www.baystat.maryland.gov/.

Maryland Smart, Green, and Growing. Accessed August 2014. Wetland Genuine Progress Indicator: Cost of Net Wetland Change. Personal Communication with Denise Clearwater. Online at: https://dnr.maryland.gov/mdgpi/Pages/default.aspx.

Moyer, D.L., Hirsch, R.M., and Hyer, K.E., 2012, Comparison of two regression-based approaches for determining nutrient and sediment fluxes and trends in the Chesapeake Bay watershed: U.S. Geological Survey Scientific Investigations Report 2012-5244, 118 p., Online at: https://pubs.usgs.gov/sir/2012/5244/.

Murphy, R. and E. Perry. 2018. Draft: Methods for Application of Generalized Additive Models (GAMs) for Water Quality Trends in Tidal Waters of Chesapeake Bay. Online at: https://www.chesapeakebay.net/groups/group/integrated_trends_analysis_team

Murphy, R.R., E. Perry, J. Harcum, J. Keisman. 2019. A Generalized Additive Model approach to evaluating water quality: Chesapeake Bay case study. Environmental Modeling and Software 118:1-13. https://doi.org/10.1016/j.envsoft.2019.03.027

National Oceanic and Atmospheric Administration, Maryland Department of Natural Resources, Maryland Department of the Environment, and U.S. Fish and Wildlife Service. 2002. Final Restoration Plan and Environmental Assessment for the April 7, 2000 Oil Spill at Chalk Point on the Patuxent River, Maryland. Silver Spring, MD. Online at: www.gc.noaa.gov/gc-rp/cp2107.pdf.

National Oceanic and Atmospheric Administration, 2007. Effects of nutrient enrichment in the Nation's estuaries: A decade of change, National Estuarine Eutrophication Assessment update. US Dept. Commerce, Washington, DC. Online at: https://yosemite.epa.gov

Rice, K. C., & Jastram, J. D. (2014). Rising air and stream-water temperatures in Chesapeake Bay region, USA. *Climatic Change*, *128*(1-2), 127-138. Retrieved June 10, 2019, from https://link.springer.com/article/10.1007/s10584-014-1295-9.

Rose, J. B., Epstein, P. R., Lipp, E. K., Sherman, B. H., Bernard, S. M., & Patz, J. A. (2001). Climate variability and change in the United States: Potential impacts on water- and foodborne diseases caused by microbiologic agents. *Environmental Health Perspectives*, *109*(2), 211-221. Retrieved

Roth, Nancy E. 2003. Stream reach lengths by sub-watershed. Pers. comm. (e-mail/attached spreadsheet file). Versar, Inc., Columbia, MD. 135

Smith, V. Kerry (Vincent Kerry) & Desvousges, William H. (1986). *Measuring water quality benefits*. Kluwer-Nijhoff Pub. ; Norwell, MA : Distributors for the U.S. and Canada, Kluwer Academic Publishers, Boston

Southerland, M.T., Rogers, G.M., Kline, M.J., Morgan, R.P., Boward, D.M., Kazyak, P.F., Klauda, R.J., Stranko, S.A. 2005. New Biological Indicators to Better Assess the Conditions of Maryland Streams. Prepared for the Maryland Department of Natural Resources. Annapolis, MD. 52p. + appendices.

Tiner, Ralph W., Jr. and David G. Burke. 1995. Wetlands of Maryland. U.S. Fish and Wildlife Service, Ecological Services, Region 5, Hadley, MA and MD Dept. Natural Resources, Annapolis. Cooperative publication. 193 p.

United States, Environmental Protection Agency, Chesapeake Bay Program. (2010, October). *Quality Management Plan for the Chesapeake Bay Program Office*. Retrieved from https://www.chesapeakebay.net/content/publications/cbp_59047.pdf

United States Federal Government. (2019, June 5). Code of Federal Regulations. Retrieved from https://www.ecfr.gov/cgi-bin/ECFR?page=browse

U.S. Census Bureau. 2010. State and County Quick Facts. Census 2010. Online at: https://www.census.gov/quickfacts/table/PST045216/00.

U.S. Centers for Disease Control and Prevention. 1997. Case definitions for infectious conditions under public health surveillance. Morbidity and Mortality Weekly Rev 1997;46(No. RR-10): i-ii. Online at: https://www.cdc.gov/mmwr/preview/mmwrhtml/00047449.htm.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. 1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. https://www.census.gov/prod/3/98pubs/mdfhw698.pdf

US Environmental Protection Agency. 1983. Chesapeake Bay Program: Findings and recommendations. Region 3, Philadelphia, PA. 48p.

US Environmental Protection Agency. 1991. Total state waters: Estimating river miles and lake acreages for the 1992 water quality assessments. Office of Water, Washington, DC. 42p.

US Environmental Protection Agency. 1997a. Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic updates: Report contents and supplemental volumes. Office of Water, Washington, DC. EPA 841-B-97-002A and -002B.

US Environmental Protection Agency. 1997b. Mid-Atlantic Landscape atlas. Region III, Philadelphia, PA. Online at: https://archive.epa.gov/emap/archive-emap/web/html/ma_atlas.html

US Environmental Protection Agency. 1998. Guidance on Use of Clean Water Act and Safe Drinking Water Act Authorities to Address Management Needs for Lakes and Reservoirs. US Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. https://www.epa.gov/sites/production/files/2015-09/documents/guidance_on_use_of_clean_water_act_and_safe_drinking_water_act_authorities_to_address_management_needs_for_lakes_and_reservoirs.pdf

US Environmental Protection Agency. 1998. Lake and reservoir bioassessment and biocriteria. Technical guidance document. Office of Water, Washington, DC (EPA 841-B-98-007).Online at: https://nepis.epa.gov/Exe/ZyNET.exe/20004ODM.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1995+Thru+1999&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C95thru99%5CTxt%5C00000012%5C20004ODM.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

US Environmental Protection Agency. 2002a. Guidance for Quality Assurance Project Plans. EPA/240/R-02/009, Washington, D.C. Online at: https://www.epa.gov/quality/guidance-quality-assurance-project-plans-epa-qag-5.

US Environmental Protection Agency. 2002b. National Beach Guidance and Required Performance Criteria for Grants. EPA-823-B-02-004, Washington, D.C.

US Environmental Protection Agency. 2003. Ambient water quality criteria for dissolved oxygen, water clarity and chlorophyll a for the Chesapeake Bay and its tidal tributaries. Region III, Chesapeake

Bay Pgm Office and Water Protection Div., Philadelphia, PA. EPA 903-R-03-002. 231p. + appendices.

US Environmental Protection Agency. 2004. Backgrounder for the 2004 FDA/EPA consumer advisory: What you need to know about mercury in fish and shellfish. Office of Water, Washington, DC. EPA-823-F-04- 008. Online at:https://nepis.epa.gov/Exe/ZyNET.exe/P1009KJV.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2000+Thru+2005&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000026%5CP1009KJV.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

US Environmental Protection Agency. 2004. Chesapeake Bay Program analytical segmentation scheme: Revisions, decisions and rationales, 1983-2003. Chesapeake Bay Program, Tidal Monitoring and Analysis Workgroup, Annapolis, MD. EPA 903-R-04-008. 30p. + appendices.

US Environmental Protection Agency. 2005. National water program guidance: Fiscal Year 2006. Office of Water, Washington, DC. 60p. + appendices. https://www.epa.gov/sites/production/files/2017-09/documents/fy18-19-ow-npm-guidance.pdf

US Environmental Protection Agency. 2007. Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries–2007 Addendum. EPA 903-R-07-003. CBP/TRS 285-07. Region III Chesapeake Bay Program Office, Annapolis, Maryland.

US Environmental Protection Agency. 2008. Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries: 2008 Criteria Assessment Protocols Addendum. June 2008 - EPA Doc # CBP/TRS-290-08 903-R-08-001

US Environmental Protection Agency. 2010. Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus, and Sediment. US Environmental Protection Agency, Chesapeake Bay Program: Annapolis, MD.

US Environmental Protection Agency. 2017. EPA Interim Evaluation of Maryland's 2016-2017 Milestones. June 30, 2017. Accessed: January 29, 2018. Online at: https://www.epa.gov/sites/production/files/2017-06/documents/md_interim_2016_2017_milestone_eval_20170630_0.pdf.

US Geological Survey. (2016). Methods of Data Compilation and Analysis: How Does the WRTDS Model Work?. Retrieved June 14, 2019, from https://cbrim.er.usgs.gov/methods.html

US Geological Survey. 2017. Water Quality Loads and Trends at Nontidal Monitoring Stations in the Chesapeake Bay Watershed: Summary of Nitrogen, Phosphorus, and Suspended-Sediment Loads and Trends Measured at the Chesapeake Bay Nontidal Network Stations: Water Year 2016 Update, Online at: https://cbrim.er.usgs.gov/summary.html.

Wazniak, Catherine E., Matthew R. Hall, Tim J.B. Carruthers, Brian Sturgis, William C. Dennison, and Robert J. Orth. 2007. Linking water quality to living resources in a Mid-Atlantic lagoon system, USA. Ecol. Appl. 17(5) Supplement. p. S64-S78.

Wheeler, Judith C. 2002. Personal communications. US Geol. Survey, Annapolis, MD

Wheeler, Judith C. and Lillian B. Maclin. 1988. Maryland and the District of Columbia ground-water quality, pp. 287-296. In: National water summary 1986: Ground-water quality. U.S. Geological Survey, Reston, VA. USGS Water Supply Paper 2325.