Maryland's Final 2014 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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EXECUTIVE SUMMARY

Maryland's 2014 Integrated Report (IR) is submitted in compliance with sections 303(d), 305(b) and 314 of the federal Clean Water Act (CWA). This biennial 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.[1] In addition, the report provides information about the progress on addressing impaired waters (Categories 4 & 5) 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.

The 2014 IR incorporates several changes this year which include the implementation of revised assessment methodologies for bacteria and biological data. In addition, there are newly developed guidelines for biological data submission and a brand new assessment methodology for stream temperature (for Use Class III and III-P only). For the 2014 IR, Maryland made a significant effort to incorporate more non-state government data than has ever been used in a previous Maryland IR. Datasets used included those collected by federal agencies, county governments, water utility agencies, and non-profit watershed organizations. As with the previous IR, the 2014 IR includes a GIS submittal that provides coverages for streams, impoundments, and estuarine waters which depict assessment information at appropriate scales. MDE also continues to make Integrated Reporting data available to the public in user-friendly formats. Through the use of MDE's searchable IR database and the interactive online pollutant maps, users can query IR information and explore water quality information in a graphic format. The searchable IR database and clickable map application are available online at http://www.mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/303d.aspx and the interactive pollutant maps can be found at http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/ImpairmentMaps.aspx.

These changes are all part of an on-going effort to improve Maryland's reporting and assessment activities required under the CWA. Further, Maryland continues to work closely with EPA's Chesapeake Bay Program (CBP) and other state partners (VA, PA, D.C., NY, and DE) on the assessment process for the Chesapeake Bay water quality criteria. Maryland has adopted an assessment

[1] The Integrated Report places all waters of the State into one of five "categories": Category 1 indicates that a water body is meeting all standards, Category 2 means it is meeting some but not all standards, Category 3 indicates that there is insufficient data to determine whether standards are being met, Category 4 means that water quality standards are not being met but a TMDL is not needed, either because it has already been completed, other more immediate fixes are available, or the impairment is not load related, and finally, Category 5 indicates that a water body is impaired and a TMDL is needed.

process that was created and agreed to by the partner states and the CBP. This assessment process split the Chesapeake Bay into 53 new segments (in the Maryland portion) based on the salinity regime. The current Chesapeake Bay assessments will continue to evolve as new assessment methodologies are developed and as additional data are collected. More details on the Chesapeake Bay assessments can be found at: http://www.chesapeakebay.net/about/programs/monitoring.

There are 138 additions to the list of Category 5 (impaired, TMDL needed) waters in 2014. Seventy-one of these new Category 5 waterbody-pollutant combinations (also referred to as listings) resulted from the newly implemented temperature assessment methodology for Use Class III and III-P streams. Another thirty-five of these new Category 5 listings resulted from MDE's Biological Stressor Identification Analyses. Of these 35 new 'biostressor' listings, ten are for chlorides, eight are for total suspended solids, seven are for sulfates, six are for total phosphorus, and four are listed for pH. In addition, there are eight new PCB listings for fish tissue, seven fecal coliform listings in shellfish harvesting waters, six mercury listings for fish tissue, three listings for high pH in streams, and one new heptachlor epoxide listing. Finally, there are seven new Category 5 listings for failures to attain the aquatic life designated use (pollutant(s) not yet specified).

Table 1: Changes to Category 5 Listings from 2012 to 2014

Integrated Report Year/Status	Category 5 Listings
2012 Total Category 5 Listings	**195**
2014 New Category 5 Listings	138
2014 New Delistings (Category 5 to Category 2 or 3) *(See Table 2)*	-38
Approved TMDLs* (Category 5 to Category 4a, since the 2012 IR)	-33
2014 Grand Total Category 5 Listings	**262**

*Other TMDLs may have been approved during this time but they did not address waters on Category 5.

Thirty-eight waterbody-pollutant combinations were removed from Category 5 (impaired, TMDL needed) in 2014.[2] Twenty-one biological listings without a specified impairing substance have been replaced by specific pollutant listings enumerated by the Biological Stressor Identification analyses (BSID). Four other listings have been removed from Category 5 as it was determined that manganese is not impairing the drinking water designated use. Another listing, the Atkisson Reservoir – sediment listing, was moved to Category 3 after an evaluation of more recent information demonstrated that Atkisson Reservoir is currently functioning as a beneficial wetland. One other Category 5 listing was removed from the IR altogether (Edgewater Village Lake – total phosphorus) because the impoundment is classified as a stormwater retention pond. Two more listings, for chromium, were delisted based on a series of studies which demonstrated that chromium was not impairing the aquatic life use in the Northwest Branch and Bear Creek portions of the Patapsco River (tidal). The remaining nine delistings are a combination of waters that meet aquatic life standards for total phosphorus (four delistings), sediment-related parameters (two delistings), biological evaluations (one delisting), copper (one delisting), and mercury in fish tissue (one delisting). Many of these listings were originally based on

[2] The number thirty-eight does not include partial delistings whereby a smaller geographic portion of a Category 5 (impaired) listing was split out from the original assessment unit and delisted. These partial delistings are provided in Section C.3. This number also does not include listings that were addressed by a TMDL (moved to Category 4a), nor does it include listings that were in Categories 4a, 4b, or 4c but which now meet standards.

limited data (especially those listings originating in the 1996 and 1998 303(d) Lists). In many cases, it is not possible to attribute these waters now meeting standards to a particular restoration 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. Table 2 shows the general water body-pollutant combinations that have been delisted from Category 5.

Table 2: 2014 Delistings (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 – specific pollutant now specified (BSID process)	21
Total Phosphorus – Meeting standards	4
Manganese - Drinking water standards met in finished water	4
Sediments – Meeting standards	2
Chromium – Meeting standards	2
Biological Listing - now meeting aquatic life designated use	1
Hg - Fish Tissue Concentrations now meeting fishing designated use	1
Copper - Meeting standards	1
Sediments – Moved to Category 3 – lack of impairment data, potential use change	1
Total Phosphorus – Removed the IR completely – impoundment properly classified as a stormwater pond	1
2014 Total Number of Delistings	**38**

Another notable set of delistings, which were not counted in Table 2[3], are several that occurred in the tidal portion of the Patapsco River (PATMH). Specifically, the Category 4b (impaired, technological fix) nickel listing, which was associated with three separate industrial point sources, was delisted on the basis of recent discharge monitoring report (DMR) data and ambient water quality monitoring data. In addition, the Category 4b listing for copper has also been partly delisted on the basis of DMR and ambient water quality data. In both cases, these data demonstrated that effluent limits were being met and that nearfield water met ambient water quality criteria. For more details on the Category 4b delistings in PATMH please see Section C.3.

Another particularly noteworthy delisting that was not counted in Table 2 was the removal of the low pH impairment to the mainstem of Aaron Run in Garrett County, MD. This is the first instance where a specific restoration project, undertaken by the State, has been directly linked to designated use attainment (aquatic life). In this case, MDE's Bureau of Mines Division coordinated the construction of several acid mine drainage treatment systems which increased stream pH to levels within the pH criteria range. As part of this restoration effort, DNR Fisheries transplanted brook trout from nearby streams to Aaron Run which, based on recent reports, are not only surviving but also reproducing.

Water quality successes are also being documented from the effort at addressing nutrient impairments throughout the state. Though many Maryland waters are still listed as impaired (most are in Category 4a

[3] These specific listings started (in 2012) in Category 4b and were moved to Category 2 (meeting some standards). Table 2 only counts those listings that moved from Category 5 to Categories 2 or 3. Likewise, listings that started in Category 4a or 4c, were also excluded from Table 2.

– impaired, TMDL completed) for nitrogen and/or phosphorus, trend analyses completed by the United States Geological Survey (USGS) demonstrate significant long-term (30-year) reductions at many of the monitoring locations in Maryland and in the larger Chesapeake Bay watershed. In addition, based on reported implementation efforts, Maryland has achieved 41% of its nitrogen and 62% of its phosphorus reduction goals as assigned by the Phase II Watershed Implementation Plan.

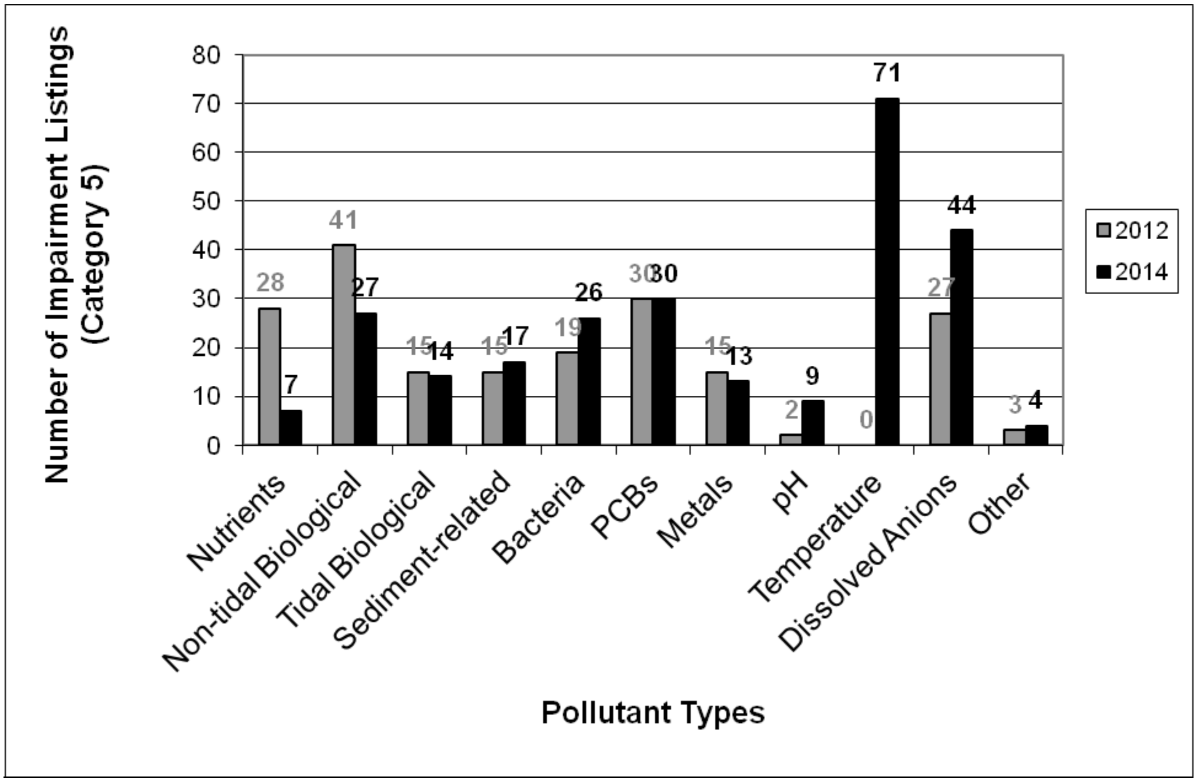

Figure 1: Comparison of the Number of Category 5 (impaired, TMDL not yet completed) Listings Between the 2012 and 2014 Integrated Reporting Cycles per Pollutant Group.

There have also been some notable developments in Maryland's water programs since the last Integrated Reporting cycle in 2012. Maryland completed a total of 36 TMDLs, Water Quality Analyses and Biostressor Identification Analyses in 2012 and 2013 that addressed previous Category 5 assessments. Twelve of the 36 meet specific requirements of the memorandum of understanding (MOU) with EPA that sets TMDL production schedules for Maryland. Also, in February 2014, the Maryland Department of the Environment (MDE), in cooperation with Delaware and Virginia, completed an updated series of TMDLs addressing Maryland's entire portion of the Coastal Bays and establishing pollution limits for both nitrogen and phosphorus. These TMDLs were subsequently approved by EPA in August of 2014 and are captured within this report. In addition, Maryland has made efforts to improve assessment resolution of the Chesapeake Bay water quality segments by incorporating non-government data for the first time, starting with the 2014 Bay assessments. Specifically, data collected by the South River Federation (SRF) was combined with data collected by DNR which demonstrated, for the first time, that the 30-day mean dissolved oxygen criterion was met in the South River.

Since the Chesapeake Bay TMDL was completed in December 2010, Maryland has continued to evaluate and compare the new Chesapeake Bay TMDLs with the previously approved nutrient TMDLs. For these segments, MDE will be determining which TMDL should be the TMDL of record and will, in the future, develop documentation to describe this evaluation. This documentation will undergo a public review period either as part of a future Integrated Report or as a stand-alone document. For a brief synopsis of this evaluation please read Section C.3.1. In addition, MDE has provided Parts G and H (in this IR) to help explain the history of the Chesapeake Bay listings and TMDLs. Included in this historical recount is how completed TMDLs impacted MD's MOU with EPA and how specific segments were affected (Part H).

Other notable new actions taken by the State include:

- Completion of the Phase II Chesapeake Bay Watershed Implementation Plan that proposes localized loading reductions and strategies for meeting the water quality goals of the Chesapeake Bay TMDL.
- The continuing work of the Marcellus Shale Safe Drilling Initiative to provide additional baseline monitoring, studies, and recommendations for dealing with environmental liability issues as well as best practices for all aspects of gas drilling to protect both the environment and public health.
- An increase in the Bay Restoration Fund (BRF) fee to help fund enhanced nutrient removal at minor waste water treatment plants.
- Passage of the Sustainable Growth and Agricultural Preservation Act of 2012 (the septic law) which creates a planning requirement for jurisdictions to identify areas planned for certain types of development (septic versus sewered) in an effort to limit new areas served by septic systems, a largely unchecked source of nutrient pollution.
- A 640 percent increase in the level of funding for the Chesapeake and Coastal Bays Trust Fund which finances projects that support Maryland's Watershed Implementation Plan by reducing nonpoint source pollution.
- Revision of the statewide nutrient management regulations to achieve consistency in the way all sources of nutrients are managed to help Maryland meet the nitrogen and phosphorus reduction goals in the Watershed Implementation Plans (WIP).
- The Maryland Agricultural Certainty Program, passed during the 2013 legislative session, offers farmers who voluntarily implement advanced best management practices (BMPs) the certainty that they can conduct their business without additional regulations for ten years. The goal of this program is to accelerate implementation of agricultural best management practices in order to meet nutrient and sediment reduction requirements under the WIP while preserving the economic viability of Maryland's farms.
- Passage of the lawn fertilizer law which limits nitrogen and phosphorus in fertilizer products, requires certification of lawn care professionals, and establishes application restrictions for both homeowners and professionals.

In addition to these efforts, the Maryland State legislature passed House Bill 987 requiring that the 10 most populated jurisdictions in Maryland charge citizens, businesses, and organizations a stormwater utility fee. This fee is specifically aimed at reducing the area's fastest growing source of pollution, stormwater from urban and suburban development. Funds generated by this fee will be used to complete stream restoration projects, create bioretention facilities such as rain gardens, and to maintain current stormwater infrastructure, all toward the larger effort of improving local and Chesapeake Bay water quality.

PREFACE

Maryland's Integrated Report, when approved by the US Environmental Protection Agency, will satisfy Sections 303(d), 305(b) and 314 of the federal Clean Water Act (CWA). The following lists the requirements of these sections.

Clean Water Act §303(d) (Impaired waters) Requirements

- A list of water quality-limited (impaired) waters still requiring TMDL(s), pollutants causing the impairment and priority ranking for TMDL development (including waters targeted for TMDL development within the next two years).
- A description of the listing methodologies used to develop the list.
- A description of the data and information used to identify waters, including a description of the existing and readily available data and information used.
- A rationale for any decision to not use any existing and readily available data and information.
- Other reasonable information such as demonstrating good cause for not including waters on the list.

Clean Water Act §305(b) (Water quality inventory) Requirements

- A description of the quality of all waters in the state and the extent to which the quality of waters provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water.
- An estimate of the extent to which control programs have or will improve water quality, and recommendations for future actions necessary and identification of waters needing action.
- An estimate of the environmental, economic and social costs and benefits needed to achieve the objectives of the CWA and an estimate of the date of such achievement.
- A description of the nature and extent of nonpoint source pollution and recommendations of programs needed to control each category of nonpoint sources, including an estimate of implementation costs.
- An assessment of water quality of all publicly owned lakes as specified in §314(a)(1).

Clean Water Act §314 (Clean Lakes) Requirements

- An identification and classification according to eutrophic condition of all publicly owned lakes.
- A description of procedures, processes, and methods (including land use requirements), to control sources of pollution of such lakes.
- A description of methods and procedures, in conjunction with appropriate federal agencies, to restore the quality of such lakes.
- Methods and procedures to mitigate the harmful effects of high acidity, including innovative methods of neutralizing and restoring buffering capacity of lakes and methods of removing from lakes toxic metals and other toxic substances mobilized by high acidity.
- A list and description of those publicly owned lakes for which uses are known to be impaired and those in which water quality has deteriorated as a result of high acidity that may be due to acid deposition.
- An assessment of the status and trends of water quality in lakes, including but not limited to, the nature and extent of pollution loading from point and nonpoint sources and the extent to which the use of lakes is impaired as a result of such pollution, particularly with respect to toxic pollution.

PART A: INTRODUCTION

In Maryland, the Departments of Natural Resources (DNR) and the Environment (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 water quality standards, compiles and assesses water quality data, and 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 water quality standards and no use is threatened;

Category 2: water bodies meeting some water quality standards but with insufficient data and information to determine if other water quality standards 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 water quality standards 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 by EPA;
- **Subcategory 4b**: Other pollution control requirements (i.e., permits, consent decrees, etc.) are expected to attain water quality standards; 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.

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 water quality standards) for having low levels of copper. 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 Clean Water Act 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 water quality standards;

(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 Clean Water Act and the adoption of a multi-category reporting structure, Maryland has developed a two-tiered approach to data quality. Tier 1 data are used to determine impaired waters (e.g., Category 5 waters or the traditional 303(d) List) and are subject to the highest data quality standards. Maryland waters identified as impaired using Tier 1 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 Quality Assurance Project Plans. Dec 2002. EPA /240/R-02/009 available at http://www.epa.gov/quality/qs-docs/g5-final.pdf. Tier 1 data analysis must also be consistent with Maryland's Assessment Methodologies (see Section C.2).

Tier 2 data are used to assess the general condition of surface waters in Maryland and may include land use data, visual observations of water quality condition, or data not consistent with Maryland's Assessment Methodologies. Such data may not have a QAPP or may have one that is not consistent with EPA guidance. Waters with this level of data may be placed in Categories 2 or 3 of the IR, denoting that water quality is generally good or that there are insufficient data to make an assessment, respectively. However, Tier 2 data alone are not used to make impairment decisions (i.e., Category 5 listings requiring a TMDL) because the data are of insufficient quantity and/or quality for regulatory decision-making. Table 3 below identifies the organizations and/or programs that submitted data to MDE for the 2014 IR.

Table 3: Organizations/Programs that submitted water quality data for consideration in the 2014 Integrated Report.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Versar Inc. provided data on behalf of Frederick County	Non-tidal biological data	Benthic index of biological integrity	1	Data integrated with MBSS data for biological assessment
Montgomery County Department. of Environmental Protection	Non-tidal Biological Data	Benthic index of biological integrity, fish index of biological integrity, habitat	1	Data could not be used for the 2014 IR because it is assessed using non-state reference conditions and metrics. More analysis required to attain comparability.
Baltimore County Dept. of Environmental Protection & Sustainability	Bacteria data for non-tidal watersheds Jones Falls, Gwynns Falls, and Herring Run	*E. coli*	1	Data used to update bacteria assessments for select watersheds
Nanticoke River Watershed Alliance	Collected tidal and non-tidal water quality data throughout the Nanticoke watershed.	Dissolved oxygen (DO), water temperature, saturation, salinity, fecal coliform.	1	Not currently used. Data needs to be integrated with Chesapeake Bay Program Interpolator in order to be used. This will be future priority.
South River Federation	DO profiles and supporting info from stations in South River	DO, pH, salinity, conductivity, water temperature, chlorophyll a, secchi depth	1	Data used to update the DO/nutrient assessment for the South River.
National Park Service	Physical and chemical water quality data from Catoctin Mountain Park	DO, pH, water temperature, turbidity	2	Data not incorporated in 2014 IR. Need station coordinates. More coordination anticipated in future.
MDE - Mining Program	Physical water quality data and biological data	DO, temperature, benthic and fish indices of biotic integrity.	1	Biological data collected at targeted sites, not appropriate for probabilistic assessment. Data used for Tier II high quality waters evaluation instead.
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 leaking infrastructure	1	Data used to inform bacteria assessments for areas with little or no water quality data
Susquehanna River Basin Commission	Physical and chemical water quality data, fish and benthic macroinvertebrates	DO, alkalinity, nutrients, TSS, raw benthos and fish numbers	1	Biological data was collected from targeted stations, not random, as is required for state watershed assessments. Data used for general informational purposes instead.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Baltimore City Dept. of Public Works	Baltimore City Reservoir data on DO and chlorophyll a	DO, depth, chlorophyll a	1	Data used to confirm impairments.
MDE – Fish Tissue Monitoring Program	Fish Tissue data on Polychlorinated Biphenyls (PCBs), Heptachlor epoxide, and Mercury (Hg)	Concentration of PCBs, Heptachlor epoxide, and mercury in fish tissue	1	Data used to update fish consumption related assessments.
MDE – BEACH Certification Program	Bacteria data collected at designated bathing beaches by County Health Departments.	Enterococcus levels	1	Data used to update beach assessments.
Washington Suburban Sanitary Commission	Physical and chemical water quality data from the Patuxent Reservoirs	nutrients, turbidity, chlorides, DO	1	Not currently used. Data provided in report form. Need to obtain raw files in the future to conduct independent assessment.
Baltimore County Dept. of Environmental Protection & Sustainability	Non-tidal benthic data	Benthic index of biological integrity, habitat.	1	Data integrated with MBSS data for biological assessment.
Chesapeake Bay Program	Chesapeake Bay Benthic Data	Biological Index Scores	1	Data used to update biological assessments for tidal tributaries of the Chesapeake Bay.
MDE – Shellfish Certification Program	Bacteria data for stations in the Tidal areas of the Chesapeake Bay and Coastal Bays	Fecal coliform	1	Data used to update bacteria assessments as they relate to the shellfish harvesting designated use.
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	1	Data used to update the DO/nutrient assessments for the Chesapeake Bay and its tidal tributaries
MD DNR Monitoring and Non-Tidal Assessment Program	Core Trend Non-tidal monitoring data	Nutrients, turbidity, water temperature, pH, conductivity, DO	1	Data used to update non-tidal assessments.
Blue Water Baltimore	Bacteria Monitoring data from Baltimore Harbor/tidal Patapsco River	Enterococcus and supporting parameters	1	Data used to update the Baltimore Harbor bacteria assessment.
Baltimore City Dept. of Public Works	Bacteria data around the Baltimore Harbor and Middle Branch	Enterococci	1	Data used to update the Baltimore Harbor bacteria assessment.
MDE - Biostressor Identification Program	Analysis that provides the specific pollutants that impair biological integrity	Biological Index Scores and the correlation to stressors	1	Data used to update biological assessments to reflect actual impairing substance.

Data Provider	Data Description	Parameter(s) Measured	Data Tier	Notes
Anne Arundel County Dept. of Public Works	Physical water quality data and biological data	Benthic index of biological integrity, habitat, stream geomorphology measures	1	Was not able to complete full QA/QC of BIBIs. More materials still needed. Data will be focus of future efforts.
MD DNR Maryland Biological Stream Survey	Biological, habitat, chemistry, and landuse information.	Benthic index of biological integrity, fish index of biological integrity, habitat	1	Data used for statewide biological assessments
MD DNR and Virginia Institute of Marine Science	Assessments of sediment levels in the Chesapeake Bay through the use of the SAV and water clarity indicators	SAV coverage and water clarity acres	1	Data used to update the SAV/sediment assessments for the Chesapeake Bay and its tidal tributaries
MDE - Environmental Assessment & Standards Program, Field Services Program	Metals monitoring data collected along the mainstem of the Choptank River	Copper (Cu), Lead (Pb), Chromium (Cr), Nickel (Ni), Arsenic (As), Cadmium (Cd), Selenium (Se), Silver (Ag), Zinc (Zn)	1	Data used to verify a copper impairment on the Choptank as shown in previous NOAA study.
MDE - Environmental Assessment & Standards Program, Field Services Program	Metals monitoring data collected near NPDES outfalls of three major dischargers	Cu, Pb, Cr, Ni, As, Cd, Se, Ag, Zn, Hg	1	Data used to reassess previous Category 4b listings that remained from historical 304l list.
Maryland Department of the Environment, TMDL Program	Habitat and sedimentation information on Atkisson Reservoir	Habitat and sedimentation information on Atkisson Reservoir	1	Data used to reassess the Atkisson Reservoir-sediment impairment.

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 growing number of biological impairments in Category 5 of the IR, Maryland will be relying more heavily on land use analyses, GIS modeling, data mining, and other innovative approaches to identify stressors, define ecological processes, and develop TMDLs.

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), Quality Assurance Project Plan (QAPP) for each monitoring program, and field and laboratory Standard Operating Procedures (SOP). Water monitoring programs conducted under contract to the US Environmental Protection Agency (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 may not have a QAPP. Unless there are contractual requirements, water monitoring QAPPs for these groups are not reviewed or approved by the State. While it is recommended that a QAPP or equivalent planning document be developed, some water quality monitoring programs may have no QAPP or documentation on quality control. 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 these 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 are 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, ammonium, 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 oxygen criteria or nuisance levels of algae are attributed to high nutrients levels. 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 because few of these substances are found in ambient waters at levels exceeding criteria. Specific toxics 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 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 statistical 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. 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 (Versar, Inc. and Old Dominion University), aquatic grass coverage (VA Institute of Marine Science), water clarity (MD DNR), and dissolved oxygen (US Environmental Protection Agency's Chesapeake Bay Program).

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		5,773,552	N/A	U.S. Census Bureau, 2010
Surface Area	Total (square miles)	12,193	Unknown	MD DNR 2001
	Land (square miles)	9,844		
Rivers and streams (miles)		19,127	1:24,000 NHD Coverage	MDE, 2012
Impoundments	All Lakes/Reservoirs (number/acres)	947 lakes / 77,965	1:100,000 (RF3)	US 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 http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.08.02.]. 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 use classes. Each of these may also be given a "-P" suffix which denotes that the water body also supports public water supply.

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

Each use 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. 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 (not 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 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 toxics 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 Clean Water Act and its amendments require that states update their water quality standards every three years, subject to review and approval by the US Environmental Protection Agency (http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/Programs/WaterPrograms/TMDL/wqstandards/index.aspx). Water quality standards are updated through changes to the regulatory language in COMAR and go through a public review process.

B.1.1.1 Water Quality Standards for Chesapeake Bay and its Tidal Tributaries

Maryland has detailed water quality standards 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 Use Class II waters and establish five designated uses (see Figure 2) 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 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. 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 (MSN) 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.

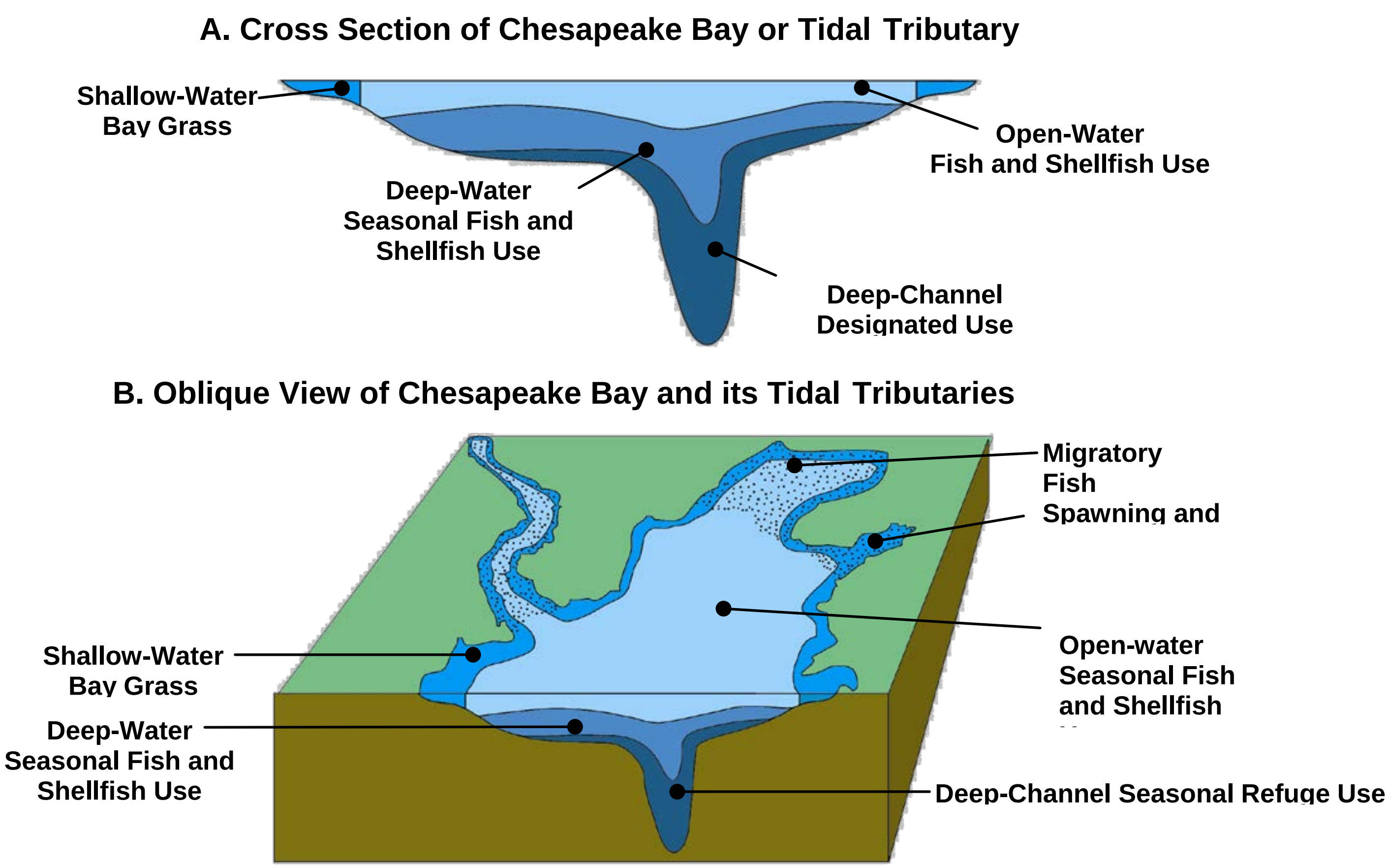

Figure 2: Illustration of the designated uses for Chesapeake Bay (Chesapeake Bay Program, 1998). Uses are both overlapping and three-dimensional.

B.2 Water Pollution Control Programs

Maryland implements a host of water pollution control programs to ensure that water quality standards are attained, many of which are funded by federal dollars under the Clean Water Act. 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 http://www.mde.state.md.us/Waterpermits.

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 is in the process of updating antidegradation regulations and developing detailed implementation guidance to help regulated entities better understand and implement these regulations. Once these proposed regulations have been agreed upon internally, the Department will incorporate these into the Triennial Review. The antidegradation program aims to protect high quality waters by requiring more rigorous permit application reviews and by restricting the amount of buffering capacity (i.e., assimilative capacity) that can be used by a discharger. More information on Tier II can be found at http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/Antidegradation_Policy.aspx.

B.2.3 Grant Programs

A number of financial assistance programs are offered and/or facilitated by the Maryland Department of the Environment. 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 the Department can be found at http://www.mde.state.md.us/WQFA.

B.2.4 Total Maximum Daily Loads (TMDLs)

Waters listed on Category 5 of this Integrated Report may require a Total Maximum Daily Load (TMDL). A TMDL is an estimate of the amount or load of a particular pollutant that a water body can assimilate and still meet water quality standards. 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 http://www.mde.state.md.us/TMDL. 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.3.1.

B.2.5 Stream Restoration

With new funding sources (e.g. Chesapeake and Coastal Bays Trust Fund) becoming available and an increased emphasis on reducing nutrient and sediment loads throughout the state, more and more stream restoration projects are being proposed by a variety of stakeholders. Since these projects are necessarily located within wetlands and waterways, it is MDE's responsibility to review these projects so as to limit impacts and maximize potential benefits. To address this increased caseload, MDE entered (in 2013) into an interagency agreement with the U.S. Fish and Wildlife Service (USFWS) to facilitate the assessment, review, enhancement and creation of technical services that will allow the Department to meet its goals and objectives for restoring and enhancing the quality of Maryland's water and floodplain resources. USFWS is developing guidelines for a detailed function-based stream assessment method, a rapid field function-based stream assessment method, and a stream restoration design review method for typical projects in Maryland. The Service will also develop and deliver training on the methods. Training will be held in September 2014. The training is adapted from on the guidelines provided in the document: *A Function-based Framework for Stream Assessment and Restoration Projects* (Harman et al., 2012) (Stream Functions Framework).

B.2.6 Drinking Water Supply and Protection

MDE is charged with ensuring that all Marylanders have a safe and adequate supply of drinking water. The Department has programs to 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. More information on Maryland's Water Supply Programs can be found at http://www.mde.state.md.us/WaterSupply.

B.2.7 Corsica River Targeted Watershed

The Corsica River Watershed Project is a pilot program designed to demonstrate that a tidal tributary of Chesapeake Bay can be successfully restored. The goal of this targeted watershed restoration is to remove the Corsica River from the Impaired Waters List. For more information, go to http://www.corsicariver.com.

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 continues to be a nexus for Maryland's water quality restoration activities. The Interagency TMDL Workgroup, chaired by MDE, and which includes the Departments of Natural Resources, Agriculture, Planning and Transportation and the University of Maryland, addresses needs for enhanced coordination between agencies (i.e., Data-sharing, TMDL project selection and review, and TMDL implementation planning, etc.) stemming from the accelerated TMDL production schedule, as well as for federal (Section 319) funding guidance for watershed restoration plans that can be used to develop TMDL implementation plans. State staff also meet regularly with other groups, such as the State Water Quality Advisory Committee and the Maryland Water Monitoring Council, to ensure program coordination with local and federal government agencies, as well as the private sector, academia, and Maryland's citizens.

In 2013, MDE and DNR began the process to update Maryland's Water Monitoring Strategy. This work continues in 2014 as both agencies take the opportunity to reevaluate monitoring goals and objectives to determine if current monitoring programs are still meeting state needs. This process will be used to help document data gaps that the State hopes to fill before the next updates are made to the strategy.

Prioritization Approach for Integrated Report and NPS Management Plan

In December of 2013, EPA finalized its documentation of a Long-Term Vision for Assessment, Restoration, and Protection under the CWA Section 303(d) program (the 'New Vision'), with a focus on demonstrable improvement in water quality for watersheds prioritized by states. The vision goals incorporate the concept of adaptive management, placing an emphasis on the need for states to set their own priorities and pace, and allowing flexibility for states to make decisions regarding their waters' protection efforts.

The New Vision consists of six elements or goals, which, along with their expected timelines for adoption by the states, are specified by EPA. The elements are enhanced Engagement (beginning 2014); watershed Prioritization (2016); Protection (2016); programmatic Integration (2016); incorporation of TMDL Alternatives (2018), and Assessment (2020). Overall evaluation will take place in 2022. Details of the New Vision, and full descriptions of these elements, are available from EPA at http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/programvision.cfm.

The Prioritization goal, as the foundation to guide planning and implementation of the other goals, requires that by 2016, states review, prioritize, and report priority watersheds or waters for restoration and protection. To that end, Maryland is establishing methodology to prioritize the State's watersheds for TMDL development, TMDL revision and, where appropriate, alternative means of protection and restoration. In keeping with the Engagement goal, MDE is developing this methodology in a transparent manner, and it will be documented in the 2014-2015 Annual Report and Workplan that MDE will submit to EPA in October 2014 as established in the 2012 Memorandum of Understanding between Maryland and EPA (MOU). By 2016, MDE will set a pace for development of these TMDLs for the period spanning 2016-2022, when states will evaluate accomplishments. MDE will maintain its commitments and responsibilities to address impaired waters as outlined in the 2012 MOU.

B.3 Cost/Benefit Assessment

One specific reporting requirement of the Clean Water Act 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.

B.3.1 Program Costs

A substantial level of federal funding for water pollution control efforts comes from some agencies (US Environmental Protection Agency) 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 3.

While some new water programs are occasionally initiated, overall, there has been a general decline of federal funding available to states for various water quality-related programs. The figure below shows a summary of EPA budget data from traditional water grants (Clean Water Act §106, §319, §104b planning, wetlands, targeted watersheds, public water supply, and beach monitoring).

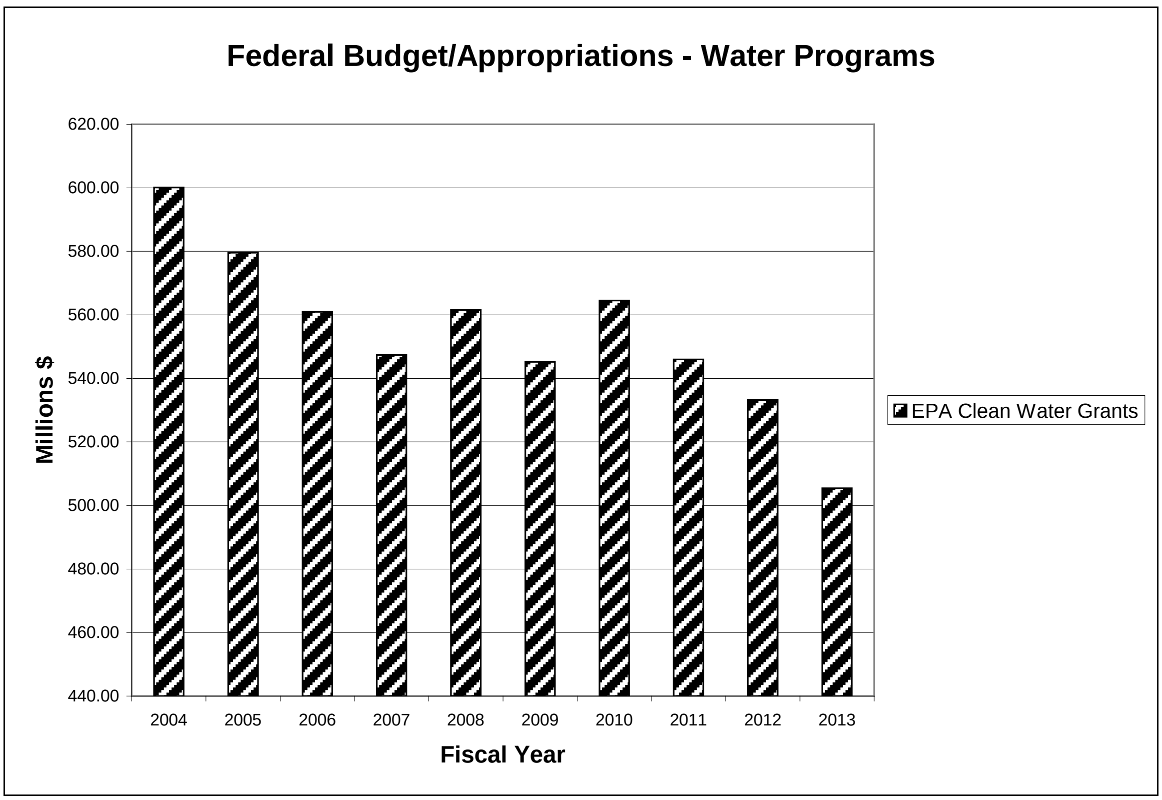

Figure 3: Federal Budget Appropriations to Water Programs (2004-2013). (Source: Association of Clean Water Administrators (ACWA) FY2014 Funding Chart)

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 4.

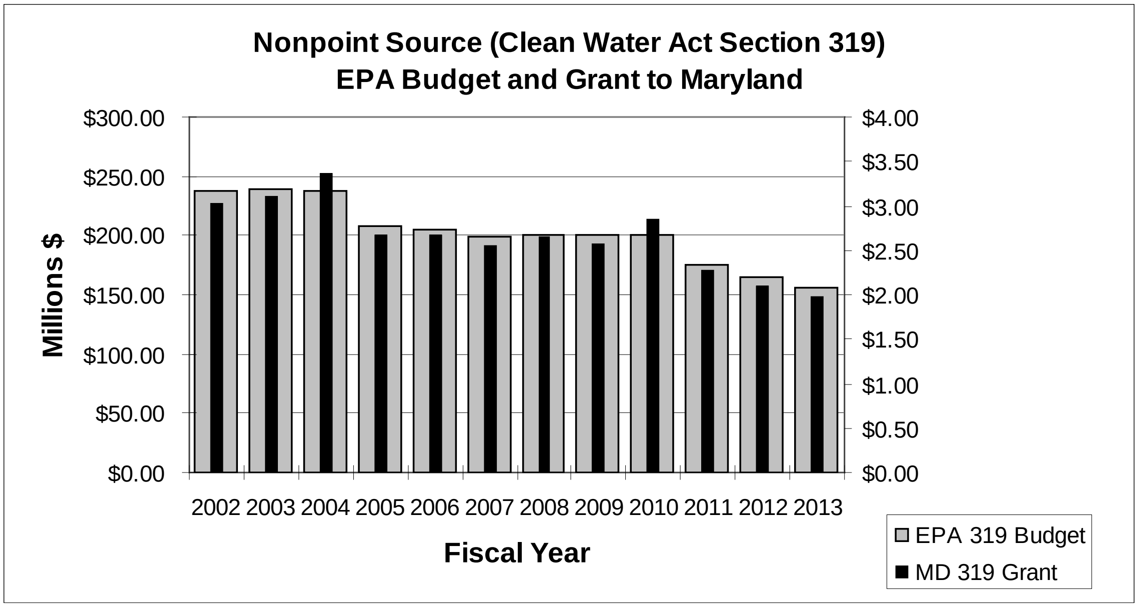

Figure 4: Federal nonpoint source total budget allocation including the Maryland totals. (Sources: Association of Clean Water Administrators FY2014 Report and MDE's 319 Annual Report)

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. But while 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, more than 500,000 Maryland residents are anglers (about one in 10) and residents comprise 70 percent of the State's anglers. In 1996, these anglers spent $475 million in the State on fishing expenses - an average of $664 per angler per year. Most of these expenses (56 percent) were trip-related (food, lodging, transportation, equipment rental). Equipment costs accounted for another large portion (39 percent) and other items (membership dues, magazines, permits, stamps and leases) amounted to $27 million (US Fish and Wildlife Service, 1998).

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 Clean Water Act. 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 the major focal point for water quality planning and restoration efforts across the State. Since the Chesapeake Bay TMDL was finalized in December 2010, states have completed both Phase I and Phase II Watershed Implementation Plans (WIP) which effectively allocate the nutrient and sediment reductions necessary to support the water quality goals for the Chesapeake Bay and tidal tributaries. To help local jurisdictions with this effort, the State developed the Maryland Assessment Scenario Tool (MAST) which allows users to estimate nutrient and sediment reductions based on different Best Management Practice (BMP) scenario inputs. In addition, Maryland continues to measure progress in achieving the two-year milestones that serve as interim goals to help track Maryland's progress in restoring the Bay. Results show that, as of April 2014, Maryland is already exceeding its 2015 milestone goals for cover crop enrollment, riparian buffers on private land, and air pollution reductions.[4] Still, much work needs to be done as other goals for agriculture, urban areas, and public land restoration have not yet been met. In addition, recent legal challenges to the Chesapeake Bay TMDL threaten the progress made by the Chesapeake Bay partnership. Regardless, Maryland stands steadfast in its support of the Bay TMDL and the effort to restore this iconic body of water.

In addition to the Chesapeake Bay work, Maryland is increasingly engaged in protecting its high quality waters. Over the past several years, MDE has continued its outreach to local governments by identifying high quality waters in their jurisdictions needing special protection (COMAR 26.08.02.04) and raising awareness on the need for antidegradation reviews. Maryland also continues to review wetlands and waterways permits and water and sewer plans to ensure that Tier II waters receive adequate protection to maintain high quality status. Maryland also continues its targeted watershed work utilizing the 319 Nonpoint Source Program and the Chesapeake Bay and Atlantic Coastal Bays Trust Fund. Both funding programs provide grants and assistance to organizations interested in completing water quality restoration projects. Worth noting, Governor O'Malley's 2014 Fiscal Year State Budget includes $68 million in funding for the Chesapeake Bay and Atlantic Coastal Bays Trust Fund which represents an approximate six-fold increase in funding since inception.[5]

Maryland faces many emerging issues in the effort to reduce the amount of pollutants entering state waters. An ongoing concern is the detection of endocrine disrupting chemicals in Maryland waters. These chemicals are being studied for effects on fish reproduction and, in some cases, have been linked to low reproductive success. These substances will be increasingly investigated to determine the magnitude of their effect on fish stocks and whether it is feasible to control them at the source. Another emerging water quality issue is the salinization of state fresh waters due to road salt application. Spikes in stream conductivity and declining aquatic biological communities have been linked to increasing chloride levels throughout the State. In response, MDE is currently developing draft ambient chloride criteria to better assess and protect our flowing waters.

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[4] From Maryland BayStat web site at http://www.baystat.maryland.gov/
[5] From the Maryland Chesapeake Bay and Coastal Bays Trust Fund web site at: http://www.dnr.maryland.gov/ccs/funding/trust_fund.asp.

Another notable development is that the Maryland State Legislature recently (2014) passed HB 118 that establishes a task force to study the impacts of ocean acidification on state waters. This task force will analyze the current scientific findings on this subject and provide recommendations for strategies to mitigate acidification impacts on state waters.

Maryland also continues to advance the study of Marcellus shale gas (methane) extraction through the Marcellus Shale Safe Drilling Initiative. The initiative and task force were created to provide information and recommendations, in the form of a three-part study, to state policymakers to address the environmental and human health risks associated with drilling in Marcellus shale. So far, Maryland has completed Part 1 of the study which provides recommendations for establishing revenue sources and standards of liability for gas exploration and drilling. Part 2 focuses primarily on providing recommendations for best practices for Marcellus shale drilling. The draft version of Part 2 recently underwent public review and should be finalized soon after addressing public comments. The third and final part of this study will be finalized in August 2014 and will address findings and recommendations concerning the impact of Marcellus shale drilling to groundwater quality, disposal and handling of wastewater, forest and ecological resources, greenhouse gas emissions, and economic development.

Maryland continues to meet its commitments to EPA and other stakeholders in developing Total Maximum Daily Loads for restoring impaired waters. However, to achieve its water quality goals, Maryland will have to find more effective ways to ramp up both restoration and protection efforts. The limiting factors for making restoration progress continue to be funding constraints and unsustainable growth patterns. The State's efforts to increase environmental funding as well as current efforts to better align monitoring and assessment programs through a coordinated state monitoring strategy will help to address these limiting factors. Meanwhile, new development in suburban and rural watersheds threatens the progress being made in other areas by creating new pollution sources. A statewide policy called "PlanMaryland" will help to guide future development toward existing urban centers but local governments will need to embrace this vision if growth patterns are to be significantly changed. To protect water quality, the State must continue to implement its antidegradation policy for high quality waters as well as develop clarifying guidance and regulations consistent with both water quality goals and the State's Smart Growth Initiative. To do this effectively, Maryland will have to work more closely with local jurisdictions and the public and be willing to face any associated legal challenges.

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 (http://www.mde.state.md.us/programs/ResearchCenter/EnvironmentalData/Documents/www.mde.state.md.us/assets/document/Maryland_Monitoring_Strategy2009.pdf). Maryland's water quality monitoring programs are designed to support State Water Quality Standards (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 current 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 during the recent recession as declining monitoring budgets have increased the need for greater monitoring efficiency. In the fall of 2013, MDE and DNR began to update this strategy to reflect changing needs and priorities. The strategy will incorporate new monitoring priorities and enhanced data sharing so as to make more efficient use of limited monitoring resources.

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 water quality standards (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. The public is invited to review and comment on any of these methodologies during the public review period for the Integrated Report.

For the 2014 reporting cycle, changes were made to the bacteria and biological assessment methodologies. The bacteria assessment methodology has now been merged with the previously separate methodology for combined and sanitary sewer overflows. The previous "combined and sanitary sewer overflow" assessment methodology addressed waters that did not have ambient bacteria data but which did have information on the frequency of sewer overflows. Since the assessment goals for both of these methodologies (the bacteria and the combined and sanitary sewer overflows methodologies) were complementary (they both assess support of water contact) they were simply merged to provide better continuity and consistency. In addition, this now combined methodology also includes new language in the beach assessment section to further clarify the assessment process for beaches. The full text of this methodology is provided in Section C.2.1 below.

It is worth noting that in the first draft of the 2014 Integrated Report (IR) available for public review, changes were proposed to the Toxics Assessment Methodology that sought to clarify assessment protocols when water column and fish tissue data were available for assessing the fishing designated use (specifically organism consumption). These changes were ultimately scrapped due to concerns about independent applicability and the methodology was returned to its previous form as it existed in the 2012 IR. To read the full text of the revised toxics assessment methodology please visit: http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/ToxicsAM2014.pdf.

For the 2014 Integrated Report (IR), it was necessary to revise the Biological Assessment Methodology in order to incorporate county-collected biological data as part of the 8-digit watershed assessments. For the first time ever, state assessors integrated Baltimore and Frederick County biological data with state data (Maryland Biological Stream Survey, MBSS) to improve the accuracy and spatial coverage of watershed assessments. To integrate this data properly state assessors had to take into account both spatial and sampling[6] differences between the MBSS dataset and county datasets. Since the counties sampled only within their borders and because some 8-digit watersheds cross county boundaries, MDE established a geographic weighting procedure. This procedure weights county data according to the proportion of stream miles in a watershed that are within that county's boundaries. Doing this ensures that the county data, which may be concentrated in one geographic portion of the watershed, does not bias the assessment of the entire 8-digit watershed. The main sampling difference between state-collected data and county-collected data are that these counties do not collect fish community data as part of their bioassessments. To account for this, MDE developed a multi-step assessment process that runs two independent analyses, one which assesses MBSS data alone (both fish and benthos) and another that assesses only benthic data from MBSS and the county (county data are weighted). In the final step of the assessment process the results from these two analyses are compared to determine the appropriate listing category. Concurring results provide greater confidence in the final assessment and corresponding Category (e.g. 2, 3, 5, etc) assignment. Results that conflict will be moved to Category 3 (insufficient information) or Category 5 (impaired, may need a TMDL) depending on the underlying circumstances and then prioritized for additional data collection.

Another revision made to the Biological Assessment Methodology was the removal of language under the "Data Limitations" section that established a 10-year cutoff date for excluding older biological data. Unfortunately, following this rule led to many watersheds throughout the State having inadequate sample sizes for assessment. As a result, MDE chose to include older data (e.g. all of Round One MBSS data, sampled between 1995-1997) in the 2014 biological assessments and commits to re-evaluating watershed sample sizes in the future. To read the full text of the newly revised Biological Assessment Methodology for Non-tidal Streams, please see Section C.2.3 below.

Another important development related to Maryland's Biological Assessment Methodology was the creation of a complementary document entitled "MDE Requirements for Use of In-Situ Biological Stream Data". This new set of guidelines helps to clarify MDE's data quality requirements for accepting and using biological data for regulatory purposes, which include, but are not limited to: water quality criteria development, Integrated Report assessments, TMDL development, Tier II high-quality water determinations, and measuring NPDES permit or 401 certification compliance. These new guidelines are provided in full text in Section C.2.4.

[6] The MBSS collects both benthic macroinvertebrate and fish data so as to produce corresponding indices of biotic integrity. Baltimore and Frederick Counties limit their data collection to benthos alone.

The last major development in Maryland's assessment methodologies (for 2014) was a temperature assessment methodology designed to evaluate support of temperature criteria in Use Class III and III-P (coldwater) streams. The full text of this new methodology is provided below in Section C.2.5. This and all other assessment methodologies are also available on MDE's Web site at http://www.mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/programs/waterprograms/tmdl/maryland%20303%20dlist/ir_listing_methodologies.aspx. The public is invited to review and provide comments on any of the assessment methodologies on this web page. All comments should be submitted in writing to Matthew Stover at matthew.stover@maryland.gov.

C.2.1 Assessment Methodology for Identifying Waters Impaired by Bacteria in Maryland's Integrated Report

Introduction

MDE routinely monitors shellfish harvesting waters for fecal coliform bacteria and conducts pollution source surveys to ensure that shellfish harvested in Maryland are safe for human consumption. In addition, MDE coordinates the State's Beach bacteria monitoring program. Beach sample collection and notification of advisories is delegated to the Counties, in order to protect public health at Maryland's designated bathing beaches.

Fecal indicator bacteria are used in these programs since monitoring for actual pathogens is not feasible. It is assumed that if fecal indicator bacteria are present, then human pathogens may also be present. Since the primary goal of both the Shellfish and Beach programs is to ensure that public health concerns are addressed in a timely fashion, ongoing management decisions by these programs are designed to be overly conservative. One such example is that beach advisories may be based on a single sampling event. However, bacteriological indicators are known to be variable in the environment and a single high measurement does not always coincide with fecal contamination. For this reason, this assessment methodology, developed for conducting Integrated Report (IR) assessments, will make use of larger sample sizes before making impairment determinations that could result in a Total Maximum Daily Load (TMDL). Doing this allows MDE to continue to protect public health in a timely fashion (by both the Shellfish and Beach programs) but also allows for a higher level of confidence to be used prior to initiating a potentially costly TMDL development process. This helps to enhance the accuracy with which impairment determinations are made and enables the Department to focus on the highest priority impairments first.

The rules used by MDE to interpret bacteria data and apply the water quality standards are discussed below in four sections. The first section generally describes the protocols that MDE uses. The second and third sections describe how bacteria monitoring data are assessed to determine support of the shellfish harvesting designated use and the water contact recreation use, respectively. The fourth section describes how MDE, in the absence of bacteria monitoring data, will use information on sewage overflows to assess waters with a high likelihood of bacterial contamination.

I. Protocols

Data collected and analyzed using approved methods (Food & Drug Administration (FDA) or EPA) and in accordance with strict QA/QC guidelines may be utilized for decision making with respect to designated use support status. All available data will be considered but may be used for prioritization, additional study, or revised monitoring. In all cases, it is critical that bacteria sampling be carried out in a way that is representative of conditions in time and space. Per EPA's *Ambient Water Quality for Bacteria - 1986*, the calculated "densities are for steady state dry weather conditions." A sampling event means samples taken at a beach, or other waterbody to characterize bacterial concentrations with the number and placement of sampling stations sufficient to characterize conditions in the full extent of the beach area or waterbody. High spatial and temporal variability suggest that infrequent or moderately elevated bacteriological levels alone do not necessarily represent a human health risk or impairment. The bacteriological standard is descriptive and includes numerical criteria. The intent of this methodology is to allow the 'number' to be judged in conjunction with the sanitary survey that identifies probable sources of bacteria and allows regulators to assess the probability of human health risk. The methodology recognizes the inherent variability of the bacterial measurement and recognizes the inadequacies of indicator organisms. The Most Probable Number (MPN) or Colonies Forming Units (CFU) test used to determine the level of bacteria is not a direct count but a statistical estimation subject to a high degree of variability.

The current analytical methods used for bacteria sample analysis are specific to the use being evaluated (e.g. shellfish harvest vs. swimming). For the shellfish harvesting use, FDA has approved the Multiple Tube Fermentation method which measures fecal coliform as MPN/100 ml. For evaluating the recreational use, EPA has approved two methods; the membrane filtration (MF) method and the most probable number (MPN) method. However, in Maryland, the most commonly used tests for recreational waters are both MPN methods; the ONPG-MUG (Colilert) test measures *E. coli* and the MUG media (Enterolert) test measures Enterococci.

II. Interpretation of Fecal Coliform Data for Assessing Use II Shellfish Harvesting Areas

The indicator and criteria used for shellfish (bivalve molluscan shellfish only) harvesting waters is established by the National Shellfish Sanitation Program (NSSP) and is promulgated in Code of Maryland Regulations (COMAR) 26.08.02.03-3. In order to demonstrate support of the shellfish harvesting designated use, the measured level of fecal coliform in water (expressed as MPN/100 ml) must have a median of less than 14 and a 90th percentile of less than 49, calculated from a minimum of 30 samples taken over a three year period. MDE conducts routine bacteria water quality sampling and pollution source surveys to assess shellfish harvesting areas so that waters can be assigned to one of three classifications used for protecting shellfish consumers. The following sections describe the different shellfish area classifications and how these classifications relate[7] to assessment categories on the Integrated Report.

[7] Please note that shellfish area classifications do not directly relate to bacteria water quality. In some cases, certain shellfish area classifications are made based on administrative protection measures and not water quality data. In all cases, shellfish areas are assigned to categories on the Integrated Report (IR) based on water quality data alone.

A. Restricted: A restricted classification for shellfish waters means that no shellfish harvesting is permitted in those waters. This classification is used in the following three scenarios:

1. Shellfish harvesting areas that do not meet the NSSP bacteria water quality standards described above will be classified as restricted and listed as impaired in Category 4 or 5 (depending on whether a TMDL was completed or not) of the IR.

2. Shellfish harvesting waters located in the vicinity of wastewater treatment plant (WWTP) outfalls are classified as restricted as a preventative public health protection measure and is required under the NSSP. Administrative closures of this type are not based on a water quality assessment but are designed to establish a protective buffer area in case of a system failure. Shellfish waters classified in this way but which have no evidence of actual bacteriological impairment are NOT listed as impaired (in Category 4 or 5) in the IR. MDE regularly evaluates treatment plant performance and its impact to shellfish harvesting waters. If bacteria data shows violations with State standards (notwithstanding the fact that the area is under an administrative closure or restriction) it will be listed appropriately on the impaired (Category 4 or 5) part of the IR.

3. The upper Chesapeake Bay is another area restricted to shellfish harvesting for administrative reasons which are not based on water quality readings. This area has insufficient shellfish resource for harvesting due to the fresh water input from the Susquehanna River. Since there are no oysters or clams to harvest and the NSSP requirements for sanitary survey are not met, the area is classified as restricted. In this case, retaining the shellfish harvesting water designation helps to protect shellfish waters directly downstream from this area. Water quality is routinely monitored in this area for fecal coliform, however, regardless of the result; this area will continue to have a restricted classification. If bacteria data demonstrates that State standards are being met, this area will not be listed as impaired (Category 4 or 5) on the IR. If bacteria data shows violations with State standards (notwithstanding the fact that the area is under an administrative closure or restriction) it will be listed as impaired (Category 4 or 5 of the IR) on the IR.

B. Conditionally Approved Waters: Certain shellfish harvesting areas are classified as conditionally approved and are closed to harvesting for three days following a rainfall event of greater than or equal to one inch in twenty-four hours. This classification has been assigned to certain shellfish waters based on previous studies which showed that after a 1 inch rainstorm, bacteria levels exceeded State standards for a period lasting up to two days. In these studies it was found that elevated bacteria levels were due to runoff which could not be traced to any source with public health significance. However, as a conservative management practice, no shellfish harvesting is permitted in these areas for three days following such a rainfall event. Conditionally approved harvesting areas generally meet the bacteriological water quality criteria at all other times and shellfish can be harvested from these areas when in the open status (other than three days following a rain event of one inch in twenty four hours). Therefore, these areas are not listed as impaired (Category 4 or 5) in the IR and are placed in Category 1 or 2 of the IR.

C. Approved Waters: Waters classified as approved for shellfish harvesting meet the water quality standards for shellfish harvesting waters and are placed in Category 1 or 2 (meeting water quality standards) of the IR.

D. Shellfish Waters – Geographic Scale of Assessment

For the purposes of the Integrated Report, MDE will georeference shellfish harvesting impairments as polygonal bodies of water within the larger estuarine waters (i.e. Chesapeake Bay segments, Coastal Bays, etc). The shape of these ‘polygonal’ areas of estuarine water will be determined by the spatial arrangement of monitoring stations and by nearby shoreline features.

III. Interpretation of Bacteria Data for Water Contact Recreation Use

A. Maryland has implemented the EPA recommended enterococcus (marine or freshwater) and *E. coli* (freshwater only) standards for all waters except shellfish harvesting waters, where the more stringent NSSP standard must be met.

According to EPA’s *Ambient Water Quality Criteria for Bacteria -1986*, the indicators *E. coli* and enterococcus have been found through epidemiological studies to have the best quantifiable relationship between the density of an indicator in the water and the potential human health risks associated with swimming in sewage contaminated waters. “Indicator organisms are a fundamental monitoring tool used to measure both changes in environmental (water) quality or conditions and the potential presence of hard-to-detect pathogenic organisms. An indicator organism provides evidence of the potential presence or absence of a pathogenic organism that survives under similar physical, chemical, and nutrient conditions. (EPA Beach Guidance, June 2002).

Maryland’s bacteria indicator criteria are conservative measures, which protect the public from the potential risks associated with swimming and other primary contact recreation activities. These criteria are used during the beach season by beach managers to issue advisories and to notify the public. A few high values of the indicators may or may not be indicative of impairment. Therefore, it is necessary to evaluate the results from indicator organisms from multiple sampling events over time to adequately quantify water quality conditions.

Maryland generally classifies recreational waters into two main divisions; beaches and other recreational waters. Beaches are typically monitored more frequently than other recreational waters due to the frequency of use. Sections II.B. and II.C. further describe the differences between these divisions. However, it is worth noting that, for the purposes of the Integrated Report, both recreational water divisions are assessed using the same protocols detailed in Section II.D.

B. Beaches

Beaches are designated as “Beaches” from Memorial Day through Labor Day (Beach Season). During this time period, beaches are monitored closely using a tiered approach based on risk to human health from known pollution sources and frequency of use. High, Medium, and Low priority beaches are monitored weekly, biweekly, and monthly, respectively. Low priority beaches are re-evaluated regularly to determine if they should be prioritized higher or removed from the list of beaches. This ensures that all beaches will have the necessary number of sampling events needed to perform an adequate assessment.

MDE has delegated the authority for designating beaches, monitoring beaches, and notifying the public regarding beach water quality conditions to local health departments. Local health departments can make administrative decisions to add or remove beaches based on the level of use. To do so, health departments must submit correspondence (form) to MDE notifying the Department of their intention. When a local health department removes a bathing area from the list of beaches, it also effectively removes the beach/bathing area from Category 4 or 5 of the IR, if the beach was previously listed as impaired. This is done to avoid having to monitor a waterbody for contact recreation support when, in reality, the waterbody is not used for such activity.

MDE's role in this process is to assure that beaches state-wide are managed uniformly. MDE maintains a database of all designated beaches in Maryland including latitude and longitude coordinates of the endpoints identifying the beach segment, annual sanitary survey information provided by the local health departments, and monitoring results (all beach monitoring samples are submitted to the Department of Health and Mental Hygiene (DHMH) for laboratory analysis). This data, along with all other available data will be used to determine which areas are to be listed as impaired.

C. Other Recreational Waters (Non-Beaches)

Other waters, besides designated beaches, may be assessed for the water contact recreation use. Such waters may include non-tidal flowing waters or portions of estuarine waters. The frequency of use as well as the scale of assessment for these waters can vary widely. Some examples of such waters included in the 2012 Integrated Report include the nontidal watersheds Double Pipe Creek and Anacostia River as well as the estuarine segments, Furnace and Marley Creek.

D. Assessing Support of Water Contact Recreation Use

The listing methodology for water contact recreation use waters applies to both beaches and other recreational waters.[8]

Step 1 - A steady state geometric mean will be calculated with available data from the previous year where there are at least 5 representative sampling events. The data shall be from samples collected during steady state, dry weather conditions[9] and during the beach/swimming season (recognized as Memorial Day through Labor Day) to be representative of the critical condition (highest use). If the resulting steady state geometric mean is greater than 35 cfu/100 ml enterococci in marine/estuarine waters, 33 cfu/100 ml enterococci in freshwater or 126 cfu/100 ml *E. coli* in freshwater, the water body will be included for further assessment in Step 2. If there are fewer than 5 representative sampling events for an area, data from the previous two years will be included in the dataset for evaluation. If any bacteria criteria is exceeded, that beach or recreational area will be included for assessment in Step 2. All beaches or recreational areas that meet the aforementioned criteria will be considered "not impaired".

Step 2 – Once a preliminary list is assembled, a steady state geometric mean will be calculated with available data from previous years going back no more than five years. The data shall be from samples collected during steady state, dry weather conditions and during the beach/swimming season (Memorial Day through Labor Day) to be representative of the critical condition (highest use). If the resulting

[8] The single sample maximum criteria in Code of Maryland Regulations applies only to beaches and is to be used by beach managers for closure and advisory decisions based on short term exceedences of the geometric mean portion of the standard. It will not be used for Integrated Report assessments.

[9] Steady state, dry weather conditions are not met for a sampling event if the area being assessed has received an inch or more of rainfall over a 24 hour period within 48 hours of the bacteria sampling event.

geometric mean is greater than 35 cfu/100 ml enterococci in marine/estuarine waters, 33 cfu/100 ml enterococci in freshwater or 126 cfu/100 ml *E. coli* in freshwater, the water body will be listed on Category 3 (insufficient information) of the IR as requiring more data (Step 3). In some cases, the assessor may take into account whether bacteria levels are increasing or decreasing as this may indicate improving or worsening conditions. In all cases, MDE retains the ability to use best professional judgment in determining the appropriate assessment category.

Step 3 - Category 3 of the Integrated Report
Once waters are listed on Category 3 of the IR, an intensive sanitary survey must be conducted to identify potential sources of pathogenic bacteria. If the sanitary survey identifies significant sources of pathogenic bacteria and they are not corrected before the end of the next listing cycle, the waters will be moved to Category 5 of the IR (impaired, TMDL required). If the sanitary survey is conducted and all potential sources of pathogenic bacteria are remedied, the waters will be moved from Category 3 to Category 2 (meeting this particular water quality criterion) of the IR. If a sanitary survey is not conducted before the next listing cycle, the waters will be moved from Category 3 to Category 5.

Step 4 - Category 5 of the Integrated Report (Impaired, TMDL required)
For waters listed under Category 5 of the IR, a sanitary survey must be conducted if it was not conducted before or after the waters were listed on Category 3 of the IR. A water body can be removed from Category 5 of the IR and placed in Category 2 if it meets both of the following conditions:
(a) it meets the steady state geometric mean standard referenced in Step 1 AND,
(b) a sanitary survey is conducted at the water body and there are no sources of pathogenic bacteria found, or if sources of pathogenic bacteria are remedied.

E. Geographic Scale of Assessment

Beaches - For the purposes of the Integrated Report, waters identified and assessed as beaches will be georeferenced as linear stretches of water, having only the dimension of length. As a result, the water body size reported for beaches will be expressed in miles. Since bathing beaches are typically narrow bands of water where water contact recreation occurs, this will help focus the georeferencing process to those areas of shoreline where beach access occurs.

Recreational Waters (not beaches) - Recreational waters, as the term is used here, generally refers to non-tidal flowing waters that may, from time to time, be used for full body contact recreation. For the purposes of the Integrated Report, when a bacterial monitoring station is assessed on non-tidal flowing waters, all upstream waters within the Maryland 8-digit watershed will be georeferenced as having the same assessment result. The only exception to this rule will be when there is an in-stream impoundment that significantly alters flow up and downstream of the dam. Recreational waters can also include tidal waters that may have had special assessments completed outside of the normal beach monitoring program. Waters such as the Baltimore Harbor and Marley Creek are two examples. Assessments for these waters will be based on the spatial arrangement of monitoring stations and any nearby shoreline features. As a result, the geographic depiction of these assessments will show a polygonal body of water.

IV. Sewage Releases

Certain areas of the State served by aging public sewer systems experience periodic sewage releases, most often occurring due to rain events. Bacteria released during single or rare combined sewer overflows (CSO), sanitary sewer overflows (SSO) or other releases will dissipate naturally after several weeks. However, repeated sewage releases of significant size may result in violations of the water quality standards, particularly if the volumes are large or frequent and the water bodies are small, slow-moving or poorly flushed. Under such spill conditions, violations are presumed to have occurred even in the absence of actual monitoring data. If a TMDL is scheduled to be developed for a water body that has previously been identified as impaired, additional data relative to spill events will be collected. Regardless of such documented spill events, if water quality is consistent with the bacterial standard, a Water Quality Analysis or delisting (removal of a water body from the impaired part of the IR) demonstrating the lack of such an impairment will be completed (rather than a TMDL). However, if data indicate that water quality standards are not being met, a TMDL will be completed.

Methodology

Based on data in Maryland's Reported Sewer Overflow Database, if any water body segment has received three or more spills of greater than 30,000 gallons within the previous 5-year assessment period, that water body will be considered impaired. This listing methodology will be applied only in the absence of bacteria monitoring data. If such monitoring data are available, the appropriate decision methodology for bacteria (shellfish harvesting areas or water contact recreation areas) will apply.

References

National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish. 2011 Revision. U.S. Food and Drug Administration. Accessed on August 27, 2013 at: http://www.fda.gov/downloads/Food/GuidanceRegulation/FederalStateFoodPrograms/UCM350344.pdf.

United States Environmental Protection Agency, Ambient Water Quality Criteria for Bacteria - 1986, Office of Water Regulations and Standards Criteria and Standards Division, Washington, DC 20460, EPA440/5-84-002, January 1986.

United States Environmental Protection Agency, National Beach Guidance and Required Performance Criteria for Grants, Office of Water (4305T), Washington, DC 20460, EPA-823-B-02-004, June 2002.

C.2.2 Toxics Assessment Methodology – No Revisions Adopted

In the first publicly available draft of the 2014 IR, MDE proposed revisions to the Toxics Assessment Methodology to clarify assessment procedures for fish consumption assessments when both water column and fish tissue data were available. Due to concerns regarding independent applicability these revisions were scrapped and the methodology returned to its former state.

The full text of the toxics assessment methodology is available at: http://www.mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/ToxicsAM2014.pdf.

C.2.3 Biological Assessment Methodology for Non-tidal Wadeable Streams

Please note that alphanumeric section headings for this methodology are separate and distinct from those used throughout this document [the 2014 Integrated Report (IR)].

I. BACKGROUND

As mandated by the Clean Water Act (CWA), the Maryland Department of the Environment (MDE) is required to describe the methodology used to assess use support and define impaired waters (CWA Sections 305b/303d). The assessment methodology should be consistent with the State's WQSs, describe how data and information were used to make attainment determinations, and report changes in the assessment methodology since the last reporting cycle (US EPA 2006). This document describes how biological data are assessed for the purposes of the Integrated [combined 303(d) and 305(b)] Report. The methodology considers all existing and readily available data and information, and explains the analytical approaches used to infer watershed conditions at the 8-digit scale.

All of the State's waters must be of sufficient quality to provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allow for recreational activities in and on the water (40 CFR §130.11). Biological criteria (biocriteria) provide a tool with which water quality managers may directly evaluate whether such balanced populations are present. Maryland's biocriteria use two multi-metric indices of biological integrity (IBI); one based on fish communities (F-IBI) and the other on benthic (bottom) macroinvertebrate communities (B-IBI). These indices are developed from reference sites that consider regional differences in biological communities. These indices, as described below, are based on characteristics of fish and benthic communities commonly used to assess the ability of streams to support aquatic life, and can be calculated in a consistent and objective manner. Both indices will be used in Maryland to evaluate biological data for the Clean Water Act requirements.

The Maryland Department of Natural Resources' (DNR) Maryland Biological Stream Survey (MBSS)[10] program, on which these biocriteria methods are based, uses a statewide probability-based design to assess the biological condition of first-, second-, third-, and fourth-order, non-tidal streams (determined based on the solid blue line shown on U.S. Geological Survey 1:100,000-scale maps) within Maryland's 8-digit watersheds (Klauda et al. 1998, Roth et al. 2005). To date, the MBSS has completed three rounds of sampling between 1995 and 2013: the first round of MBSS sampling was designed to assess major drainage basins (i.e., Maryland 6-digit) on 1:250,000-scale maps; and the second and third rounds were designed to assess smaller (i.e., Maryland 8-digit) watersheds on 1:100,000-scale maps. The use of random assignment of sampling locations within the population of first- through fourth-order streams supports the assessment of all of the State's waters.

For the purposes of the Integrated Report (IR), the results of biological sampling will be applied at the Maryland 8-digit watershed level. If a watershed is determined to be impaired, corrective action must be taken. That action may begin with additional monitoring and evaluation to determine the cause of the impairment (i.e., stressor identification). Once the stressor has been identified, it may be appropriate to develop a TMDL for the stressor.

[10] Data produced by the DNR MBSS constitutes the vast majority of data used for this methodology. In this methodology, the terms "MBSS data" and "State data" will be used interchangeably so as to also allow the use of biological data collected by MDE to serve these same purposes, when appropriate.

II. BRIEF HISTORY OF THE METHODOLOGY AND RATIONALE FOR THE CURRENT APPROACH

The first biological assessment methodology, developed for the 2002 IR, used MBSS data on fish and benthic communities to obtain an average 8-digit watershed IBI score. State assessors used the average watershed IBI scores and their associated confidence limits to determine if a watershed was impaired (Category 5). While this method (i.e. the average IBI score method) provided information on the magnitude of the degradation it did not give an indication of the extent of degradation (e.g., length of stream) found within a watershed, a current EPA requirement for integrated reporting. In addition, this method also utilized a smaller scale assessment process that classified 12-digit watersheds (approximately 10 square miles) as impaired if one low IBI value from one site (i.e., 75 meter sample) was found. This site-level assessment scale negated the advantage of the random monitoring design and the ability to report on the total stream system. Moreover, Southerland et al. (2007) assessed the average variability of the F-IBI and B-IBI scores at different spatial scales, and demonstrated that single site IBI scores were not representative of the 12-digit watershed scale.

Due to the limitations of this first biological assessment methodology, MDE, in coordination with DNR, set out to develop a new methodology to be used in the 2008 IR. This new methodology removed the 12-digit watershed scale assessment and made major changes to how the 8-digit watersheds assessments were conducted. The overarching goals for this new methodology (which has gone relatively unchanged since 2008) were that it:

1. Maintain consistent application at the current water quality management spatial scale (i.e., MD 8-digit watersheds);
2. Maximize the advantages of a probabilistic monitoring design;
3. Include a report on the extent of impact within the stream system (i.e., number of stream miles not supporting the aquatic life designated use);
4. Consider the uncertainty in various components of the assessment approach.

Addressing these four key goals helps to ensure the accuracy of regulatory decisions regarding water quality in Maryland. For goal number one, the advantages of using this assessment scale is that it is (1) consistent with many of the other water quality assessments contained within the Integrated Report; (2) it promotes consistency with subsequent TMDL development; (3) it allows for further spatial refinements during the TMDL development process, where more data may be available; and (4) it supports the use of probabilistically sampled biomonitoring data. Regarding goal number two, states are required by the Clean Water Act to assess all their waters on a regular basis for 303(d)/305(b) purposes. By incorporating a probabilistic monitoring and assessment method, Maryland is able to draw statistical inferences about the quality of all Maryland streams (first- through fourth-order) without the need to conduct census sampling. The MBSS, the State's primary data source for non-tidal biological assessments, helps fulfill this goal due to its stratified random monitoring design which is both meaningful and appropriate for management purposes.

To address the third goal, the biological reporting metric was changed so that now, the extent of degradation in stream miles (or proportion of stream miles) can be applied in assessment, a metric that was unavailable in the previous biocriteria assessment methodology. Identifying the extent of degraded stream miles within an assessment unit is consistent with EPA Integrated Reporting requirements and meets EPA EMAP reporting recommendations. Using a watershed-based approach and reporting the extent of degraded conditions also allows the converse estimate, i.e., the extent of non-degraded or healthy streams. This allows the inclusion and identification of high quality (Tier II) waters that may be present in assessment units (8-digit watersheds) that are listed as impaired.

The fourth and final major goal for the biological assessment methodology was to account for the uncertainty involved with various aspects of biological sampling. Addressing uncertainty is critical to making accurate water quality management decisions that have significant implications on water quality improvement funding. Therefore, the current biological assessment methodology incorporates methods to account for the uncertainty that results from the temporal and spatial variability in the sampling design. Section III visits this topic in more detail.

This biological assessment methodology has remained largely unchanged since the 2008 IR. However, for the 2014 IR, Maryland began incorporating county-collected biological datasets to help bolster State assessments. This effort added new complexity to the process as county datasets were sampled randomly, but only within county borders. In addition, many counties sampled only benthic macroinvertebrate communities rather than both benthos and fish communities (as done by the MBSS). As a result, MDE added an alternate assessment procedure to be used for those watersheds where counties provided high quality biological data (in addition to State data). These new steps help to account for the sampling differences between the MBSS and the county and allow for a statistically valid 8-digit watershed assessment. In order to address the fact that some counties do not collect fish community data, MDE decided to use two independent assessments: one that assesses only MBSS data (both fish and benthos) and another that assesses only benthic data but uses both MBSS and county data. The results from each of these independent assessments are then compared for agreement (e.g. both meeting standards) to determine the appropriate IR listing category (e.g. Category 2, 3, 5). An important part of the benthic-only assessment is the incorporation of a spatial weighting scheme that weights county data according to the percentage of stream miles within an 8-digit watershed that are also within the county. This helps to ensure that an abundance of county data representing only a small geographic area within a watershed will not bias the entire 8-digit watershed assessment.

III. THE FOUNDATION FOR THE WATERSHED ASSESSMENT

Desirable properties for any assessment methodology are clarity and transparency. While water quality evaluations often deal with complex issues, the priorities for this assessment methodology are that it be objective, transparent, and quantitative. Specifically, the revised biological assessment methodology should: 1) use a scientifically defensible numeric indicator (IBI) based on reference sites, 2) produce unbiased results for the assessment units, 3) follow a clear and logical framework and 4) be robust enough to yield the same results when applied by multiple analysts.

The revised assessment methodology uses the scientifically robust F- and B- IBI developed by the MBSS program and documented in Southerland et al. (2005). To obtain unbiased results, the Department invoked a quantitative component to address temporal variability and sampling uncertainty from the MBSS monitoring design. In this report, variability is the year-to-year change in stream conditions that results from non-anthropogenic variation (e.g., climate, hydrology); and uncertainty is the result of inferring condition from the limited number of sites that can be sampled, given available resources. Finally, the assessment method employs an assessment approach that is transparent and can be understood by a wide audience.

A. Reference Sites and Conditions

Reference sites are the foundation for biological assessment. Using reference sites that are minimally disturbed is critical to IBI development because reference conditions define the scoring criteria applied to the individual metrics (Figure 5). Selection of metrics for inclusion in the IBIs is based on how well they distinguish between reference and degraded sites. In Maryland, reference and degraded sites are identified using lists of abiotic criteria. A complete list of criteria for reference and degraded conditions can be found in Southerland et al. (2005).

Once reference sites have been identified, DNR sequestered them into groups at minimal natural ecological variability by geography and stream type. The MBSS dataset provided enough reference sites (approximately 40) for F-IBI development in each of four naturally different stream types: Coastal Plain, Eastern Piedmont, warmwater Highlands, and coldwater Highlands. For the B-IBI, the Highland stratum was not split by temperature because, unlike fish, benthic macroinvertebrates assemblages are not typically depauperate in minimally disturbed coldwater streams.

The MBSS computes the IBI as the average of individual metric scores for a site (see Southerland et al. 2005). Individual metric scores are based on comparison with the distribution of metric values at reference sites within each geographic stratum (Figure 5). Metrics are scored 1 (if < 10th percentile of reference value), 3 (10th to 50th percentile), or 5 (> 50th percentile). The final IBI scores are calculated as the average of the scores and therefore range from 1 to 5.

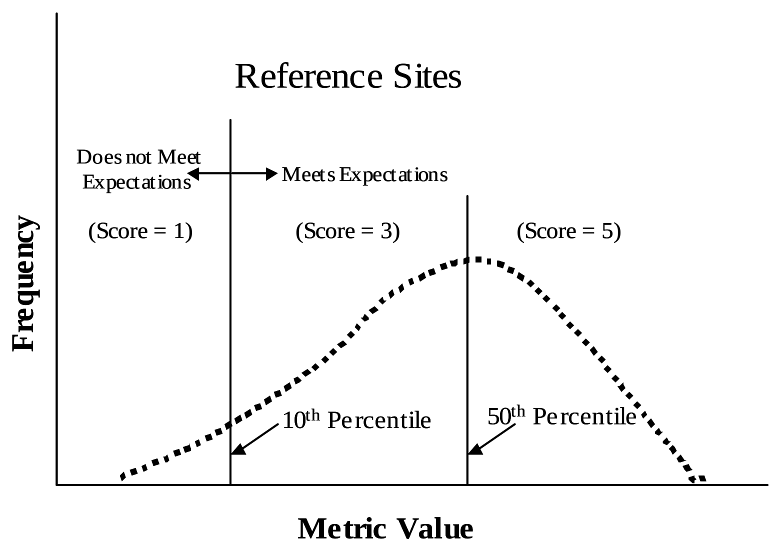


Figure 5: Scoring Criteria based on reference site distribution.

B. Year-to-Year Variability

All streams, regardless of anthropogenic changes, experience natural variability. These changes are a result of variability in precipitation and corresponding flows that result in fluctuation in the physical characteristics of the stream systems (Grossman et al. 1990). MBSS sentinel sites used to evaluate the natural year-to-year variability represent the best (based on physical, chemical and biological data) streams in Maryland. Sentinel sites are present in all regions (Highland, Eastern Piedmont and Coastal Plain) and stream orders (first through third). Most importantly, they are located in catchments that are not likely to experience a change in anthropogenic disturbances over time.

The year-to-year variability of the sentinel sites was examined by comparing the annual IBI values for individual sites over a five-year monitoring period. The coefficient of variation was used to compare site results since this normalizes the site variability to the mean site score. There were a total of 17 sites that had five years of B-IBI scores and 15 sites with five years of F-IBI scores. The average coefficient of variation was approximately 9% for the B-IBI and 13% for the F-IBI. Therefore, it can be expected that over a five-year period the standard deviation of year-to-year IBI scores will vary by 9 – 13% of the mean score.

C. Spatial Uncertainty of Stream Condition

The condition of all streams could in principle be measured through a census (i.e., without the need to resort to inferring condition), but would require visiting every length of stream in the State. The reality is that monitoring cannot be conducted on every foot or even mile of streams in a state due to resource constraints. Also, the sampling of a targeted non-random stream segments does not provide an unbiased estimate on the conditions of streams within a larger assessment unit. Therefore, MDE uses the MBSS dataset, which is a statewide probability-based sample survey, for assessing the biological condition of wadeable, non-tidal streams in Maryland's 8-digit watersheds (Klauda et al. 1998, Roth et al. 2005). MBSS sites are randomly selected from the 1:100,000-scale stream network and sampled within a 75-m segment of stream length. Individual sampling results are considered representative at the 75-m segment, but because of design the data can be used to estimate unbiased conditions of streams within an assessment unit.

Realizing that randomly selected sampling sites may not always proportionately represent the assessment unit in which they are selected; MDE investigated the relationship between the number of sampling sites and the representation of watershed land use heterogeneity (See Appendix A). Generally, it was found that when approximately 10 sites were sampled within a watershed, that the average percent similarity between the number of sites within each land use were 85% similar to the stream mileage found within those same land uses (within the same watershed). Using this information as a guide, and a precision level of 25%, a minimum sample size of 8 samples was developed so as to capture both spatial heterogeneity and sample uncertainty for the watershed assessments.

D. Developing a Target Value for Degradation

Using the scoring criteria at reference sites, an IBI > 3 indicates the presence of a biological community with attributes (metric values) comparable to those of reference sites, while an IBI < 3 means that, on average, metric values fall short of reference expectations. Because a metric score of 3 represents the

10th percentile threshold of reference conditions, IBI values less than 3 represent sites that are suspected to be degraded. In contrast, values greater than or equal to 3 (i.e., fair or good) indicate that most attributes of the community are within the range of those at reference sites. However, Southerland et al. (2005) reported that "good" water quality was found at reference sites with low IBIs and that the distribution of reference and degraded site IBI values overlap, thus sites with a metric below the 10th percentile of reference sites (used for scoring) may have good quality waters. Ideally the State would be able to compute an average site IBI score, based on a minimum of three consecutive years of data, to be compared to the threshold of 3. However, this is rarely possible and therefore, the year-to-year variability will be based on the information from sentinel sites. Given the natural variation of IBI scores in time (observed at sentinel sites), it is expected that a site with an average score of 3 will likely have a distribution of annual values above and below 3 (Figure 6). For these cases the coefficient of variation in combination with an assumed normal distribution is used to determine the minimum detectable difference and the subsequent minimum allowable limit (MAL). The MAL decreases the likelihood of a type I error, classifying a site as degraded when it is actually in good condition, given there is only one sample in time. The following formula is applied to estimate the MAL:

$$MAL = IBI_{avg} - z * IBI_{avg} * CV$$

where

MAL = Minimum Allowable IBI Limit to determine if a site is degraded
IBIavg = Average annual allowable IBI value (3 for B-IBI and F-IBI)
z = Standard normal score (1.28 for 90% one-sided confidence interval)
CV = Coefficient of variation

The minimum allowable limit for the F-IBI is 2.5, assuming a coefficient of variation of 13%, while the minimum allowable limit for the B-IBI is 2.65, assuming a coefficient of variation of 9%.

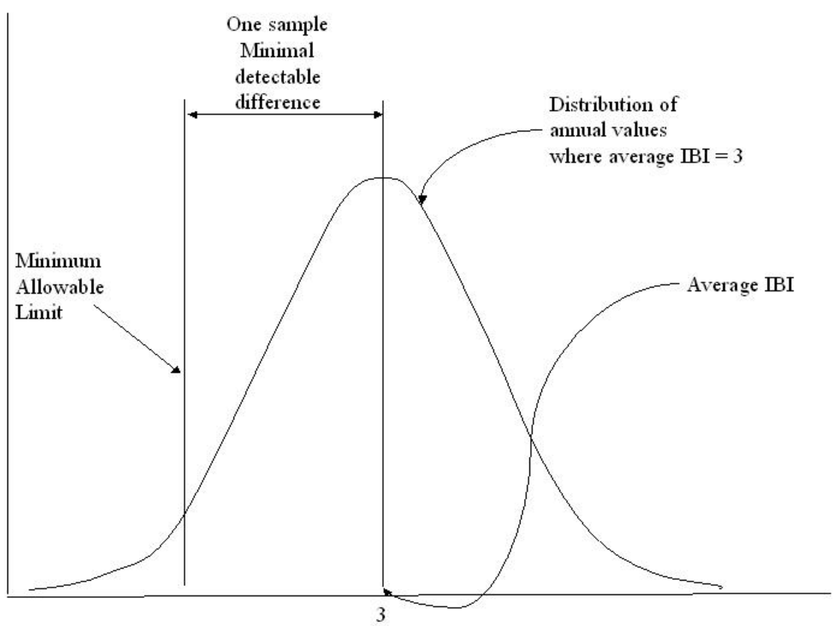


Figure 6: Distribution of annual values at site with average IBI of 3.

E. Watershed Assessment: The Null Hypothesis

The watershed assessment method tests the null hypothesis that the candidate assessment unit (8-digit watershed) does not violate narrative criteria for the support of aquatic life. In the watershed assessment method there is a general sample size provision to ensure that the random monitoring sites generally represent the spatial heterogeneity in the Maryland 8-digit assessment units. This sample size helps control the type II error (false negative - classifying a water body as meeting criteria when it does not) and an alpha level is set to control the type I error (false positive - listing a water body as impaired when it is not).

To test the null hypothesis (i.e., assess a watershed), the exact binomial confidence intervals are calculated using the Pearson-Clopper method and monitoring data in an assessment unit. Calculation of the binomial confidence intervals requires the total number of monitoring sites, the number of sites that are degraded, and the confidence level. The null hypothesis is that the populations of streams in the assessment unit are similar to the population of reference sites, which equates to less than 10% of the streams classified as degraded. A degraded site is defined as a site with either the B-IBI or F-IBI score below the specified threshold of the MAL. With small sample sizes the type II error rate is typically large and can result in accepting the null hypothesis when it is not true (classifying a watershed as meeting criteria when it does not). To reduce the type II error rate, a required precision is specified in the method. The three possible outcomes are as follows:

- Null hypothesis accepted but precision is low: If the lower confidence limit is less than or equal to 10% but half the width of the confidence interval is greater than 25% (low precision), the watershed will be classified as inconclusive and assigned to Category 3 of the Integrated Report and considered for future monitoring.
- Null hypothesis accepted and precision is acceptable: If the lower confidence limit is less or equal to 10% and half the width of the confidence interval is less than 25% (acceptable precision), the watershed will be classified as pass and assigned to Category 2 on the Integrated Report.
- Null hypothesis rejected: If the lower confidence limit is greater than 10%, the watershed will be classified as failing and assigned to Category 5 on the Integrated Report.

To further reduce possible listing errors, the development of the methodology took into account the spatial distribution of the random monitoring sites as compared to the spatial heterogeneity of landscape features in the watershed. To do so, the Maryland 8-digit watershed landscape heterogeneity was determined using landscape clusters (groups of similar landscape conditions) that incorporate land use, land use change, soil erodibility, slope, precipitation, and population density (US EPA 2007). For all assessment units, the distribution of streams within landscape clusters were compared to the distribution of MBSS round 1 and round 2 monitoring sites. Results indicated that, on average, approximately 85% of the heterogeneity in 8-digit watersheds was captured with ten monitoring stations (see Appendix A).

To ensure clarity and transparency, the assessment method was summarized in a simple lookup table (Table 6) below. The table incorporates (1) testing the null hypothesis that the candidate assessment unit does not violate narrative criteria for the support of aquatic life; (2) applying 90% exact binomial confidence intervals; (3) requiring a precision of 25%; and (4) ensuring that the monitoring sites capture the watershed landscape heterogeneity.

Table 6: Biocriteria Assessment Table

Total Number of Random Sites in Assessment Unit	Maximum Number of Degraded Samples in Assessment Unit to be Classified as Pass (Category 2)	Minimum Number of Degraded Samples in Assessment Unit to be Classified as Fail (Category 5)
≤7	1 (a)	3 (b)
8-11	2	3
12-18	3	4
19-25	4	5
26-32	5	6
33-40	6	7
41-47	7	8
48-55	8	9
56-63	9	10
64-71	10	11
72-79	11	12

Notes:

a. If n<=7 and at least 6 samples are not degraded then watershed classified as Pass (Category 2).

b. If n<=7 and 3 or more samples are degraded then watershed classified as Fail (Category 5).

IV. THE BIOLOGICAL ASSESSMENT PROCESS

This section describes the current biocriteria assessment approach which was adapted to allow for the incorporation of non-State data[11] into the 2014 Integrated Report assessments. This process was specifically modified to address two different biological data scenarios: 1) when 8-digit watersheds have only been sampled by the MBSS, and 2) when watersheds have been sampled both by the MBSS and by a non-state government organization (usually county). Figure 7 and Figure 8 illustrate the generalized steps in the assessment process for these two data scenarios. The individual steps (identified alphanumerically in the decision diagrams) are then discussed in greater detail in their corresponding sections (e.g. Step 1, Substep 2b, etc). In general, the assessment methodology has not changed drastically. It still uses the MAL thresholds and the Biocriteria Assessment Table (Table 6) based on confidence intervals to determine the appropriate IR listing categories. The main difference is that for watersheds that have non-state data, the process will involve several more steps that help to account for differences in spatial sampling scale and in indicators[12] assessed. This entire assessment process focuses on assessing the condition of 8-digit watersheds with multiple sites by assessing the percentage of sampling sites that are degraded. Use of the percentage of degraded sampling sites allows for State assessors to approximate the number of stream miles degraded in a sampled watershed.

[11] The use of non-state data is currently limited to those datasets which use the MBSS IBI framework. This helps to ensure comparability with the state-established reference conditions.

[12] Most county biological sampling programs sample for benthic macroinvertebrates and do not include sampling for fish communities.

A. Assessment Process for Watersheds with MBSS Data Only

The following assessment process outlined in Figure 7 is for use for those 8-digit watersheds that have only been sampled randomly by the MBSS (no county data are available). This biological assessment process has remained unchanged from the previous (2012) version. A detailed description of each step shown in Figure 7 is provided in the corresponding numbered sections below.

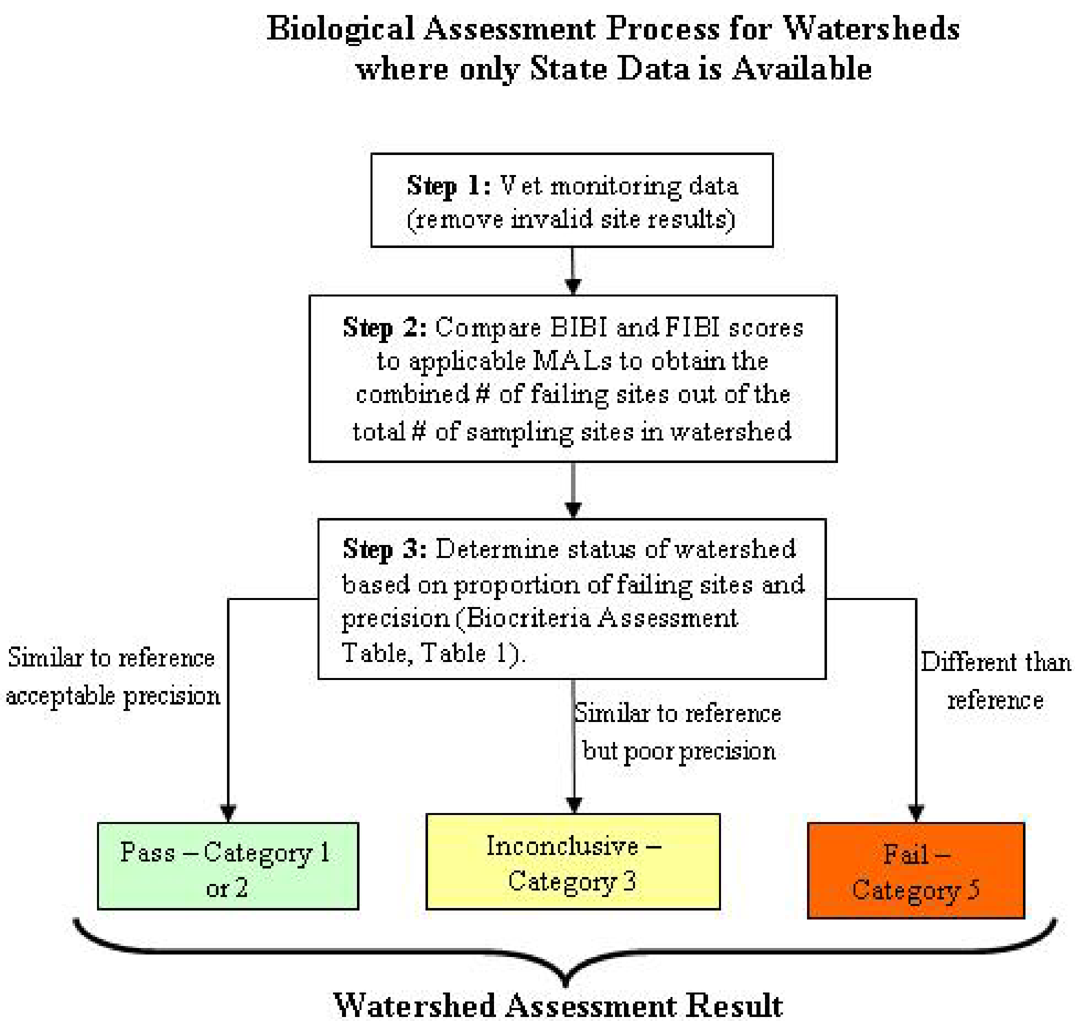


Figure 7: Watershed assessment procedure for watersheds having only State-collected data.

Step 1: Vetting Monitoring Data

In all cases, State biologists may use professional judgment in evaluating biological results. However, to aid in the data review, a set of rules is used to guide the data vetting process. These rules evaluate specific data parameters such as flow, catchment size, and buffer width to determine if the IBIs are reliable indicators of current watershed conditions. As a specific example, if there was a temporary or significant natural stressor such as drought or flood, sample results were evaluated to determine whether IBI scores resulted from anthropogenic influences or natural conditions. The final master database contains all biological sites considered valid for use in the assessment process. The following rules for eliminating site results were developed by MDE with help from DNR to address situations when the IBIs are not representative of stream condition.

(a) Sampling locations with less than a 300-acre catchment or watershed often have limited fish habitat and naturally low fish diversity. As a result, the F-IBI will not be used for assessment decisions at these sites unless the score is significantly greater than 3.

(b) Due to the unique chemistry of blackwater streams and the lack of defined blackwater reference conditions, the IBIs tend to underrate this stream type. For this reason, all blackwater sites (dissolved organic carbon > 8 mg/l and either pH <5 or acid neutralizing capacity (ANC) <200 □eq/L) with eitherthe B-IBI or F-IBI indeterminate or significantly less than 3 will not be used. If the B-IBI and the F-IBI are significantly greater than 3, the stream will be rated as meeting the aquatic life designated use.

(c) If the number of organisms in a benthic sample is less than 60, that sample will not be used unless the B-IBI is significantly greater than 3 or supporting data (e.g., habitat rating, water quality data) indicate impairment (presence of anthropogenic stressors) and there is no evidence of sampling error or unusual natural phenomena.

(d) Heavy rain and other runoff events (e.g., sudden heavy snowmelt) can scour the streambed and transport fish and/or benthics out of a stream segment. As such, samples taken within two weeks of such events may be considered invalid in the best professional judgment of State biologists and not used for evaluation of stream condition.

(e) The IBI scores of stream sampling sites that are tidally influenced will not be used to determine designated use attainment.

(f) The IBI scores of streams affected by excessive drought or intermittent conditions will not be used in assessment decisions. Other sampling sites influenced by low flow conditions may also not be used.

(g) The IBI scores of sampling sites that are dominated by wetland-like conditions (e.g., no flowing water, shallow, abundant organic matter) may be considered invalid in the best professional judgment of State biologists.

(h) The IBI scores of streams impounded by beaver dams may be considered invalid. For example, a site within a natural impoundment that was created by beaver activity between the spring benthic macroinvertebrate sampling and the summer fish sampling. Man-made alterations to selected stream segments (e.g., channelization, dredging) should be noted, but they do not invalidate the IBIs.

(i) Sampling sites where the results may be skewed due to sampling error will not be used for assessment purposes.

In addition to these cases, State biologists may use best professional judgment to evaluate any streams sampled under conditions that are not characterized by reference stations.

<u>Step 2: Comparing IBI Scores to the MALs</u>

In step 2, State assessors compare the F-IBI and B-IBI score from each sampling location to the applicable minimum allowable limit (MAL), which for F-IBIs equals 2.5 and for B-IBIs equals 2.65. For any sampling location that has either a F-IBI and/or a B-IBI below the MAL, that site will be classified as a failing site. Next, the total number of failing sites is summed for each 8-digit watershed. Note:

Some sites may have both a failing F-IBI and a failing B-IBI. Regardless, such a site will only count once toward the total number of failing sites within an 8-digit watershed.

Step 3: Determining Status Based on Proportion of Failing Sites

Using the number of the failing sites in a watershed and the total number of sites within that watershed, State assessors use 90% confidence intervals and precision to determine watershed status. This is equivalent to using Table 6 above. This lookup table was developed as a simple way to test watersheds for similarity with reference watersheds. The minimum sample size incorporated into this table accounts for spatial variability by requiring an acceptable level of precision. A watershed that is significantly different than the reference condition is classified as impaired and listed on Category 5 in the Integrated Report. If a watershed is not determined to be significantly different from reference conditions, the assessment must have an acceptable precision (half the width of the confidence interval is <25%) before the watershed is listed as attaining the water quality criterion (Category 1 or 2). If the precision is not acceptable, the watershed is listed as inconclusive and placed in Category 3.

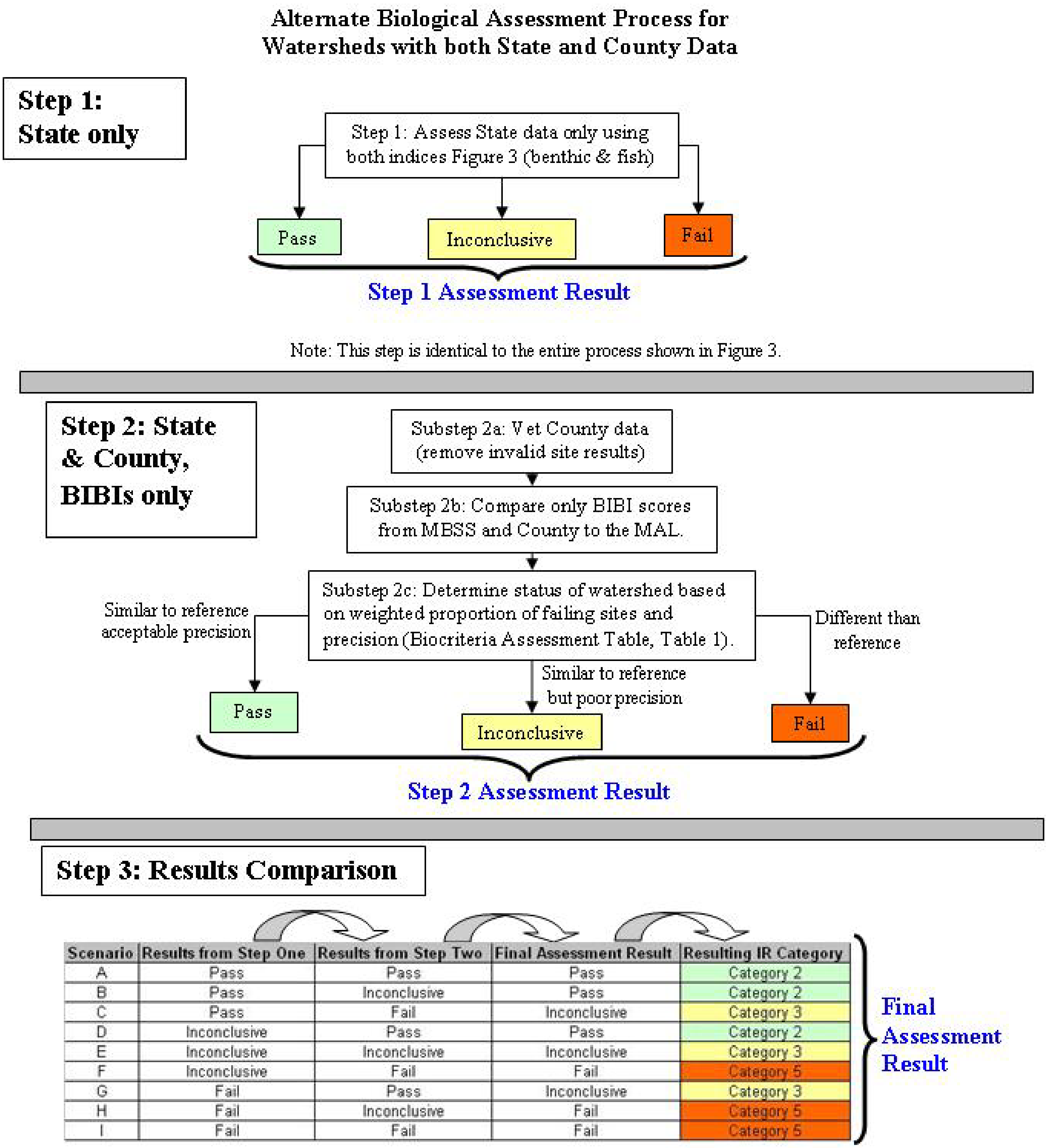
Minimum Sample Size

Considering the watershed/monitoring site similarity analysis results and the required statistical precision for a definitive classification, a watershed can be reasonably assessed if it has at least eight random monitoring sites. However, if less than eight sites are within an 8-digit watershed and three of them are classified as degraded, the watershed will be classified as not supporting aquatic life and placed on Category 5 of the Integrated Report. The rationale is that if five more samples were collected (to total eight) then the watershed would be listed on Category 5 regardless of the results at the new sites. Likewise, if there are less than eight monitoring sites but at least six sites are not degraded then the watershed will be classified as supporting aquatic life and placed on Category 2. Similarly, the rationale is that if two more sites were added to the monitoring design, the watershed would be listed on Category 2 regardless of the new site results. However, in the future, it is recommended that biological monitoring designs have at least eight sites per 8-digit watershed.

B. Alternate Assessment Process for Watersheds with State and County Data

Prior to the 2014 IR, State assessors depended solely upon MBSS data for assessing entire 8-digit watersheds. Starting with the 2014 IR, the State began integrating county-collected biological data with MBSS data so as to increase watershed sample sizes and provide more up-to-date information. In order to do this, however, State assessors had to address two major differences between the MBSS and county data. For one, county data are typically only sampled in that portion of a watershed that is within county borders. As a result, using this data to assess an entire 8-digit watershed (that crosses into another jurisdiction) has the potential to bias the watershed assessment. Secondly, many county biological sampling programs collect only benthic data instead of both benthic and fish information (as in the MBSS). This too can bias the result as each county site has only one chance (benthos) to be classified as failing instead of two chances (benthos and fish). In order to account for these differences in biological sampling, it was necessary for the State to develop an alternate assessment process that weights IBI scores according to the spatial scale sampled and the number of indicators used. Please note: This assessment process, shown in Figure 8, is only applied for those 8-digit watersheds where both MBSS and county data are available. All other watersheds will be assessed using the process described in Section IV.A.

This new assessment process includes two separate analyses: one that makes use of both B-IBI and F-IBI scores (Step 1) and another that only uses B-IBI scores (Step 2). Having these two independent analyses ensures that F-IBI scores from the MBSS still play a role in the final assessment result but also ensures that the lack of a F-IBI score in the county datasets does not significantly bias the overall assessment. In the second analysis (Step 2), weights are applied to county B-IBI results to account for the portion of stream miles in the watershed that the county data assessed. These weights help to nullify any spatial scale bias that might occur from using the county data. Figure 8 outlines the assessment process used for those 8-digit watersheds that have been sampled both by the MBSS and by a county. A detailed description of each step shown in Figure 8 is provided in the corresponding sections below.



Scenario	Results from Step One	Results from Step Two	Final Assessment Result	Resulting IR Category
A	Pass	Pass	Pass	Category 2
B	Pass	Inconclusive	Pass	Category 2
C	Pass	Fail	Inconclusive	Category 3
D	Inconclusive	Pass	Pass	Category 2
E	Inconclusive	Inconclusive	Inconclusive	Category 3
F	Inconclusive	Fail	Fail	Category 5
G	Fail	Pass	Inconclusive	Category 3
H	Fail	Inconclusive	Fail	Category 5
I	Fail	Fail	Fail	Category 5

Figure 8: Watershed assessment procedure for watersheds that have both State and County data.

Step 1: Assess State Data Only (Benthos and Fish)

This step simply follows the assessment process described in Section IV.A. and shown in Figure 7. Here the assessment result will be used only as an endpoint for Step 1 in the alternate assessment process rather than as the final watershed assessment result as in Section IV.A.

Step 2: Assess State and County Data, Benthic Data Only

In Step 2 of the alternate assessment process, State and county benthic monitoring data are integrated to fill in data gaps and increase the overall sample size. The purpose of introducing the separate second step was to allow for a means to include samples with B-IBI scores only, and to account for non-spatially coincident watershed-county boundaries. Here, the process incorporates weighting to account for the difference in spatial scale represented by the county data. The specifics of this are described in more detail in the following substeps.

Substep 2a: Vetting Monitoring Data

This substep involves vetting the county monitoring data according to the same procedures used for State data and described in Section IV.A. - Step 1 of this document. This step helps to eliminate invalid data and to ensure that county-submitted data are subjected to the same standards of review as State data.

Substep 2b: Compare B-IBI Scores to MAL

Next, the B-IBI scores from both State and county datasets are compared to the MAL for B-IBIs which equals 2.65. For any site that has a B-IBI below the MAL, that site will be classified as failing. In this step it is important to maintain the distinction between the number of failing county sites and the number of failing State sites. These two values will be assigned different weights in Substep c.

Substep 2c: Weighting Procedure and Determination of Step 2 Status

For this part of the assessment, the assessor must determine the percentage of stream miles of an 8-digit watershed that is within the county's borders (for watersheds that cross county boundaries). Since counties typically only sample within their borders, their sampling sites will be limited to this portion of any given 8-digit watershed. To avoid biasing the assessment for the entire 8-digit watershed the assessor must weight the county sampling sites by this percentage. These weighted county values are then combined with the State values to obtain an overall weighted proportion of failing sites. The equation below describes this procedure.

$$\frac{D_w}{T_w} = \frac{\sum_{i=1}^{n}(B_i W_i)}{\sum_{i=1}^{n} W_i}$$

where

Dw = Weighted number of sites with degraded B-IBI scores in a watershed
Tw = Weighted total number of sites with B-IBI scores in a watershed
n = Number of sites with B-IBI scores in a watershed
i = Counter for each site with a B-IBI score in a watershed
Bi = Binary B-IBI score for each site: 1 for degraded, 0 for not degraded
Wi = Weight. For State MBSS sites, 1; for county sites, the proportion of a watershed's stream miles within each county's borders

Note: An alternate equation, with corresponding explanation, that yields identical results is provided in Appendix B.

These proportions are then used to calculate 90% confidence intervals, which are the basis for the Biocriteria Assessment Table (Table 6). The output is a pass/fail/inconclusive designation for Step 2. Similar to Step 1 from Section IV.B., the assessor uses the assessment result from this step (Step 2) for use in Step 3, following.

Step 3: Results Comparison

The final step of the alternate assessment process involves a simple comparison of the results from Step 1 and Step 2. The purpose of this is to mute any bias that may be introduced as a result of using county data while at the same time, taking advantage of the increased sample size. The following table (Table 7) shows the possible assessment scenarios that can result from this process. As noted, any time agreement exists between Step 1 and Step 2 (Scenarios A, E, and I), the shared result will stand. Any time the results of one step are inconclusive and the other step is not, the conclusive result will be used for IR listing (Scenarios D and F). Finally, when the results from the two steps disagree (Scenarios C and G), it will generally result in a Category 3 listing as more data are needed to confirm watershed status. In certain cases though, State assessors may use professional judgment and default to an impaired status (Category 5) so as to be more conservative with the overall assessment.

Table 7: List of assessment scenarios that can result from the alternate bioassessment process.

Scenario	Results from Step One	Results from Step Two	Final Assessment Result	Resulting IR Category
A	Pass	Pass	Pass	Category 2 – meets standards
B	Pass	Inconclusive	Pass	Category 2– meets standards
C	Pass	Fail	Inconclusive	Category 3 – insufficient info
D	Inconclusive	Pass	Pass	Category 2– meets standards
E	Inconclusive	Inconclusive	Inconclusive	Category 3– insufficient info
F	Inconclusive	Fail	Fail	Category 5 - impaired
G	Fail	Pass	Inconclusive	Category 3– insufficient info
H	Fail	Inconclusive	Fail	Category 5- impaired
I	Fail	Fail	Fail	Category 5- impaired

C. Data Limitations

Previous versions of the Biological Assessment Methodology discussed the State's preference to use only the most recent 10 years of biological data for IR assessments. However, since there is an insufficient sample size for some 8-digit watersheds as of the 2014, it makes using older data (e.g. Round One and Two of the MBSS) necessary. As a result, for the 2014 IR, MDE will continue to use all three rounds of data from the MBSS to probabilistically assess 8-digit watersheds. MDE will review this matter in future assessments to determine if and when older data should be omitted from State assessments.

As the MBSS Program continues to collect more data around the State, they may continue to refine and enhance the respective benthic and fish IBIs in order to better discriminate between healthy and degraded stream conditions. In doing so, the IBI scores from an older site may change depending on what metrics are used and how the IBI is calculated. To keep assessments transparent and repeatable for regulatory purposes, MDE may choose to continue using the 2005 IBIs and corresponding metrics. Specific data scenarios may arise in the future that cannot be predicted. At all times, it is MDE's goal to maintain the scientific defensibility of these assessments and others that depend on the use of biological data.

V. USE OF NON-STATE DATA

Given that a key use of these procedures is for the Integrated Report and that the State is required to consider all readily available data, MDE recognizes the need to incorporate local biological data into the assessment process. Counties or other water monitoring programs that intend to submit their data to support decisions made using the biological framework should carefully follow the general guidelines below. Additional detail is also provided in the document named "Biological Data Quality Guidelines" and can be found on MDE's website at: http://www.mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Biological_Data_Quality_Guidelines.pdf.

- Data collected using MBSS (field, laboratory and IBI protocols) or comparable methodology must be:
  - Documented to be of good quality;
  - Fully integrable with MBSS data;
  - Provided in a format readily available for merging into the MBSS database;
  - Contain the additional habitat, physical, and chemical information that the MBSS provides that allow for vetting.

- If MBSS methodology is not used but data are documented to be of good quality, in accordance with guidance and technical direction from the State, the data may still be used to supplement fully integrated MBSS and local data.

Data not meeting the requirements stated above may be helpful for non-regulatory purposes (e.g., targeting, education). Such data will be stored and documented for these uses. State biologists may refer submitters to information sources that will help them to improve the quality of their monitoring data.

VI. BIOLOGICAL STRESSOR IDENTIFICATION

If a watershed is determined to be impaired (Category 5) based on biological data, it is MDE's goal to identify the impairing pollutant(s) so as to facilitate TMDL development and/or to direct water quality restoration. To support this effort, the MDE Science Services Administration has developed a biological stressor identification (BSID) analysis that uses a case-control, risk-based approach to systematically and objectively determine the likely cause(s) of reduced biological conditions. In effect, the BSID process links potential causes/stressors identified by the analysis with general causal scenarios and concludes with a review for ecological plausibility by State scientists. Once the BSID process is completed, one or several stressors (i.e., pollutants) may be identified as probable causes of the poor biological conditions within the Maryland 8-digit watershed.[13]

MDE will use identified stressor(s) (e.g., sediment, chlorides, and nutrients) to support current pollutant listings, add new pollutant listings, and/or change the category assessment for a pollutant on the Integrated Report. As a result, when stressor(s)/pollutant(s) are identified for a biologically-impaired 8-digit watershed, the biological listing will be removed from Category 5 and will be replaced by the appropriate pollutant listing(s) (in Category 4c or 5, as appropriate). An example of this is illustrated below in Tables 8 and 9.

Table 8: Example of a Category 5 Biological Listing

AU-ID	Basin Name	Category	Cause	Indicator
MD-02130906	Patapsco Lower North Branch	5	Cause Unknown	Fish and Benthic IBIs

[13] These probable causes each have an associated 'percent attributable risk' value which is an estimate of the excess prevalence of the specified stressor at impaired sites beyond stressor prevalence at unimpaired sites.

Table 9: Example of changes to the Integrated Report Listings that result from the BSID Analysis. These three listings essentially take the place of the previous biological listing (combination benthic/fish bioassessment) for watershed MD-02130906.

Cycle First Listed	Assessment Unit-ID	Basin Name	Category	Cause	Indicator	Notes
1996	MD-02130906	Patapsco Lower North Branch	5	Total Suspended Solids (TSS)	Fish and Benthic IBIs	This pollutant listing existed previous to the BSID analysis. The BSID confirmed that this pollutant was impairing the watershed.
2010	MD-02130906	Patapsco Lower North Branch	5	Chlorides	Fish and Benthic IBIs	Newly identified stressor/cause
2010	MD-02130906	Patapsco Lower North Branch	5	Sulfates	Fish and Benthic IBIs	Newly identified stressor/cause

As shown in Table 9, the impairment 'cause' field was changed to reflect the actual cause/pollutant impairing the watershed. Those watersheds that do not have the stressor identification process completed will remain as "Cause Unknown" until stressors are identified. In some cases, more biological, chemical, or physical data may need to be collected in order to inform the BSID analyses. The BSID analysis and process can be reviewed in more detail by visiting MDE's webpage at: http://www.mde.state.md.us/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/bsid_studies.aspx. This page includes a link to the report titled *Maryland Biological Stressor Identification Process which provides the background on the analysis methods. Please note that this report will soon be updated in late 2014.*

VII. USING BIOLOGICAL DATA FOR TIER II DESIGNATION

As specified in COMAR [26.08.02.04-1] biological assessment data will be used for the purpose of identifying Tier II waters to be protected under the Department's Anti-degradation Policy Implementation Procedures. According to these regulations, when biological assessment data indicates that water quality is within 20% of the maximum attainable value of the index of biological integrity, those waters will be assigned a Tier II designation. For data sampled and scored according to MBSS protocols, this equates to having both a fish and benthic IBI score of 4.00 or greater at a single site. Using these two pieces of biological information sampled during different seasons of the year helps to independently validate the high quality status of a segment.

Tier II segments can exist in watersheds that are listed as impaired (Category 5) by the methodology spelled out in this document, despite Section 26.08.02.04-1D(2) of the Anti-degradation Procedures. This section states, "Water bodies included in the List of Impaired Waters (303(d) List) are not Tier II waters for the impairing substance." The biological assessment methodology only assesses the biological condition of streams at the 8-digit watershed scale (approximately 90 square miles) and calculates the percentage of sites impaired within this larger scale. As a result, it is possible for smaller stream segments located within 'impaired' (Category 5) 8-digit watersheds to be of Tier II quality due to local variation in stressors and land use. Since local water quality conditions are better characterized through site-specific monitoring, individual stations are used to identify and designate Tier II segments regardless of the watershed assessment result. For more information on Maryland's Tier II high quality waters please visit: http://www.mde.state.md.us/programs/Water/tmdl/water%20quality%20standards/pages/antidegradation_policy.aspx. To see what waters are currently designated as Tier II please refer to http://www.mde.state.md.us/programs/Water/TMDL/Water%20Quality%20Standards/Pages/HighQualityWatersMap.aspx.

VIII. FUTURE MONITORING PRIORITIES

Monitoring prioritization will focus on the watersheds determined to be inconclusive in the final assessment (Category 3) and will be based on the following specific factors. First, the watersheds with the largest percentage of perennial non-tidal 1st through 4th order stream miles/drainage area will receive preference over basins with a large percentage of tidal stream miles/drainage area. Secondly, the available data for each watershed will be evaluated and best professional judgment applied to determine whether obvious causes of low IBI scores exist due to natural conditions (i.e., a high percentage of intermittent or blackwater streams in the watershed) and/or anthropogenic influences. In some cases, watersheds will be addressed by a Water Quality Analysis or referred for further stressor identification. To allow for the most efficient use of resources, consideration will be given to the number of stations monitored by DNR and the counties so as to limit redundant sampling efforts.

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Appendix A. Evaluating the Spatial Representation of the Monitoring Data

An analysis of MBSS data representation of each 8-digit watershed determines if stream monitoring stations adequately capture watershed landscape heterogeneity and can thus be used to support a biological assessment. Watershed landscape heterogeneity is assessed using the distribution of landscape clusters (groups of similar landscape conditions) that incorporate land use, land use change, soil erodibility, slope, precipitation, and population density (US EPA 2007). Nine distinct cluster types were identified and are presented in Figure 9.

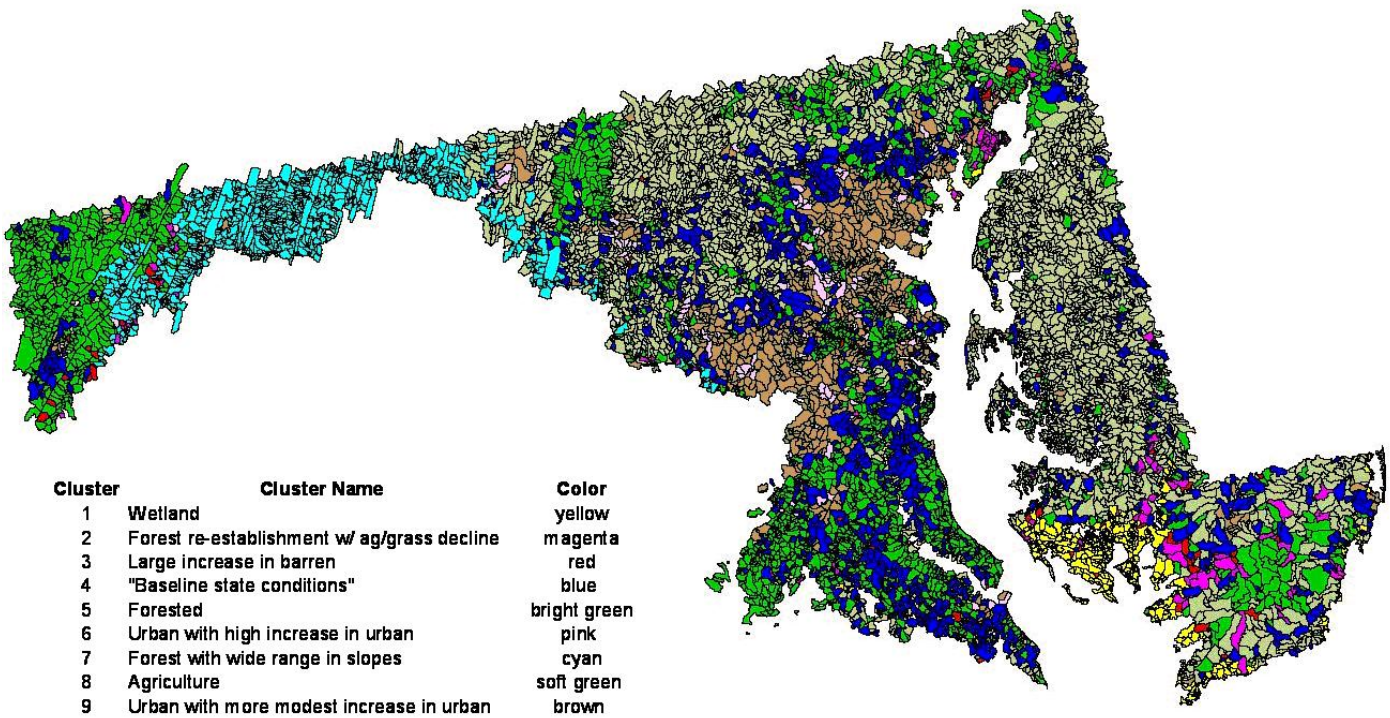

Figure 9: Landscape Similarity in Maryland.

The nine cluster groups can be described as follows: Cluster 1 watersheds are dominated by wetlands and concentrated in the southwest corner of the Delmarva Peninsula. Cluster 2 watersheds are characterized by forest re-growth mainly at the expense of agriculture. Cluster 3 watersheds are characterized by large increases in barren land. They are mainly scattered around the margins of the Chesapeake Bay with another concentration in the westernmost portion of the panhandle. Cluster 4 is perhaps best labeled as “baseline state condition,” since all cluster means are close to the average. Cluster 4 watersheds are scattered throughout the State. Cluster 5 and 7 watersheds are dominated by forest with the main difference being that cluster 7 watersheds have a broader range of slopes. Clusters 6 and 9 are dominated by urban land use, with cluster 6 having a much higher rate of urban increase. Cluster 8 watersheds are dominated by agriculture.

Representation of watershed heterogeneity is assessed by determining if the distribution of sample stations within cluster groups is proportional to the distribution of stream length within cluster groups. A Percent Similarity Index (PSI), also called the Renkonen Index (Krebs 1989), is calculated using proportions of 1st through 4th order streams within clusters and proportions of monitoring stations within clusters. Despite the simplicity of this measure, it is a robust quantitative similarity coefficient and is commonly used in ecological research when comparing communities using species proportions. The PSI ranges from 0% (no similarity) to 100% (complete similarity). The index is calculated as

$$PSI = \sum_{i=1}^{S} minimum(p_i^{streams}, p_i^{stations})$$

where

$p_i^{streams}$ is the percentage of 1st – 4th order streams in cluster i
$p_i^{stations}$ is the percentage of monitoring stations in cluster i
i is a cluster type
S is the number of cluster types occurring in a watershed (sum of proportions must equal 100% within a watershed)

A plot of the similarity between the watershed landscape clusters and the number of MBSS round 1 and round 2 monitoring sites in an 8-digit watershed is presented in Figure 10. It is evident that a greater number of sites results in a higher watershed Percent Similarity Index. Also, Figure 10 illustrates that PSI has a large range for watersheds with less than ten sites but begins to reach an average of about 85% approximately when the number of sites is greater than eight.

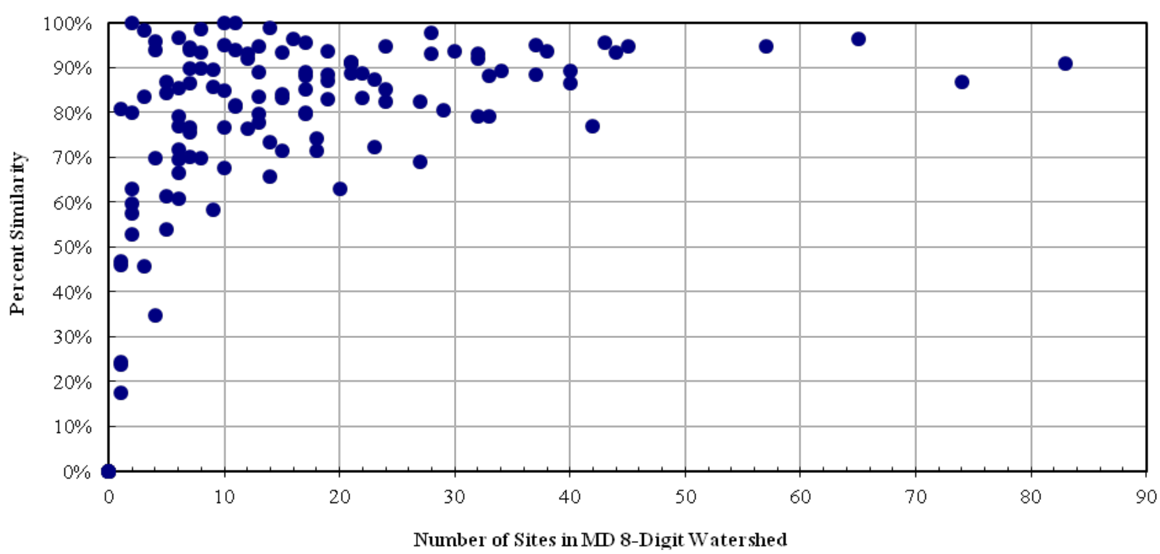

Figure 10: Watershed Percent similarity index vs. number of sites in a Maryland 8-digit watershed.

Appendix B. Alternate Weighting Procedure for Assessing State and Non-State Data

To enable better understanding of the weighting procedure used for incorporating non-state biological data into the 8-digit watershed assessments (Substep 2c), Maryland provides the following alternate weighting equation. Please note that watershed results produced by this equation are identical to those yielded by the equation in the main portion of this methodology document (specifically Section IV.B.). The strength of this equation is that it lends itself to doing the calculations by hand whereas the previously mentioned equation is more suited to automated calculation by statistical software programming.

$$\frac{D_w}{T_w} = \frac{D_s + D_c W}{T_s + T_c W}$$

where

Dw = Weighted number of sites with degraded B-IBI scores in a watershed
Tw = Weighted total number of sites with B-IBI scores in a watershed
Ds = Number of sites with degraded B-IBI scores from State MBSS data in a watershed
Ts = Total number of sites with B-IBI scores from State MBSS data in a watershed
Dc = Number of sites with degraded B-IBI scores from county data in a watershed
Tc = Total number of sites with B-IBI scores from county data in a watershed
W = Weight: proportion of a watershed’s stream miles falling within county borders

This equation can also be adapted for watersheds that are split by county borders and sampled by more than one county. In those cases, the equation would be modified to include the additional county’s failing scores, total scores and weights. An example is provided below for illustration.

$$\frac{D_w}{T_w} = \frac{D_s + D_{c1} W_{c1} + D_{c2} W_{c2} \ldots}{T_s + T_{c1} W_{c1} + D_{c2} W_{c2} \ldots}$$

where the altered terms

Dc1 = Number of sites with degraded B-IBI scores from one county in the watershed
Tc1 = Total number of sites with B-IBI scores from that same county in the watershed
Wc1 = Weight: proportion of a watershed’s stream miles within that one county’s borders

Dc2 = Number of sites with degraded B-IBI scores from the second county in the watershed

Tc2 = Total number of sites with B-IBI scores from the second county in the watershed

Wc2 = Weight: proportion of a watershed's stream miles within that second county's borders

C.2.4 Biological Data Quality Guidelines

MDE Requirements for Use of In-Situ Biological Stream Data

Intent and Purpose

The purpose of this document is to outline the requirements and specifications relating to the use of biological stream data in Maryland's regulatory framework. Specifically, this document was created to serve as a reference for those organizations providing the Maryland Department of the Environment (MDE) with biomonitoring data for regulatory decision making. Examples of the types of regulatory decisions that may utilize biological data include, but are not limited to, decisions regarding water quality criteria development, Integrated Report (305(b)/303(d)) assessments, TMDL development, Tier II high-quality water determinations, and measuring NPDES permit or 401 certification compliance. MDE also uses biological data for other non-regulatory purposes including trend analysis, restoration targeting, and measuring restoration progress. This document does not address Whole Effluent Toxicology (WET) testing, or other laboratory-based biological monitoring protocols, as they are covered under other programs. This document will instead address in-situ biological stream monitoring with a focus on data collected using Maryland Biological Stream Survey (MBSS) or similar protocols. The biological data quality guidelines provided within this document serve as supplementary information for the Biological Assessment Methodology for Non-tidal Streams[14] and as the guidelines in force for entities collecting MBSS-comparable data in response to permit requirements or conditions. In addition, all data submitted for Tier II high quality waters evaluations must also meet these minimum guidelines in order to be considered for Tier II designation or for evaluating assimilative capacity.

Biological Data Collection Methods

The paragraphs below provide brief summaries of some of the biological stream sampling methods used in Maryland. This is not an exhaustive compilation. There are other valid methods that could be used in a regulatory context. However, the methods discussed below have the longest history of use in Maryland for various Clean Water Act directives. As new methods and protocols are developed and utilized, this list may be expanded.

DNR's Maryland Biological Stream Survey (MBSS) Protocols

For Maryland's wadeable streams (1st through 4th order), MBSS protocols are used more often than any other set of biological monitoring protocols. This method, adapted from EPA's Rapid Bioassessment Protocols, samples not only the in-situ biological community (fish and benthic macroinvertebrates[15]) but also water chemistry and in-stream habitat. Benthic macroinvertebrates are collected using a multi-habitat approach and a d-frame dip net while fish are collected by conducting two-pass electrofishing. MBSS data have been collected in Maryland since 1995 and to date include over 3000 sites. As part of this sampling methodology, fish and benthic macroinvertebrate community data are used to calculate

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14 http://www.mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Biological_AMStreams_2014.pdf

15 MBSS sampling also now incorporates mussel and herpetofauna sampling as part of their standard protocols although these are not typically used for regulatory decisions.

separate indices of biotic integrity (IBI) that rate streams in comparison to reference conditions (minimally-impacted). These methods and the scoring methodology used in the IBIs are well-established and are considered quite robust (Southerland et al. 2005). The data collected using MBSS methods is used by the Department for a number of different regulatory applications including water quality standards development, Integrated Report assessment, Tier II high quality water designation, TMDL development, measuring NPDES permit compliance, restoration targeting, and measuring restoration progress. Several Maryland counties have adopted sampling methods similar to the MBSS with varying differences in protocols and analysis.

DNR's Stream Waders Protocols

The Stream Waders sampling protocols, used in Maryland since 2000, are similar to that of the MBSS methods. Benthic macroinvertebrates and habitat information are collected and a benthic IBI is calculated. However, one of the major differences from MBSS is that Stream Waders identifies benthic macroinvertebrates to the family level instead of genus. Stream Waders protocols also do not entail fish sampling. Though considered not as rigorous as the MBSS protocols, Stream Waders protocols have the benefits of being less costly and time intensive for sample collection and analysis. Additionally, Stream Waders data are collected by trained volunteers, something that cannot be done for MBSS protocols. Stream Waders protocols have helped provide the State with a low cost method for filling in stream monitoring gaps and have been used extensively for restoration targeting purposes.

Surber Device Sampling Methods

Surber sampling devices have a 0.3 m by 0.3 m size frame with attached net designed to capture dislodged benthic organisms from a 0.09 m^2 area of stream bottom (Barbour et al. 1999). There are many different versions of protocols dictating where (e.g. mid riffle, beginning of riffle, etc) and how many surber samples should be gathered from a single monitoring location. However, DNR's Core Trend monitoring program, the largest known user of surber sampling methods in the State, uses three replicate samples collected in a riffle: one at midstream and at two points equidistant from each bank (Friedman 2009). The Core Trend program has been using surber sampling methods since 1976 to characterize local benthic communities and for detecting long term changes in water quality. Data collected by the Core Trend program using surber sampling methods has been used for TMDL development in nutrient and sediment impaired watersheds.

Artificial Substrate Sampling Methods

Artificial substrate methods of biological sampling have also been used in Maryland to gather information on benthic macroinvertebrate communities. The most prominent user of artificial substrate methods, the Core Trend monitoring program, uses Hester-Dendy multiplate samplers to collect benthos in shallow streams without riffles and in slow deep streams/rivers (Friedman 2009). Since 1976, the Core Trend program has used this method at sites not appropriate for surber sampling. Data collected using multiplate samplers is also used for long term trend detection and for TMDL development.

Electrofishing for Fisheries Surveys

Electrofishing has supported fisheries management decisions in Maryland for several decades. Surveys typically determine overall fish community structure or measuring recruitment success as part of a balanced age structure. Stream fishery surveys tend to be more qualitative without strict rules for block net usage and the segment length (to be sampled). Generally, state biologists look for the presence and abundance of certain keystone or gamefish species to determine appropriate management actions.

Although fishery surveys are of relatively limited use for water quality regulatory purposes, they have been used to correct stream use classification for a number of cold water streams. In addition, fisheries surveys can provide valuable information for measuring restoration success following the implementation of a restoration project.

How MDE Uses Biological Data

Both federal and state regulations drive the utilization of biological data in Maryland. Specifically, 40 CFR section 130.7(b)(5) requires that as states assess their waters in accordance with Sections 303(d) and 305(b) of the Clean Water Act that "Each State shall assemble and evaluate all existing and readily available water quality related data and information to develop the list[16]." The Code of Maryland Regulations (COMAR) 26.08.02.03-4 provides further detail in identifying the criteria for using biological water quality data to make water quality-related assessments and decisions.[17] These criteria specify the basic requirements to be included as part of the biological assessment methodology and include items such as having a documented and repeatable process, consideration of natural variability, and the use of best professional judgment in scenarios where statistical methods may provide inappropriate results.

In general, MDE's primary use of biological data is for assessing aquatic life use attainment as required by Clean Water Act (CWA) Sections 303(d) and 305(b). To conduct these assessments, MDE makes use of a biological assessment methodology specifically designed for non-tidal wade-able streams.[18] This assessment methodology[19], though not considered a water quality standard, provides the statistical methods and decision process that Maryland uses for making impairment determinations. The assessment methodology does this by evaluating randomly sampled sites as part of a probabilistic survey to provide assessments at the 8-digit watershed scale. The Department reports the results of these assessments on a bi-annual basis as part of the Integrated Report of Surface Water Quality (IR). Historically, the non-tidal biological assessment methodology has utilized biological data collected using MBSS or MBSS-comparable protocols. Utilization of biological data collected using other protocols is possible in the Integrated Report but will require additional resources to reconcile differences and to ensure non-contradictory results.

The Department also uses biological monitoring data to designate and re-evaluate high quality or Tier II waters. For Tier II waters, biological sites are evaluated on a site by site basis instead of being assessed as part of a larger assessment unit. Sites having both a fish and benthic IBI score of 4.00 or greater are designated as Tier II and then afforded the additional protections described in COMAR Section 26.08.02.04-1. At the time of this document, Tier II waters have only been designated on the basis of data collected using MBSS protocols. Until and unless other criteria for defining Tier II waters can be proposed and accepted, future monitoring (and the identification of new Tier II locations) must be done

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[16] The 'list' being the 303(d) List or list of impaired waters, also known as Category 5 of the Integrated Report.

[17] http://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.02.03-4.htm

[18] The Department also uses a Biological Assessment Methodology for the Chesapeake Bay and all tidal tributaries. However, this document only addresses non-tidal biological monitoring.

[19] http://www.mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/Biological_AMStreams_2014.pdf

using the same (MBSS) or comparable protocols in order to make valid assimilative capacity determinations.

Additionally, biological data have been used in water quality standards development and for TMDL development. In both cases, MBSS-comparable biological data are the predominant type used, although other methods have been incorporated in the past (e.g. artificial substrate and surber sampling for TMDL purposes). Most often, biological data used in the context of water quality standards or TMDL development serves as a reference dataset to determine the appropriate pollution threshold(s) that preserves a healthy aquatic community.

Another regulatory use of biological data is for measuring NPDES permit compliance. Generally speaking, NPDES permits require WET testing as a permit condition more frequently than any other type of biological monitoring. However, an increasing number of permits are also incorporating in-situ biological monitoring to determine if permitted discharges are causing shifts in nearfield aquatic communities. In similar fashion, the Department can require the collection of biological data for granting 401 certifications for particular Non-tidal Wetlands and Waterways permits. These data can then be used to inform future management decisions as a project proceeds with development. The type of biological monitoring used in these circumstances is tailored to the discharge/pollutant of concern and may or may not require MBSS-comparable monitoring.

MDE also uses DNR's Core/Trend benthic macroinvertebrate data for non-regulatory trend analyses. These data, collected with surber or multiplate sampling devices, have been sampled at fixed locations over varying frequencies since 1976. Using this long data record facilitates temporal comparisons and longer term trend analyses. Trend analyses developed from these data have been used to gauge restoration progress and to describe the overall health of larger order flowing waters.

The last two major uses of in-situ biological monitoring data by MDE are for restoration targeting, and for measuring restoration progress. These analyses, like Tier II and NPDES compliance analyses, evaluate data on a more site-specific basis to help guide local water quality management practices. Both of these monitoring objectives rely heavily on MBSS data due to in-house familiarity and the robustness of the IBIs. The Department may use other protocols with lower costs and where a high density of sampling sites is needed, to help determine the highest priority areas for restoration.

<u>Appropriateness of Biological Sampling Protocols for Certain Monitoring Purposes</u>

Biological data collected using MBSS protocols has been the predominant biological sampling method used by MDE for various monitoring and analyses purposes. It should be noted however, that the Department does not exclusively require MBSS protocols in all cases. As stated previously, the Department is required to consider all readily available data to support water quality assessments in Maryland. Where appropriate, the Department will attempt to incorporate other forms of biological data. Still, MBSS or MBSS-comparable data can more easily be assessed due to the size of the dataset and in-house familiarity. Full utilization of other established protocols[20] that differ from MBSS can and does occur, pending resources.

[20] Other established protocols include any other generally accepted in-situ biological sampling and evaluation protocols that incorporate QA/QC and have QAPP-type documentation.

Each monitoring method has its strengths. MBSS-comparable monitoring is a comprehensive community assessment and is especially suited to those scenarios where a one-time sample is needed. Data analysts are able to leverage a large historical MBSS dataset for comparison work and it is possible to account for interannual variability after IBI scores are calculated. Biological monitoring methods involving the use of artificial substrates (multiplate samplers) and surber sampling devices essentially standardize the habitat sampled according to substrate area provided or cleaned, respectively. Both of these methods are particularly useful for trend analysis when long term sampling is conducted. Additionally, the multiplate samplers, can be used in large rivers and streams that may be unsampleable by other methods. Stream Waders sampling provides only a family-level benthic macroinvertebrate community assessment but can be accomplished at a much lower cost than other protocols. Also, because Stream Waders uses similar metrics and scoring methods to the MBSS methods, it allows for more intuitive data integration to help fill monitoring gaps left by the MBSS. Finally, even though biological sampling conducted for the purpose of fisheries surveys is not broadly applicable to many of MDE's regulatory or other data analysis goals, it can supply much needed information for identifying and correcting Maryland's water use classifications.

Table 10 has been provided below to illustrate the relationship between the Department's uses of in-situ biological stream data and the appropriate biological monitoring protocols for those uses. As a general rule, the Department will continue to use the same monitoring protocols previously used at a site or for a certain purpose so as to facilitate interannual comparisons and to allow for more rigorous trend analyses. Some monitoring scenarios may dictate particular biological monitoring methods. In the case of Tier II sampling, MBSS or MBSS-comparable protocols must be used until other definitions of Tier II waters are proposed and accepted. For other situations, the Department has the discretion to incorporate biomonitoring data collected with other protocols. Generally, MBSS protocols will work for many applications. However, there are circumstances where less costly and time-intensive sampling protocols will be used to fulfill the same purpose. In summary, Table 10 is meant to serve as a general guideline and not meant to limit the type of data acceptable to one protocol, format, or methodology.

Table 10: General Guidelines for the appropriate uses of specific in-situ biological stream monitoring protocols. Shown are regulatory and non-regulatory uses. Note: This table does not cover all situations. MDE retains the ability to exercise professional judgment when deciding the suitability of collected data.

Protocols	Regulatory Uses					Non-Regulatory Uses		
	Water Quality Standards Development	Integrated Report Assessments (impairment determinations)	Tier II High Quality Waters Determinations and Re-evaluation	TMDL Development	NPDES Permit Compliance and 401 Certification Requirements	Trend Detection	Restoration Targeting	Restoration Progress
MBSS or MBSS Comparable	✓	✓	✓	✓	✓	✓	✓	✓
Stream Waders (Benthos Family level taxonomy)				✓	✓	✓	✓	✓
Artificial Substrate Methods (e.g. Hester-Dendy multiplate sampler)	✓			✓	✓	✓	✓	✓
Surber Sampler	✓			✓	✓	✓	✓	✓
Electrofishing - Fishery Surveys	✓					✓	✓	✓

Minimum Data Quality Requirements for Data Acceptance

General Data Quality Requirements

This document does not seek to limit acceptable methods, but to establish the minimum data quality requirements to ensure that biological data submitted to MDE is of good quality. The document establishes minimum requirements for those who collect, analyze, or report the results of biological monitoring data to MDE for use in regulatory decision making.

Data providers must be proficient in the areas necessary to accomplish these tasks through related education or work experience. In certain cases, completion of training or other certification programs are also expected in order to meet the minimum qualifications for data use.[21] It is the responsibility of the data provider to be familiar with these requirements as well as any others that may be imposed as part of a special permitting condition (for NPDES permits or 401 certifications).

When submitting biomonitoring data for regulatory purposes, parties must provide adequate documentation to establish that field, laboratory, analysis, and protocol methods used to generate the data are within the established standard operating procedures (SOPs) and QA/QC plan for that type of monitoring. This documentation must, at a minimum, answer the questions of *who, what, where, when, why, and how* before MDE can consider it in the regulatory process. Data provided that does not provide all of this information can still be utilized by MDE for other purposes such as a general water quality indicator, for restoration targeting or for presence/absence comparisons. Such information can also be used to prioritize streams for future follow-up monitoring with more rigorous methods.

Specific Data Quality Requirements

MDE recognizes the following three roles as those generally necessary to conduct biological monitoring with the purpose of providing data to MDE for regulatory or non-regulatory uses.

1. The Principal Investigator (PI)
2. Research Assistant (RA)
    a. Field Research Assistant (Field-RA)
    b. Laboratory Research Assistant (Lab-RA)

Principal Investigator (PI)

The PI is the individual(s) primarily responsible for the coordination, development, and completion of the biological monitoring study, and oversight of all related data management. The responsibilities of this position may be shared between qualified individuals.

The PI role is further defined as follows:

- The central point of contact regarding all aspects of the survey work and MDE
- Directly responsible for ensuring that the survey work is completed in a satisfactory fashion that complies with all applicable protocols, procedures, and methodologies

[21] Since MBSS sampling is a more rigorous method requiring a variety of sampling and taxonomic skills, experience and/or additional training and certifications are required.

- Maintains current relevant working experience, including where available, any training or certifications. The PI may not be performing all aspects of the survey work, but must ensure that there is an adequate number of qualified biologists available for data collection and analysis, including field taxonomic identifications, laboratory taxonomic identifications, and for other laboratory processing and analysis
- Develops the monitoring plan and associated technical reports for the survey activity and provides this documentation to MDE, including related analysis such as IBI generation. For data intended for regulatory uses these documents must meet the conditions referenced above (See: General Data Quality Requirements).
- Responsible for leading, directing, and organizing the overall surveys and RAs and other staff throughout the survey process
- Ensures that all monitoring equipment are calibrated and in proper working order prior to the sampling event
- Ensures that all necessary permits, permissions, and other necessary approvals have been granted prior to the survey

Research Assistants (RA)

The RA is any individual(s) that operates under the supervision and/or direction of the PI, and as such performs duties as assigned provided they are qualified to do so which may require additional testing, training, or certifications.

The Field-RA role is further defined as follows:

- Conducts the field work necessary to complete the biological monitoring study, related research and analysis, or other duties associated with study completion.

The Laboratory-RA role is further defined as follows:

- Conducts laboratory analysis, data processing/entry, sorting and/or taxonomy work, QA/QC, and chemical analysis to meet biological monitoring study objectives.

The purpose of the following table is to help ensure that there is no significant delay in the use of, or disqualification of biological data provided to MDE for either regulatory or non-regulatory uses.

Table 11: Biomonitoring Roles and the Qualifications Required.

PIs must possess or meet the following:	Field-RAs must possess or meet the following:	Lab-RAs must possess or meet the following:
✓ Formal education with a background in relevant areas of study enabling them to lead appropriate staff, conduct biological monitoring, and accurately generate all necessary technical reports. Five years of related current work experience may be substituted for education. ✓ MDE protocol qualifications including current documented formal training and certification as related to specific biological monitoring protocols (i.e. MBSS, etc.). ✓ An understanding of the process of data management to ensure the coordination of all members of the biological monitoring study team in order to meet all regulatory conditions for quality data submissions to MDE.	✓ No experience is necessary, but must be able to adequately follow the direction of the PI to ensure that proper technique and protocols are followed. ✓ For MBSS sampling only, one year of documented formal training related to the specific biological monitoring protocols (for Stream Waders training required every year). ✓ Specifically for MBSS sampling, those Field-RAs identified as lead (field) fish taxonomic experts responsible for fish identification during field surveys should provide documentation that the MBSS laboratory fish taxonomy test was passed for the current sampling year.[22]	✓ Formal education with a background in relevant areas of study enabling them to perform taxonomic and related laboratory duties. Five years of related current work experience may be substituted for education. ✓ The minimum standards set by the appropriate laboratory governing body (i.e. for chemical analyses). ✓ Specifically for sorting and identifying benthic macroinvertebrate samples for MBSS style sampling, one year of documented formal training in the laboratory protocols ✓ To identify benthic macroinvertebrates to the genus level, Society for Freshwater Science (SFS) certification in Group 2 (Eastern EPT taxa) and Group 3 (Eastern Chironomidae) genera[23] **OR** Must send 10% of total samples (voucher) to an independent laboratory that is SFS certified. Voucher subsamples must meet acceptable error agreement during QAQC.

[22] Currently, the Maryland Department of Natural Resources' MBSS program offers this test annually in May.
[23] You must contact the Society of Freshwater Science to arrange genus-level benthic macroinvertebrate taxonomic certification.

The information contained in Table 11 sets the minimum standard. It is within the purview of the specific MDE administration, program, or group issuing an individual permit to establish more rigorous data standards, as necessary. The Department has the discretion to make case-by-case decisions on whether to utilize a biological dataset for regulatory purposes. To help data providers understand MDE's requirements for biological data submission (for use in regulatory purposes) this document includes Appendices A and B which cover MBSS-comparable data submissions and other biological data submissions. Please refer to these checklists when submitting data to MDE.

Data used for regulatory purposes will be held to a high standard due to the wide-reaching impact that such decisions may have. In all cases, it is the Department's goal to enhance the credibility of decision-making through the use of high quality environmental data.

Links to Sampling Protocols

The links below provide method-specific documentation for each set of biomonitoring protocols. Some of these documents include results and other ancillary information that may or may not be useful to a data collector. Electrofishing protocols for fisheries studies are not provided as the methods vary depending on the fishery study's purpose.

MBSS

Field Protocols
http://www.dnr.state.md.us/streams/pdfs/ea-07-01b_fieldRev2013.pdf

Laboratory, Field, and Analytical Methods
http://www.dnr.state.md.us/streams/pdfs/ea-05-3_methods.pdf

IBI Calculation Procedures
http://www.dnr.state.md.us/streams/pdfs/ea-05-13_new_ibi.pdf

Stream Waders

Protocol Manual
http://www.dnr.state.md.us/streams/pdfs/SW_Manual2011.pdf

Surber and Multiplate Sampling

General Description of Sampling Methods
http://www.dnr.state.md.us/streams/pdfs/12-332009-375_benthic.pdf

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Friedman, E. 2009. Benthic Macroinvertebrate Communities at Maryland's Core/Trend Monitoring Stations: Water Quality Status and Trends. DNR CBWP-MANTA-MN-09-1. Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD.

Southerland, M.T., G.M. Rogers, M.J. Kline, R.P. Morgan, D.M. Boward, P.F. Kayzak, R.J. Klauda, and S.A. Stranko. 2005. New Biological Indicators to Better Assess the Condition of Maryland Streams. DNR CBWP-MANTA-EA-05-13. Maryland Department of Natural Resources, Chesapeake Bay and Watershed Programs; Annapolis, MD.

MBSS Comparable Submissions to MDE for Regulatory Use

This list represents the minimum level of documentation and information that MDE may request when evaluating any Maryland Biological Stream Survey (MBSS) comparable data submission for regulatory uses.

Staff/Personnel
Principal Investigator(s) ☐ 5 years of work experience/education conducting field-based biological monitoring ☐ Completed MBSS training (spring & summer field) for proposed sampling year(s) ☐ MBSS certified (Benthic Macroinvertebrate Sampling & Fish Crew Leader) to cover the period of the proposed sampling year(s)
Research Assistant (RA)
Field RA ☐ Completed MBSS training (spring and/or summer field) at least once ☐ Passed MBSS laboratory fish taxonomy exam for the proposed sampling year (if responsible for fish identification during summer sampling)
Laboratory RA ☐ Education/experience in taxonomic identification or related lab duties ☐ Work conducted in lab free of probation or other disciplinary actions Primary personnel responsible for benthic taxonomy: ☐ Completed MBSS training (Benthic Macroinvertebrate Processing and Subsampling) ☐ Possess Society for Freshwater Science Group 2 (East EPT) and Group 3 (East Chironomidae) certifications **OR** ☐ Must Send 10% of total samples to independent laboratory with certification. Voucher subsamples must meet acceptable error agreement during QAQC.

Technical Data Reporting
☐ Monitoring plan or QAPP-like documentation answers the who, what, when, where, why and how of data collection ☐ Includes contract laboratory and QA/QC documentation ☐ Appendix to summary final report includes raw data submission (excel spreadsheet)

Other Necessary Authorizations
☐ Possession of collections permit prior to survey work (from MD DNR)

Figure 11: APPENDIX A from "Biological Data Quality Guidelines"

Biological Data (non-MBSS) Submissions to MDE for Regulatory Use

This list represents the minimum level of documentation and information that MDE may request when evaluating biological sampling data for regulatory uses.

Staff/Personnel
Principal Investigator(s) ☐ 5 years of experience/education (post-graduate) conducting field-based biological monitoring
Research Assistant (RA)
Field RA ☐ Completed training (for Stream Waders only) ☐ Personnel conducting fish taxonomy must have work experience/education demonstrating proficiency
Laboratory RA ☐ Education/experience in benthic taxonomic identification or related lab duties ☐ Work conducted in lab free of probation or other disciplinary actions Primary personnel responsible for benthic taxonomy (if identifying to the genus level): ☐ Possess Society for Freshwater Science Group 2 (East EPT) and Group 3 (East Chironomidae) certifications **OR** ☐ Must Send 10% of total samples to independent laboratory with certification. Voucher subsamples must meet acceptable error agreement during QAQC.

Technical Data Reporting
☐ Monitoring plan or QAPP-like documentation answers the who, what, when, where, why and how of data collection ☐ Includes any contract laboratory information and QA/QC documentation ☐ Appendix to summary final report includes raw data submission (excel spreadsheet)

Other Necessary Authorizations
☐ Possession of collection permit prior to survey work (from MD DNR)

Figure 12: APPENDIX B from "Biological Data Quality Guidelines"

C.2.5 Temperature Assessment Methodology for Use III(-P) Streams in Maryland

Background

Code of Maryland Regulations (COMAR) Section 26.08.02.08 assigns use classes and the corresponding designated uses for water bodies throughout Maryland. Designated uses define the water quality goals for a water body. At a minimum, the Maryland Department of the Environment (MDE) must provide water quality for the protection and propagation of fish, shellfish, and wildlife, and provide for recreation in and on the water, where attainable (Clean Water Act (CWA) Section 101(a)(2)). Where numeric thresholds are available, MDE adopts these as water quality criteria to protect designated uses. Such criteria must be scientifically defensible and relate, directly or indirectly, to attainment of the designated use.

Studies have shown that temperature is a key parameter for protecting aquatic life and Maryland has adopted numeric temperature criteria. Temperature is a physical property of water that affects most biological and chemical processes that occur in water (Bogan et al. 2003). Water temperature is an important measure of water quality and influences the overall health of aquatic ecosystems (Kelleher et al. 2011; Caissie 2006; Coutant 1999). In many cases, the geographic distribution of aquatic species (e.g., fish and benthic macroinvertebrates) is determined by the thermal regime of streams in the region. Anthropogenic activities can alter the temperature regime of streams and rivers causing changes (sometimes permanent) in the biological community (Allan 1995). For example, if the thermal tolerance of a fish species is exceeded in a stream reach, it can result in direct fish mortality (Easton and Scheller 1996; Caissie et al. 2001). Since temperature can affect the attainment of designated uses, it is necessary to assess and protect stream temperature as an essential component of the total aquatic environment to achieve and maintain designated uses.

Code of Maryland Regulations groups waters of the State into four main use classes according to the unique water body types and the specific designated uses that apply. The four main use classes are listed below.[24]

- I(-P) - Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life,
- II(-P) - Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting,
- III(-P) – Nontidal Cold Water, and
- IV(-P) - Recreational Trout Waters

Each of these use classes has a numeric water temperature criterion. However, this temperature assessment methodology will focus only on assessing Use Class III(-P) Nontidal Cold Waters and the associated temperature criterion. A temperature assessment methodology for Use Classes I(-P), II(-P), and IV(-P) waters may be developed in the future.

Certain waters of the State possess water quality suitable to support cold water community assemblages. To protect the conditions necessary for cold water community survival and persistence, Maryland's regulations (COMAR 26.08.02.02B(5)) establish Use Class III: Nontidal Cold Waters. Use Class III(-P) is defined in COMAR Section 26.08.02.02 as follows:

[24] Each of these use classes can potentially have a "-P" suffix if the public water supply designated use applies to the water body.

“Use III: Nontidal Cold Water. This use designation includes all uses identified for Use Class I and waters which have the potential for or are:
(a) Suitable for the growth and propagation of trout populations and other coldwater obligate species including, but not limited to the stoneflies tallaperla and sweltsa.
(b) Capable of supporting self-sustaining trout populations and their associated food organisms.”

The temperature criteria associated with Use Class III(-P) (see COMAR 26.08.02.03-3 D. (3)) are:

“(a) The maximum temperature outside the mixing zone determined in accordance with Regulation .05 of this chapter or COMAR 26.08.03.03—.05 may not exceed 68°F (20°C) or the ambient temperature of the surface waters, whichever is greater.
(b) Ambient temperature—Same as Use Class I.
(c) A thermal barrier that adversely affects salmonid fish may not be established.
(d) It is the policy of the State that riparian forest buffer adjacent to Use Class III waters shall be retained whenever possible to maintain the temperatures essential to meeting this criterion.”

Up until the 2014 Integrated Report cycle, Maryland did not have an established methodology for assessing water temperature. Before that time, stream temperature data was rarely assessed as assessments were focused on other parameters with more robust assessment methodologies. Prior to 2014, the State recognized that monitoring and assessing temperature was a critical component in evaluating and protecting Maryland’s cold water streams. Eventually, with the advent of the Maryland Biological Stream Survey’s (MBSS) temperature monitoring program, more data was gathered and consistent protocols were developed. This greatly enhanced the reliability of temperature data and helped to provide the basis for many of the protocols and analysis methods discussed herein. Created in collaboration with Maryland DNR, this document describes the temperature assessment methodology to be used for evaluating Use Class III(-P) non-tidal cold water streams.

Rationale for Temperature Analysis Thresholds

Recent analysis by the University of Maryland Center for Environmental Science (UMCES) and DNR confirm the appropriateness of the current Use Class III(-P) temperature criterion (68°F/20°C) in protecting healthy populations of Maryland’s cold water obligates. However, these studies also noted that even in streams holding healthy populations of brook trout (*Salvelinus fontinalis*), a cold water obligate, that water temperatures do occasionally exceed 68°F/20°C. The following paragraphs describe the results from those studies.

Hilderbrand (2009) analyzed stream temperature data, from 236 Maryland Biological Stream Survey (MBSS) sampling records from 2001 to 2008 and recorded during the critical summer period (June 1 through August 31). Hilderbrand’s study found that brook trout-bearing streams exceeded 68°F/20°C approximately 10.7% of the time. In addition, the average daily mean for brook trout-bearing streams was 16.8°C.

Table 12: Temperature Statistics for Streams with brook trout (Hilderbrand 2009).

Temperature Statistic	Mean
Percent of Time Temperature > 20C	10.7%
Average Daily Mean (degrees C)	16.8°C

One limitation of this study was that it included all streams containing brook trout, including those streams that had only one individual. As a result, these statistics were calculated on a population of brook trout-bearing streams that likely included streams with a degraded (warm) thermal regime. To further clarify, some of these streams may have had a remnant or transient brook trout at the time of sampling, but for all intents and purposes, have an impaired thermal regime.

In order to overcome this limitation, DNR developed a more appropriate reference condition to effectively describe the thermal regime for healthy/persistent cold water streams. To be considered a non-degraded cold water site (i.e., reference condition), DNR chose locations sampled in July and August (generally the hottest months of the year) that had 25 or more brook trout[25] and which demonstrated multiple year classes. In all, thirty-eight sites qualified as reference sites. From this vetted dataset, DNR found that stream temperature still exceeded 68°F/20°C approximately 10% of the time (Table 13).

Table 13:Temperature Statistics for Non-impaired Cold Water Streams.

Temperature Statistic (n = 84,950 temperature measurements)	Empirically Derived Value
Percent time >20°C	10.9%
Mean Temperature (°C)	17.3
90th Percentile Temperature (°C)	20.1

Since both the UMCES and DNR studies' arrived at nearly an identical result, the Department decided to use the 90th percentile of temperature measurements to help determine[26] whether a Use Class III(-P) stream is meeting temperature criteria. Therefore, the 90th percentile temperature of a Use Class III(-P) stream must be equal to or less than 68°F/20°C, outside of any mixing zone established by the Department, to be considered not impaired. In so doing, this assessment rule is consistent with EPA's 10% rule as described in EPA guidance for the development of state's 305(b) reports (EPA 1997 and Regas 2005).

[25] Self-sustaining brook trout populations were effective indicators of healthy cold water conditions as their thermal regime matches very closely with Tallaperla and Sweltsa, two other cold water obligate taxa.
[26] This assessment methodology includes another step that incorporates an assessment of coldwater obligate populations to help confirm the temperature assessment results. This is explained later in the section titled "Temperature Assessment Process".

The Department will also utilize a secondary assessment threshold, that being an upper limit of 23.8°C, to help identify potential impairments. The purpose of this secondary threshold is to help identify those Use Class III(-P) streams that are impacted by short duration, high temperature events. In effect, this secondary threshold ensures that monitored Use Class III(-P) streams will not experience extreme increases in temperature beyond the thermal limit of cold water obligates without being identified as impaired. This value is based on literature by Embody (1921), Kendall (1924), Bean (1909), McAfee (1966), and MacCrimmon and Campbell (1969).

Temperature Assessment Process

Under Section 303(d)(1) of the federal Clean Water Act (CWA), MDE is required to develop a list of those waters that do not meet applicable water quality standards and are therefore considered "impaired" (placed in Category 5 of the Integrated Report). To achieve this, MDE considers all existing and readily available water quality data and information, and develops methods to interpret these data for each impairing substance. An impairment is identified when water quality monitoring data suggest that a water body does not meet or is not expected to meet water quality standards or applicable criteria. When a water body is assessed as impaired, the cause (pollutant or pollution) and priority of the impairment is identified.

EPA provides guidance on making 'use support determinations' for the State Water Quality Assessments 305(b) Report (EPA 1997) (referred herein as the Integrated Report). Maryland's 303(d) list and 305(b) report are combined as the Integrated Report (IR) which describes waters using five unique categories, including: Category 1 – waters attaining all standards; Category 2 – waters attaining some standards; Category 3 – waters with insufficient information to determine if water quality standards are attained; Category 4 – impaired or threatened waters that do not need or have an already completed TMDL; and, Category 5 – impaired waters for which a TMDL is required.

This assessment methodology provides the decision framework, including data collection requirements and analysis techniques, used to determine if a Use III(-P) stream or river is meeting the required temperature criteria or otherwise supporting the cold water aquatic life use. The Maryland Department of the Environment considers all current and readily available stream and river temperature data to determine if a water body should be assessed as impaired for temperature on the Integrated Report. MDE evaluates the monitoring plans, quality assurance and quality control programs of any data provided to determine what data can be included in assessments. The rules below describe how water temperature data assessed for Use Class III(-P) will be used in Integrated Reporting. As a general rule, there are three potential outcomes of the assessment of a water body, these include: Category 2 – waters attaining some standards; Category 3 – waters with insufficient information to determine if water quality standards are attained; Category 5 – impaired waters for which a TMDL is required. Categories 1 and 4 may be assigned, but are contingent on other Department actions not covered within this assessment methodology (e.g. assessment of other criteria, development of a TMDL).

Assessment Scale

The data collected by a single water temperature logger will generally be considered representative of a single stream segment, from the location of the logger upstream to the next confluence, according to the 1:100,000 scale National Hydrography Dataset (NHD). In this case, the upstream confluence is defined as either the next upstream confluence with a perennial stream or, if no upstream confluence exists, the headwaters of the stream itself. This geographic scale will therefore be the default assessment scale for the Integrated Report of Surface Water Quality (IR). However, this methodology recognizes that unforeseen environmental settings may complicate the assessment scenario and thereby require adaptability of the assessment scale. For that reason, State biologists reserve the right to use best professional judgment when specifying the final scale of assessment. It is worth noting, that regardless of using a stream segment as the defaulting listing scale, upstream waters must protect downstream uses, and all upstream sources of thermal pollution will be considered during the assessment process.

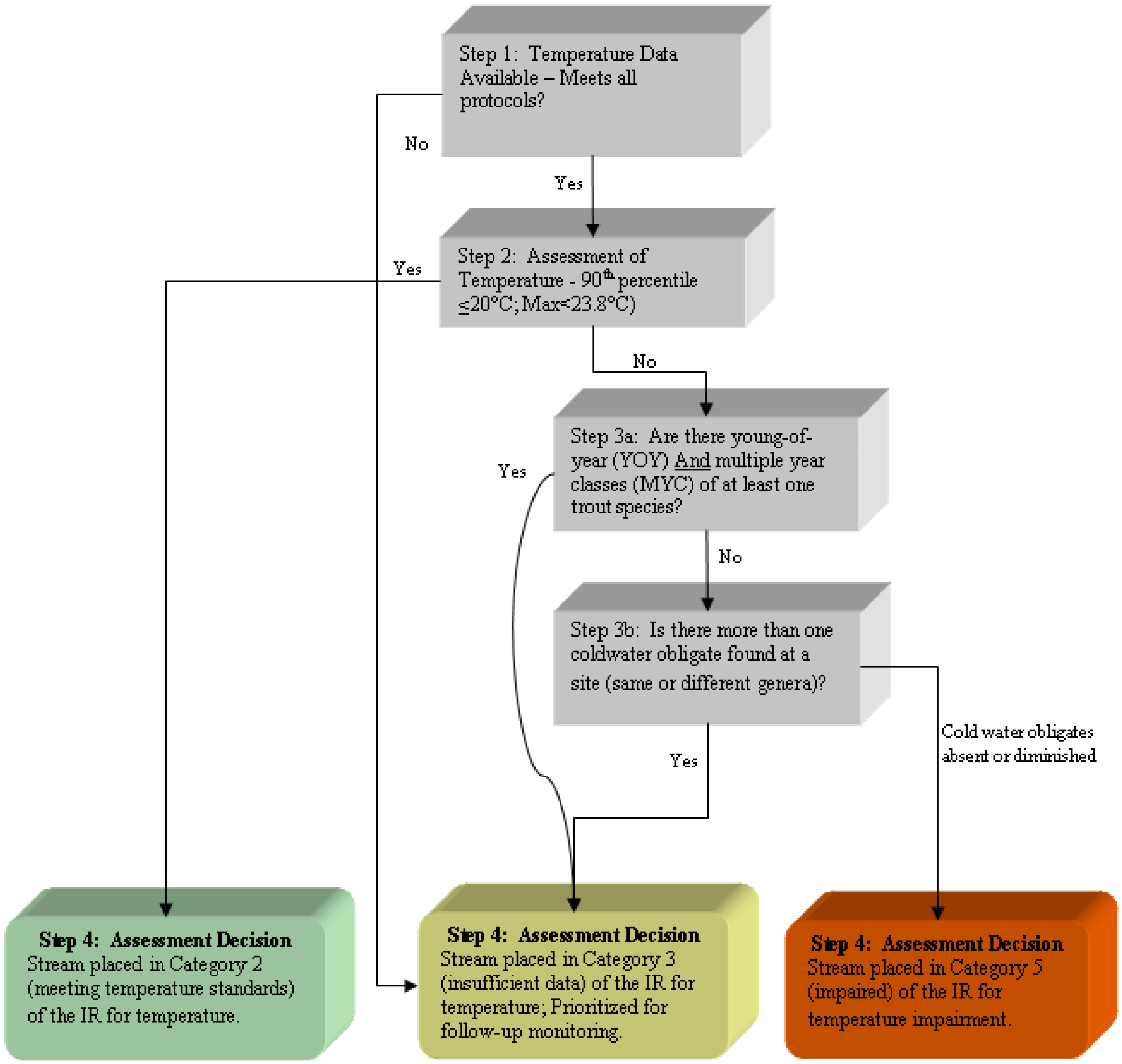

Figure 13: Decision diagram for Use III(-P) Non-tidal Cold Water attainment decisions.

Decision Diagram Step 1: Temperature Data

All data used for temperature impairment determinations must meet Maryland's stream temperature measurement protocols as detailed in Maryland's Temperature Measurement Protocols for Wadeable Streams. This document describes the procedures for measuring water temperatures in 1st through 4th order lotic systems (as defined by Strahler 1952 and 1964) that are well mixed and have nearly constant temperatures from surface to bottom (Allan 1995). This document provides information on temperature equipment, the time period and frequency for measurements, logger deployment and retrieval, quality assurance/quality control procedures, and data management. For Use Class III(-P) waters, the critical period for temperature measurement is defined as June 1 through August 31. In all cases, data should be collected with the use of continuous temperature loggers deployed in streams/rivers to record water temperature at 30 minute intervals or less. Data collected outside the critical period can be used for assessment purposes, however, temperature criteria violations are unlikely to occur at these times of year. Adequate documentation is necessary to ensure that data are of known quality. Documentation should include a detailed monitoring plan and an explicit quality assurance/quality control document whenever water temperature data are submitted to MDE.

Decision Diagram Step 2: Assessment of Temperature Regime

Use III(-P)

The Department will review all valid temperature data taken outside of any permitted thermal mixing zones and recorded between the period from June 1 to August 31. (Measurements should be taken at a minimum frequency of every 30 minutes.) If the 90th percentile of these values is equal to or less than 20°C and the maximum temperature recorded during that time period is less than 23.8°C, that stream reach will be placed in Category 2 (not impaired) of the Integrated Report. If either of these statistics is exceeded for a particular stream, that stream will be further evaluated in step 3.

It is important to note that deviations (up to 10%) above 20°C apply only to the summer months. Temperature measurements recorded between September 1 and May 31 of any year are not permitted to exceed 20°C.[27] However, to be considered valid, any data collected between September 1 and May 31 must also be collected according to the aforementioned protocols which include taking measurements in 30 minute or shorter intervals. Although data providers can conduct use support determinations, MDE reserves the right to analyze the raw data provided by individuals or groups to determine if the numeric temperature criteria are met for Use III(-P) waters.

Decision Diagram Step 3: Assessment of Cold Water Obligates

Step 3 is initiated when the temperature data for a Use Class III(-P) stream exceeds either the 90th percentile and/or the thermal maximum threshold. In either case, State assessors will assemble all data, historical and current, that describe the presence of cold water obligate species. Currently, Maryland recognizes three fish species and two benthic macroinvertebrate taxa as cold water obligates (species that generally require water colder than 68°F/20°C). Those species are listed below:

[27] In rare cases where a few exceedances occur in early September due to weather-related events, State Biologists may determine that an impairment does not exist if summer data meets the listing threshold.

Fish

- Brook trout, Latin Name: *Salvelinus fontinalis*
- Brown trout, Latin Name: *Salmo trutta*
- Rainbow trout, Latin Name: *Oncorhynchus mykiss*

Benthic Macroinvertebrates (Both Stoneflies – Order: Plecoptera)

- Latin Name: *Tallaperla*
- Latin Name: *Sweltsa*

<u>Step 3a: Assessment of Coldwater Fish</u>

When fish data are available for the site, State assessors will use this data to determine if two conditions are met:

1. Do young-of-year (YOY) trout inhabit the stream as evidenced by trout less than 100 millimeters in size? <u>**And**</u>
2. Are there multiple year-classes of that same trout species?

If both of these conditions are met, it may suggest that the temperature data and analysis for this site needs further refinement in terms of temporal or spatial sampling resolution. In such cases, MDE will place these waters in Category 3 (insufficient information) and prioritize them for follow-up monitoring. If fish data does not exist or does not meet the aforementioned conditions, the water segment will be considered in Step 3b for the presence of coldwater benthic macroinvertebrates.

To conduct this analysis, State assessors typically use the Maryland Biological Stream Survey (MBSS) data.[28] By setting up a histogram of the lengths for each species of trout caught in the stream, the assessor can determine if YOY and multiple year classes are present. Young-of-year trout are generally less than 100 millimeters in length during the time of MBSS sampling (June 1 – August 31) so individuals smaller than this are counted as YOY (Charles Gougeon, MD DNR, personal communication). To assess for multiple year classes, the assessor will look for breakpoints in the histogram that suggest divisions between year-classes of trout. Since most trout of a single species are hatched at the same time of year, the size difference between consecutive year classes usually has a discrete boundary.

Figure 14 below shows an example histogram displaying the number of brook trout of varying lengths caught at MBSS sampling station SAVA-117-R-2002. In this case, bin sizes for the histogram were set to 5 millimeters.

[28] The MBSS data provides the lengths (in millimeters) and abundance of all gamefish caught during electrofishing. (In Maryland, all trout species are considered gamefish.)

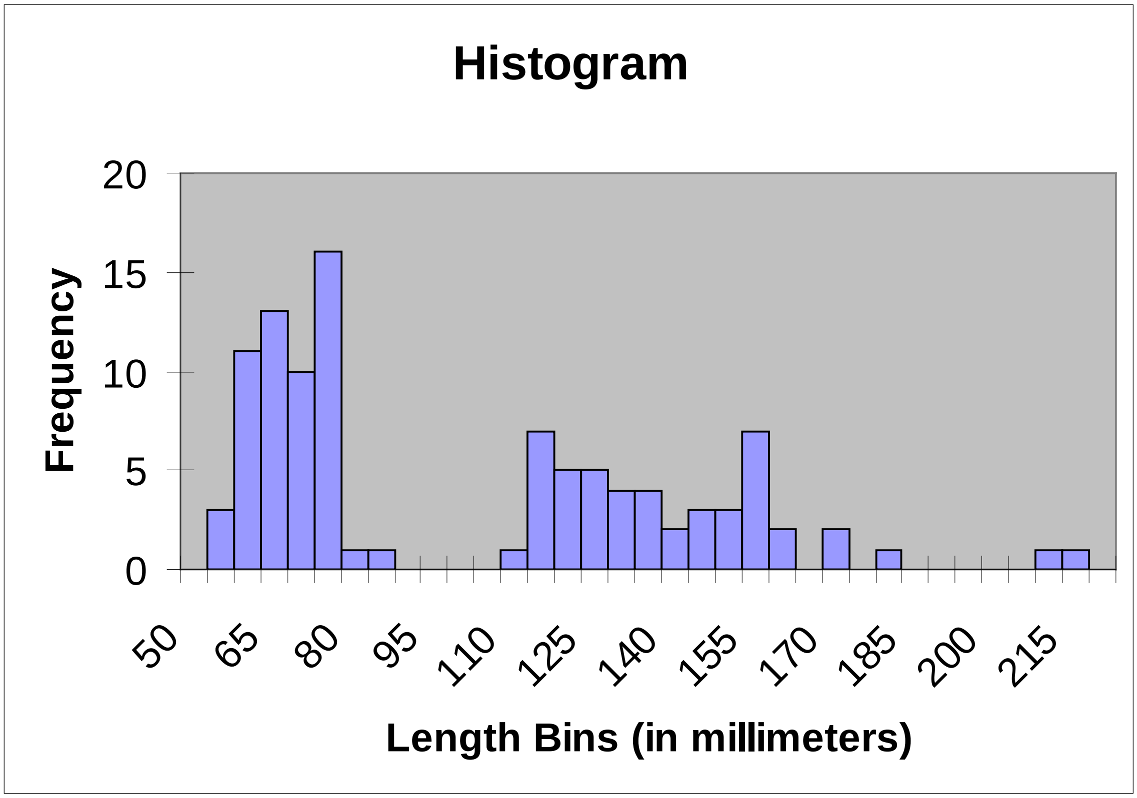

Figure 14: Histogram showing the distribution of brook trout sizes (SAVA-117-R-2002).

This particular example reveals at least three distinct year-classes as indicated by the trimodal distribution of trout lengths. In addition, the histogram shows the presence of young-of-year brook trout, illustrated by those individuals that are less than 100 millimeters in length. Such a scenario provides some evidence that stream temperatures were sufficiently cold enough to support the Use III coldwater use. If this particular stream (SAVA-117-R-2002) exceeded the thermal thresholds, MDE would place this water segment in Category 3 (insufficient information) of the Integrated Report due to conflicting information from the temperature and biological data.

For waters that have been sampled more than once, such as MBSS sentinel sites, State assessors will evaluate historical cold water fish data. For these waters, assessors will compare abundance and year-class structure over time in addition to looking at the most recent year. In this case, decreasing abundances or year classes may indicate an impacted thermal regime and could be used to support a Category 5 impairment listing. Alternatively, increasing abundances and year classes may be used to support a Category 3 (insufficient information). Many scenarios can potentially occur given the variability in stream temperature and biological data so State assessors must retain flexibility in making categorical determinations for such sites.

Step 3b: Assessment of Coldwater Benthic Macroinvertebrates

Cold water benthic macroinvertebrate information can also be useful for assessing current stream temperature conditions. Since both of the taxa that Maryland uses for cold water determinations (*Tallaperla and Sweltsa*) have long aquatic nymph stages, and are relatively immobile (as compared to fish) during this life phase, they serve as appropriate indicators of cold water use support.

For water segments that have exceeded the thermal thresholds and which do not meet the conditions under Step 3a, cold water benthic macroinvertebrate data will be considered (Step 3b). In these cases, when multiple (more than one) Tallaperla or Sweltsa are found at a sampling site that water segment will be placed in Category 3 (insufficient information). Conversely, if benthic macroinvertebrate data fails to demonstrate the presence of either taxa, the water segment will be placed in Category 5 (impaired) of the Integrated Report.

In summary, for streams that exceed the thermal thresholds described in Step 2, data demonstrating the recent persistence of any one cold water obligate species will be used to support a Category 3 (insufficient information) assessment. The five taxa discussed in this step (Step 3) represent some of the most sensitive aquatic taxa in the state. Therefore, the demonstration of persistence by any one of these cold water obligates provides significant justification for requiring additional data prior to making an impairment listing. Likewise, when data on cold water obligates shows a declining trend or an absence of cold water obligates, the stream will be assessed as impaired and placed in Category 5. The Department acknowledges that scenarios are likely to arise in which data on cold water obligates may be incomplete, inconclusive, or unavailable. In any of these scenarios, the assessor will place such streams in Category 5 (impaired) if they exceed the thermal thresholds discussed in Step 2. This document cannot anticipate all such data scenarios. For this reason, State assessors may need to exercise best professional judgment to ensure that streams are accurately characterized (i.e., placed in the appropriate listing Category) for the Integrated Report.

Table 14: Generalized matrix describing hypothetical data scenarios and likely assessment outcomes.

		Step 3: Coldwater Obligate Assessment		
		Persistent Coldwater Obligate Population	**Incomplete, Inconclusive, or Unavailable Data**	**Coldwater Obligates Absent or Diminished**
Step 2: Temperature Assessment	**Temperature Thresholds Met**	Category 2 (not impaired for temperature)	Category 2 (not impaired for temperature)	Category 2 (not impaired for temperature)
	Thresholds Exceeded	Category 3 (insufficient information)	Category 5 (impaired for temperature)	Category 5 (impaired for temperature)

Decision Diagram Step 4: Integrated Reporting (IR) of Assessment Results

For the Integrated Report, temperature assessments will generally fall into Categories 2, 3 or 5. Temperature and cold water obligate data used to put waters in Category 2 (unimpaired) or 5 (impaired) must be of sufficient quality and collected according to proper protocols (Maryland's Temperature Measurement Protocols for Wadeable Streams). Data that do not meet these quality assurance protocols can be used to place a water body in Category 3 (insufficient information).

Use Class III(-P) streams with temperature data that meets both impairment thresholds (90th percentile≤20°C and maximum≤23.8°C) will be placed in Category 2 as unimpaired by temperature (regardless of the presence/absence of cold water obligates). Streams with temperature data that exceeds one or more of the applicable thresholds (90th percentile or thermal maxima) will be reviewed in greater detail in step 3. In cases where data for step 3 is nonexistent or inconclusive, a Category 5 assessment will be made. For streams where coldwater obligate information suggests use attainment, a Category 3 assessment will result. Then, as resources permit, the Department will prioritize these streams for additional temperature sampling.

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C.3 Assessment Results

There are 138 additions to the list of Category 5 waters in 2014. Seventy-one of the new Category 5 water body-pollutant combinations (also referred to as listings) resulted from the newly implemented temperature assessment methodology for Use Class III and III-P streams. Stream segments that failed to meet applicable temperature thresholds and failed to demonstrate persistent coldwater obligate populations were listed as impaired for temperature. Another thirty-five of the new Category 5 listings resulted from MDE's Biological Stressor Identification Analyses. 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. Of these 35 new 'biostressor' listings, ten are for chlorides, eight are for total suspended solids, seven are for sulfates, six are for total phosphorus, and four are listed for pH. In addition, there are eight new PCB listings for fish tissue, seven fecal coliform listings in shellfish harvesting waters, six mercury listings for fish tissue, three listings for high pH, and one new heptachlor epoxide listing. Finally, there are seven new Category 5 listings for failures to attain the aquatic life designated use as determined by stream biological sampling data (pollutant(s) not yet specified). Table 15 below provides more detailed information regarding these new listings.

Table 15: New Category 5 (impaired, may need a TMDL) Listings on the 2014 Integrated Report.

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-02130507	Corsica River	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02130502	Miles River	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02130605	Little Elk Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02130105	Newport Bay	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02140510	Sideling Hill Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02140505	Little Conococheague	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02130803	Bird River	1st thru 4th order streams	Aquatic Life and Wildlife	Cause Unknown
MD-02131001	Magothy River	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02140504	Conococheague Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-02140509	Little Tonoloway Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02141004	Georges Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02130701	Bush River	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02130903	Baltimore Harbor	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02131003	South River	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02131104	Patuxent River upper	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02140111	Mattawoman Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-02130805	Loch Raven Reservoir	1st thru 4th order streams	Aquatic Life and Wildlife	Chlorides
MD-PAXMH-HogNeck_Creek	PAXMH - Lower Patuxent River Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-WICMH-Ellis_Bay	WICMH - Wicomico River Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-HNGMH-Great_Marsh_Creek	HNGMH - Honga River Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-CB3MH-Rock_Hall_Harbor	CB3MH - Chesapeake Bay Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-POTMH-Neale_Sound	POTMH - Lower Potomac River Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-CB3MH-Swan_Creek	CB3MH - Chesapeake Bay Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-PAXMH-BATTLE_CREEK3	PAXMH - Lower Patuxent River Mesohaline	Tidal Shellfish Area	Shellfishing	Fecal Coliform
MD-ANATF	Anacostia River	Chesapeake Bay segment	Fishing	Heptachlor Epoxide
MD-02140504-Mainstem	Conococheague Creek	River Mainstem	Fishing	Mercury in Fish Tissue
MD-02140301-Mainstem	Potomac River Frederick County	River Mainstem	Fishing	Mercury in Fish Tissue
MD-02140501-Dam4-5	Potomac River Washington County	River Mainstem	Fishing	Mercury in Fish Tissue

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-02140501-Dam3-4	Potomac River Washington County	River Mainstem	Fishing	Mercury in Fish Tissue
MD-02141001-Mainstem	Lower North Branch Potomac River	River Mainstem	Fishing	Mercury in Fish Tissue
MD-02141005-Jennings_Randolph_Reservoir	Upper North Branch Potomac River	Impoundments	Fishing	Mercury in Fish Tissue
MD-02140301-Mainstem	Potomac River Frederick County	River Mainstem	Fishing	PCB in Fish Tissue
MD-02140501-Dam3-4	Potomac River Washington County	River Mainstem	Fishing	PCB in Fish Tissue
MD-CHOOH-TF-02130404	CHOOH - Choptank River Oligohaline	Tidal subsegment	Fishing	PCB in Fish Tissue
MD-MATTF	Mattawoman Creek	Chesapeake Bay segment	Fishing	PCB in Fish Tissue
MD-CHSMH-OH-02130505	Lower Chester River	Tidal subsegment	Fishing	PCB in Fish Tissue
MD-CB4MH-Herring_Bay	CB4MH - Middle Chesapeake Bay Mesohaline	Tidal subsegment	Fishing	PCB in Fish Tissue
MD-PISTF	Piscataway Creek Tidal Fresh	Chesapeake Bay segment	Fishing	PCB in Fish Tissue
MD-CB2OH	Middle Chesapeake Bay	Chesapeake Bay segment	Fishing	PCB in Fish Tissue
MD-02140508-Mainstem2	Potomac River Allegany County	River Mainstem	Aquatic Life and Wildlife	pH, High
MD-02140202-Mainstem_segment	Potomac River Montgomery County	Non-tidal Segment(s)	Aquatic Life and Wildlife	pH, High
MD-02140501-Mainstem_segment	Potomac River Washington County	Non-tidal Segment(s)	Aquatic Life and Wildlife	pH, High
MD-02140103	St. Mary's River	1st thru 4th order streams	Aquatic Life and Wildlife	pH, Low
MD-02140509	Little Tonoloway Creek	1st thru 4th order streams	Aquatic Life and Wildlife	pH, Low
MD-02140506	Licking Creek	1st thru 4th order streams	Aquatic Life and Wildlife	pH, Low
MD-02140111	Mattawoman Creek	1st thru 4th order streams	Aquatic Life and Wildlife	pH, Low
MD-02140504	Conococheague Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Phosphorus (Total)
MD-02130705	Aberdeen Proving Ground	1st thru 4th order streams	Aquatic Life and Wildlife	Phosphorus (Total)
MD-02130805	Loch Raven Reservoir	1st thru 4th order streams	Aquatic Life and Wildlife	Phosphorus (Total)

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-02130706	Swan Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Phosphorus (Total)
MD-02130509	Middle Chester River	1st thru 4th order streams	Aquatic Life and Wildlife	Phosphorus (Total)
MD-02130301	Lower Wicomico River	1st thru 4th order streams	Aquatic Life and Wildlife	Phosphorus (Total)
MD-02131102	Patuxent River Middle	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02140502	Antietam Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02140504	Conococheague Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02130701	Bush River	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02130805	Loch Raven Reservoir	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02131104	Patuxent River upper	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-02130903	Baltimore Harbor	1st thru 4th order streams	Aquatic Life and Wildlife	Sulfates
MD-021405020192-LittleBeaver_Creek	Antietam Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403050217-UTLittleCatoctin_Creek	Catoctin Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403050220-LittleCatoctin_Creek	Catoctin Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403050217-Hawbottom_Branch	Catoctin Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403050219-Spruce_Run	Catoctin Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-050202040037-Piney_Creek	Casselman River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202020331-Big_Branch1	Deer Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-021307041131-UTBynum_Run	Bynum Run	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202020331-Big_Branch2	Deer Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071048-GlenFalls_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071046-UTLocust_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309041036-UTJones_Falls	Jones Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-050202040033-SouthBranch_Casselman_River2	Casselman River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-Principio_Creek1	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309041036-Slaughterhouse_Branch	Jones Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309051045-Red_Run	Gwynns Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309051045-UTRed_Run2	Gwynns Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309051045-UTRed_Run1	Gwynns Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-Principio_Creek2	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-050202030029-Cherry_Creek2	Deep Creek Lake	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-Principio_Creek3	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-UTPrincipio_Creek3	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-UTPrincipio_Creek2	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-UTPrincipio_Creek1	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-021410020108-PeaVine_Run	Evitts Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202020330-Deer_Creek2	Deer Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202020330-Deer_Creek1	Deer Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021306090380-UTPrincipio_Creek4	Furnace Bay	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-050202010007-DunkardLick_Run	Youghiogheny River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-050202010019-Buffalo_Run2	Youghiogheny River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403030251-UTBigHunting_Creek	Upper Monocacy River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202030344-Basin_Run1	Octoraro Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202020330-Deer_Creek3	Deer Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021311080966-Patuxent_River1	Brighton Dam	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309041036-UTNBranch_Jones_Falls	Jones Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309081023-Piney_Run1	South Branch Patapsco River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403030258-Friends_Creek	Upper Monocacy River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071046-Locust_Run1	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021311080966-Patuxent_River2	Brighton Dam	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308040298-LittleGunpowder_Falls1	Little Gunpowder Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308040299-Yellow_Branch	Little Gunpowder Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-021308040298-UTLittleGunpowder_Falls	Little Gunpowder Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308040299-Nelson_Branch	Little Gunpowder Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071046-Snowdens_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403020230-Ballenger_Creek	Lower Monocacy River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071046-Locust_Run2	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403020223-LittleBennett_Creek	Lower Monocacy River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071059-EastBNBranch_Patapsco_River	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071046-CarrollHighlands_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071059-UTEBNBranch_Patapsco_River	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071046-Locust_Run3	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071048-Timber_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071048-Keysers_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309071055-LittleMorgan_Run	Liberty Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308060314-Murphy_Run	Prettyboy Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403030243-Fishing_Creek	Upper Monocacy River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021402080865-UTWildcat_Branch	Seneca Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309081029-UTMiddle_Run	South Branch Patapsco River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-021410060084-Savage_River2	Savage River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021410060074-SForkCrabtree_Creek	Savage River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021410060074-NForkCrabtree_Creek	Savage River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308040298-LittleGunpowder_Falls2	Little Gunpowder Falls	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021403010211-UTTuscarora_Creek	Potomac River Frederick County	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021309081023-Piney_Run2	South Branch Patapsco River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308060316-UTGunpowder_Falls	Prettyboy Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202030344-UTBasin_Run	Octoraro Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-050202020025-LittleYoughiogheny_River	Little Youghiogheny River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202010319-Rock_Run1	Lower Susquehanna River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021202010319-Rock_Run2	Lower Susquehanna River	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021308050309-FirstMine_Branch	Loch Raven Reservoir	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-021402060838-NBranchRock_Creek	Rock Creek	Non-tidal Segment(s)	Aquatic Life and Wildlife	Temperature, water
MD-02131102	Patuxent River Middle	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02131101	Patuxent River lower	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02130701	Bush River	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02130903	Baltimore Harbor	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)

AU_ID	Basin_Name	Water_Type_Detail	Designated_Use	Cause
MD-02131003	South River	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02131005	Other West Chesapeake Bay	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02140509	Little Tonoloway Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)
MD-02130706	Swan Creek	1st thru 4th order streams	Aquatic Life and Wildlife	Total Suspended Solids (TSS)

Based on Maryland's bacteria assessment methodology which now (2014) includes a decision process for assessing combined sewer overflows (CSO) and sanitary sewer overflows (SSO), if any water body segment has received three or more spills of greater than 30,000 gallons within the previous five year assessment period that water body will be considered impaired. This is applied only in the absence of bacterial monitoring data; if such monitoring data are available, the decision methodology for bacteria will apply. Table 16 and 17 describe the pertinent overflow events. Though not all of these bacterial impairments are captured in the IR database, these tables serve as record of their impairment until the Department develops a more detailed methodology that will clarify how such situations will be handled and ultimately remedied.

Table 16: Summary of combined sewer overflows (CSO) that occurred 3 or more times over the past 5 years.

Receiving Waters	NPDES Permit	# Exceedences (≥30,000 gallons) from 2008 thru 2012	City/County	Consent Decree	Integrated Report Status for Bacteria
Braddock Run	MD0067547	164	La Vale/Allegany	✓	Listed and TMDL complete
Evitts Creek	MD0021598	15	City of Cumberland/Allegany County	✓	Not listed
North Branch Potomac River	MD0021598	578	City of Cumberland/Allegany County	✓	Listed on Category 3 (insufficient information)
Wills Creek	MD0021598	119	City of Cumberland/Allegany County	✓	Listed and TMDL complete
Choptank River	MD0021636	374	City of Cambridge/Dorchester	✓	Multiple shellfish areas listed with TMDLs complete
George's Creek	MD0067384	34	Westernport/Allegany	✓	Listed and TMDL complete
George's Creek	MD0067407	119	Dept. Public Works/Allegany	✓	Listed and TMDL complete
George's Creek	MD0067423	80	Frostburg/Allegany	✓	Listed and TMDL complete
Jennings Run	MD0067423	8	Frostburg/Allegany	✓	Listed under Wills Cr. And TMDL complete

Receiving Waters	NPDES Permit	# Exceedences (≥30,000 gallons) from 2008 thru 2012	City/County	Consent Decree	Integrated Report Status for Bacteria
Sand Spring Run	MD0067423	14	Frostburg/Allegany	✓	Listed and TMDL complete

Table 17: Summary of sanitary sewer overflows (SSO) that occurred 3 or more times over the past 5 years resulting from the same facility or occurring within the same jurisdiction.

Receiving Waters	Owner of Collection System	# Exceedences (≥30,000 gallons) from 2008 thru 2012	City/County	Consent Decree	Integrated Report Status for Bacteria
Anacostia River	Washington Suburban Sanitation Commission	3	Prince George's County	✓	Listed and TMDL complete
Broad Creek	Washington Suburban Sanitation Commission	16	Prince George's County	✓	Not listed
C&D Canal	Chesapeake City	4	Chesapeake City/Cecil County		Not listed
Chesapeake Bay	Calvert County DPW	4	Chesapeake Beach/Calvert County		Not listed
Conocheague Creek	Washington County Dept. of Water Quality	4	Washington County		Listed and TMDL complete
Evitts Creek	Allegany County DPW	13	City of Cumberland/Allegany County	✓	Not listed
Falls Creek	Washington County Dept. of Water Quality	8	Washington County		Listed and TMDL complete
George's Creek	Allegany County DPW	12	Allegany County	✓	Listed and TMDL complete
Gwynns Falls	Baltimore City/Baltimore County	68	Baltimore City/Baltimore County	✓	Listed and TMDL complete
Herring Run	Baltimore City/Baltimore County	37	Baltimore City/Baltimore County	✓	Listed and TMDL complete
Hunting Creek	Town of Thurmont	5	Thurmont/Frederick County	✓	Listed and TMDL complete
Jennings Run	Allegany County	39	Allegany County	✓	Listed under Wills Cr. and TMDL complete
Jones Falls	Baltimore City/County	22	Baltimore City/Baltimore County	✓	Listed and TMDL complete
Little Patuxent River	Howard County DPW/Dept. of the Army	4	Howard County/Anne Arundel County		Listed on Category 3 (insufficient information)
Maiden Choice Creek	Baltimore County	43	Baltimore County	✓	Listed and TMDL Complete
Mattawoman Creek	Charles County/Dept. of the Navy	4	Charles County		Not listed
North Branch Potomac River	Allegany County (Cresaptown System)	49	Allegany County	✓	Listed on Category 3 (insufficient information)

Receiving Waters	Owner of Collection System	# Exceedences (≥30,000 gallons) from 2008 thru 2012	City/County	Consent Decree	Integrated Report Status for Bacteria
Northeast Creek	Baltimore County	5	Baltimore County	✓	Not listed
Tidal Patapsco including Inner Harbor	Baltimore City	20	Baltimore City	✓	Listed on Category 5, TMDL not yet complete
Non-tidal Patapsco River	Baltimore County DPW	11	Baltimore County	✓	Listed and TMDL Complete
Pea Vine Run	Allegany County	37	City of Cumberland/Allegany County	✓	Not listed
Piscataway Creek	Washington Suburban Sanitation Commission	14	Prince George' County	✓	Listed and TMDL complete
Port Tobacco River	Town of La Plata	5	Town of La Plata/Charles County	✓	Listed on Category 5
Potomac River	Charles County	4	Charles County		Not Listed
Stemmers Run	Baltimore County DPW	12	Baltimore County	✓	Not Listed
Unnamed Tributary to Evitts Creek	Allegany County	12	Allegany County		Not Listed
Warrior Run	Allegany County	38	Allegany County	✓	Listed in Category 3
Western Branch	Washington Suburban Sanitation Commission	6	Prince George's County	✓	Not listed
Wicomico River	City of Salisbury	5	Wicomico County		Not Listed
Wills Creek	Allegany County	50	Allegany County	✓	Listed and TMDL complete

In 2014, there were a total of 10 assessment records that moved from Category 2 back to Category 5 or 4a (Category 4a in cases where a TMDL was previously completed and approved) on the basis of new data.   All of these assessment records were previously listed as impaired on some prior Integrated Report (IR) cycle, were then delisted on a subsequent IR, and then have been 'relisted' on the 2014 IR. These 'relistings', as they are called, are captured in Table 18. They often occur with shellfish harvesting area assessments (3), fish tissue assessments for PCBs (3) and mercury (2), and, in fewer cases, biological assessments (2). These 'relistings' are most prevalent for water bodies which approach or just barely exceed the threshold for impairment. In all cases, new data demonstrated current impairment for these waters. In some cases, a TMDL was completed after the first instance of impairment listing. Now, after being relisted as impaired, these TMDLs again take effect.

Table 18: Summary of records that have had an assessment result that went from impaired to not-impaired and then back to impaired over the course of several Integrated Reporting cycles.

Assessment Unit ID	Basin Name	Basin Code	Water Type Detail	Designated Use	IR Category	Cause	Notes
MD-CHOOH-TF-02130404	CHOOH - Choptank River Oligohaline	02130404	Tidal subsegment	Fishing	5	PCB in Fish Tissue	New data for white perch and channel catfish show PCB levels above the impairment threshold.
MD-EASMH-WYE_RIVER2	Wye River	02130503	Tidal Shellfish Area	Shellfishing	4a	Fecal Coliform	This area now fails to meet the shellfish harvesting area bacteria criteria.
MD-EASMH-Wells_Cove	Kent Narrows - Prospect Bay	02130504	Tidal Shellfish Area	Shellfishing	4a	Fecal Coliform	TMDL approved in 2006. New data now shows that bacteria water quality standards are being exceeded.
MD-CHSMH-OH-02130505	Lower Chester River	02130505	Tidal subsegment	Fishing	5	PCB in Fish Tissue	Two four-fish composites of channel catfish show high levels of PCBs. However, a full composite is required prior to TMDL development.
MD-02130507	Corsica River	02130507	1st thru 4th order streams	Aquatic Life and Wildlife	5	Cause Unknown	Round 3 data causes this watershed to barely exceed the threshold for impairment.
MD-PAXMH-BATTLE_CREEK3	PAXMH - Lower Patuxent River Mesohaline	02131101	Tidal Shellfish Area	Shellfishing	5	Fecal Coliform	This portion of Battle Creek, represented by station 0902108, was relisted as impaired based on new data from MDE's Shellfish Monitoring Program.
MD-02140501-Dam3-4	Potomac River Washington County	02140501	River Mainstem	Fishing	5	Mercury in Fish Tissue	New data shows a 5-fish composite of channel catfish exceeding the mercury contaminant threshold.
MD-02140501-Dam3-4	Potomac River Washington County	02140501	River Mainstem	Fishing	5	PCB in Fish Tissue	This listing was split from the previous watershed-wide PCB listing for the entire Potomac River Washington County watershed (02140501). The segment was split at Dam #4. New channel catfish composite (5 fish) was above contaminant threshold.
MD-02140510	Sideling Hill Creek	02140510	1st thru 4th order streams	Aquatic Life and Wildlife	5	Cause Unknown	New data demonstrated impairment.

Assessment Unit ID	Basin Name	Basin Code	Water Type Detail	Designated Use	IR Category	Cause	Notes
MD-02141001-Mainstem	Lower North Branch Potomac River	02141001	River Mainstem	Fishing	5	Mercury in Fish Tissue	New walleye and smallmouth bass data show fish tissue mercury levels above the contaminant threshold.

There were a total of thirty-eight waterbody-pollutant combinations removed from Category 5 in 2014 (Table 19).[29] Twenty-one of these were generic biological listings (cause unknown) that did not specify a particular pollutant or stressor as the cause of impairment. These listings have now been replaced by specific pollutant/stressor listings enumerated by the Biological Stressor Identification analyses, Table 43.

The remaining seventeen delistings resulted from Water Quality Analyses, reassessments using newer data, or reassessments of the appropriate use. Water Quality Analyses (WQA) are completed when State scientists collect detailed information for a listed water body in anticipation of a TMDL and find that the water body is not impaired. New assessments or reassessments are simply a reanalysis of more recent water quality data collected by ongoing monitoring and assessment programs. Four of the remaining seventeen delistings (MD-02130802, MD-02120204, MD-02140202, MD-02141001) resulted from recently completed total phosphorus WQAs. Two more delistings (MD-02120204, MD-02141001) resulted from total suspended solids WQAs, two (MD-PATMH-Northwest_Branch, MD-PATMH-Bear_Creek) resulted from a chromium WQA, one (MD-PATMH-Bodkin_Creek) resulted from a copper WQA, and one other delisting (MD-02130907-Liberty_Reservoir) resulted from a mercury in fish tissue WQA.

Another four listings, manganese impairments to the drinking water use (MD- MD-021410050039-Laurel_Run, MD-021410050040-Sand_Run, MD-021410050048-Three_Forks_Run, MD-021410050049-Elklick_Run), were delisted based on analyses of finished water from the Luke water filtration plant (the nearest drinking water intake to these tributaries). All yearly samples collected between 2006 and 2011 showed manganese levels below the 0.05mg/l national secondary drinking water standard.[30] Since manganese is only known to have organoleptic (taste, odor, and staining) effects and since no additional treatment processes were required to meet this standard, these listings were moved to Category 2.

One listing for the Choptank River (MD-CHOMH1), was delisted because new estuarine bioassessment data demonstrated aquatic life use support.

[29] The number thirty-eight does not include partial delistings (Table 21), listings that were addressed by a TMDL (moved to Category 4a, Table 25), or listings that were in Categories 4a, 4b, or 4c but which are now meeting standards (Tables 22 and 24).
[30] Maryland has not adopted this standard into Code of Maryland Regulations (COMAR). Instead, the Department has only used this level (0.05mg/l) as a general guideline for assessing manganese data.

The final two delistings (of 38) were two uncommon scenarios; one involving the Atkisson Reservoir – Sedimentation/siltation listing and the other involving the Edgewater Village Lake – total phosphorus listing. In the 2012 IR the designated use specified for the Atkisson Reservoir listing was the water contact sports designated use. However, review by State staff established that this designated use was erroneously applied (swimming has never been permitted in Atkisson) and instead, should have been specified as the aquatic life designated use. State staff also conducted an exhaustive search for the data that led to the listing of Atkisson Reservoir for sediments. However, no historical or recent data was found that could corroborate this impairment. At the same time, wetland staff from both DNR and MDE concurred that Atkisson Reservoir was now functioning as a beneficial wetland and even contains several rare plant species adapted to this type of environment. With no data to evaluate the potential impact of sediments on this water body and with the uncertain classification of this water feature, the Department chose to move this listing to Category 3 (insufficient information) so that additional information could be collected. In the case of the Edgewater Village Lake – total phosphorus listing, this listing erroneously originated in Maryland's 1998 303(d) List. Edgewater Village Lake (EVL) is a stormwater pond which was specifically designed for capturing various pollutants (e.g. total phosphorus) associated with surburban stormwater. Since the IR is not meant for reporting on stormwater facilities or BMPs, this listing has been deleted from the 2014 IR.

Table 19: New Delistings for 2014 (removed from Category 5).

ID	Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Cause	Summary Rationale for Delisting of Segment-Pollutant Combinations*
898	MD-02130301	Lower Wicomico River	02130301	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1775	MD-CHOMH1	CHOMH1 - Choptank River Mesohaline mouth 1	02130403	ESTUARY	Aquatic Life and Wildlife	Cause Unknown	1
910	MD-02130509	Middle Chester River	02130509	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1554	MD-02130701	Bush River	02130701	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
780	MD-02130705	Aberdeen Proving Ground	02130705	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
782	MD-02130706	Swan Creek	02130706	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
882	MD-02130805	Loch Raven Reservoir	02130805	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
784	MD-02130903	Baltimore Harbor	02130903	RIVER	Aquatic Life and Wildlife	Cause Unknown	5

ID	Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Cause	Summary Rationale for Delisting of Segment-Pollutant Combinations*
1584	MD-02131001	Magothy River	02131001	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1585	MD-02131003	South River	02131003	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1588	MD-02131005	Other West Chesapeake Bay	02131005	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1593	MD-02131101	Patuxent River lower	02131101	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
933	MD-02131102	Patuxent River middle	02131102	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1601	MD-02131104	Patuxent River Upper	02131104	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1616	MD-02140103	St. Mary's River	02140103	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1120	MD-02140111	Mattawoman Creek	02140111	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
555	MD-02140303-Multiple_segments	Upper Monocacy River	02140303	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
383	MD-02140502	Antietam Creek	02140502	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
810	MD-02140504	Conococheague Creek	02140504	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
414	MD-02140506	Licking Creek	02140506	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
421	MD-02140509	Little Tonoloway Creek	02140509	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
584	MD-05020201-Wadeable_Streams	Youghiogheny River	05020201	RIVER	Aquatic Life and Wildlife	Cause Unknown	5
1196	MD-PATMH-Bear_Creek	PATMH - Patapsco River Mesohaline	02130903	ESTUARY	Aquatic Life and Wildlife	Chromium – sediments	1
352	MD-PATMH-Northwest_Branch	PATMH - Patapsco River Mesohaline	02130903	ESTUARY	Aquatic Life and Wildlife	Chromium – sediments	1

ID	Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Cause	Summary Rationale for Delisting of Segment-Pollutant Combinations*
162	MD-PATMH-Bodkin_Creek	PATMH - Patapsco River Mesohaline	02130902	ESTUARY	Aquatic Life and Wildlife	Copper	1
1830	MD-021410050039-Laurel_Run	Upper North Branch Potomac River	02141005	RIVER	Public Water Supply	Manganese	1
1832	MD-021410050040-Sand_Run	Upper North Branch Potomac River	02141005	RIVER	Public Water Supply	Manganese	1
1836	MD-021410050048-Three_Forks_Run	Upper North Branch Potomac River	02141005	RIVER	Public Water Supply	Manganese	1
1838	MD-021410050049-Elklick_Run	Upper North Branch Potomac River	02141005	RIVER	Public Water Supply	Manganese	1
678	MD-02130907-Liberty_Reservoir	Liberty Reservoir	02130907	IMPOUNDMENT	Fishing	Mercury in Fish Tissue	1
9	MD-02120204	Conowingo Dam Susquehanna River	02120204	RIVER	Aquatic Life and Wildlife	Phosphorus (Total)	1
142	MD-02130802	Lower Gunpowder Falls	02130802	RIVER	Aquatic Life and Wildlife	Phosphorus (Total)	1
262	MD-02140202	Potomac River Montgomery County	02140202	RIVER	Aquatic Life and Wildlife	Phosphorus (Total)	1
300	MD-02141001	Lower North Branch Potomac River	02141001	RIVER	Aquatic Life and Wildlife	Phosphorus (Total)	1
130	MD-021307031132-Atkisson_Reservoir	Atkisson Reservoir	02130703	IMPOUNDMENT	Water Contact Sports	Sedimentation/siltation	2
8	MD-02120204	Conowingo Dam Susquehanna River	02120204	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	1
299	MD-02141001	Lower North Branch Potomac River	02141001	RIVER	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	1
172	MD-021307021130-Edgewater_Village_Lake	Lower Winters Run	02130702	IMPOUNDMENT	Aquatic Life and Wildlife	Phosphorus (Total)	2

*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.

Table 20: Key for the last column in Table 19.

*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 water quality standards
4	Impairment due to non-pollutant
5	Original listing was based on a bioassessment, specific pollutants are now identified in place of biological listing

It is worth noting that there were several partial delistings in the 2014 IR that were not counted as part of the 38 'whole' delistings mentioned above and in Table 19. These partial delistings occurred in cases where an assessment unit that was previously entirely listed as impaired had new data that demonstrated use support in some smaller geographic portion. In order to reflect this new information and the fact that a portion of these waters now meet standards, MDE split the original assessment unit into two assessment units, one which is still impaired and another that is not. This occurred in three cases shown in Table 21 below. These partial delistings were not counted in the total of 38 delistings since they did not have any effect on the total number of Category 5 listings. However, the impact of these delistings is reflected in the summary numbers (e.g. Table 32) that describe the size of waters impaired for various pollutants.

Table 21: Partial Delistings in 2014 (Category 5 to Category 2).

New Assessment Unit ID	Basin Name	Basin Code	Water Type	Designated Use	Category	Cause	Notes
MD-02130805-Gunpowder_Falls	Loch Raven Reservoir	02130805	River Mainstem	Water Contact Sports	2	Escherichia coli	Small stretch of stream below Prettyboy Reservoir (in Loch Raven watershed) is meeting bacterial water quality standards. This was split out from the bacteria listing for MD-02130805-Multiple_segments
MD-WICMH-Wicomico_River_3	WICMH - Wicomico River Mesohaline	02130301	Tidal Shellfish Area	Shellfishing	2	Fecal Coliform	The area, assessed by the station 1406201, was split out from MD-WICMH-Wicomico_River_2 since it now supports the shellfish harvesting bacteria standard.
MD-WICMH-02130302_2	WICMH - Wicomico River Mesohaline	02130302	Tidal Shellfish Area	Shellfishing	2	Fecal Coliform	The area assessed by stations 1801019 and 1801013 was split out from MD-WICMH-02130302 since both stations meet shellfish harvesting standards.

Another subset of listings/geographic areas that are now no longer considered impaired are some that were previously (2012) in Category 4a (impaired, TMDL completed). Four listings (Table 22) met this scenario under which new assessment data demonstrated that water quality criteria were being met. One of these, the Aaron Run pH listing, was particularly noteworthy as it represents the first instance where a state restoration project was directly linked to water quality standards attainment. At Aaron Run, MDE and DNR staff cooperated to remediate acid mine drainage seeps and restore native fauna. This stream was then monitored for attainment of pH criteria and for trout survival and reproduction. In all cases, the State achieved success.

Table 22: 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	Category	Cause
MD-SEVMH-Severn_River1	SEVMH - Severn River Mesohaline	02131002	Tidal Shellfish Area	Shellfishing	2	Fecal Coliform
MD-021410060075-Aaron_Run_Mainstem	Savage River	02141006	Non-tidal Segment(s)	Aquatic Life and Wildlife	2	pH, Low
MD-NANMH-SWSAV	NANMH - Lower Nanticoke River Mesohaline	02130305	Chesapeake Bay segment	Seasonal Shallow-Water Submerged Aquatic Vegetation Subcategory	2	Total Suspended Solids (TSS)
MD-RHDMH-Bear_Neck_Creek	RHDMH - Rhode River Mesohaline	02131004	Tidal Shellfish Area	Shellfishing	2	Fecal Coliform

One final subset of delistings (that were not counted in Table 19) occurred in the 2014 IR that simultaneously resulted in several assessment units being split. This unique scenario happened due to the reassessment of several Category 4b (impaired, technological solution to be implemented) listings in the tidal portion of the Patapsco River (PATMH). These listings were originally based on point source information characterized on 304(l) lists produced by Maryland in the 1980s. The listings describe toxic pollutants discharged from Bethlehem Steel, Erachem Comilog Inc., and Cristal (formerly Millenium Inorganic Chemicals). In the 2012 IR, these listings existed as three separate records (Table 23); one each for copper, cyanide, and nickel. Each listing record addressed multiple point sources (see the last column in Table 23). To help better characterize the distinct geographic areas affected by the contributing point sources, these three listings were split (in the 2014 IR) into twelve new listings (Table 24). The single copper listing now became 4 listings, the nickel listing became 5 listings, and the cyanide listing changed to 3 listings, all to reflect the distinct NPDES outfalls implicated in the original 304(l) listings. In total, seven of these twelve new listing records were moved to Category 2 due to the reassessment. In those seven cases, MDE staff reviewed discharge monitoring report (DMR) data and new ambient water quality data which demonstrated that water quality criteria were being met. The remaining 5 listing records still require more data collection and analysis to either confirm impairment or to demonstrate water quality standards attainment. The State will be following up on these remaining Category 4b listings in hopes of addressing them by the 2016 Integrated Report (IR).

Table 23: Category 4b listings in the tidal Patapsco River (PATMH) from the 2012 Integrated Report.

ID	Assessment Unit ID	Basin Name	Basin Code	Designated Use	Category	Cause	Notes
170	MD-PATMH	PATMH - Patapsco River Mesohaline	02130903	Aquatic Life and Wildlife	4b	Copper	ICS Listing - Erachem Comilog (formerly known as Chemetals) and RG Steel (formerly Bethlehem Steel) - Additional investigation needed.
171	MD-PATMH	PATMH - Patapsco River Mesohaline	02130903	Aquatic Life and Wildlife	4b	Nickel	ICS Listings - Millenium Inorganic Chemicals (formerly SCM Hawkins Point), Erachem Comilog (formerly Chemetals), and RG Steel (formerly Bethlehem Steel) - Additional investigation needed.
172	MD-PATMH	PATMH - Patapsco River Mesohaline	02130903	Aquatic Life and Wildlife	4b	Cyanide	ICS Listing - RG Steel (formerly known as Bethlehem Steel) - Additional investigation needed.

Table 24: The resultant (2014 Integrated Report) listings caused by splitting the Category 4b listings in PATMH and from reassessing new ambient water quality data.

ID	Assessment Unit ID	Basin Code	Designated Use	Category	Cause	Notes
170	MD-PATMH-SparrowsPoint-001	02130903	Aquatic Life and Wildlife	4b	**Copper**	This listing was split in 2014 to account for the different discharge outfalls from the former Bethlehem Steel Mill (ICS Listing). Listing now represents water quality only at outfall 001 at Bethlehem Steel. More investigation needed.
2381	MD-PATMH-SparrowsPoint-014	02130903	Aquatic Life and Wildlife	2	**Copper**	This listing was created in 2014 from the split of the original point source 4b copper listing in the Patapsco. Listing now represents water quality at outfall 014 at Bethlehem Steel. All Cu monitoring results meet criteria.
2382	MD-PATMH-SparrowsPoint-021	02130903	Aquatic Life and Wildlife	2	**Copper**	This listing was created in 2014 from the split of the original point source 4b copper listing in the Patapsco. Listing now represents water quality at outfall 021 at Bethlehem Steel. Ambient water quality meets copper water quality criteria.

ID	Assessment Unit ID	Basin Code	Designated Use	Category	Cause	Notes
2383	MD-PATMH-Erachem-001	02130903	Aquatic Life and Wildlife	4b	**Copper**	This listing was created in 2014 from the split of the original point source 4b copper listing in the Patapsco. Listing now represents water quality at outfall 001 at Erachem Comilog. More investigation needed.
171	MD-PATMH-SparrowsPoint-001	02130903	Aquatic Life and Wildlife	2	**Nickel**	This listing was split in 2014 to account for the different discharge outfalls (ICS Listings-Erachem, Beth Steel, Millenium). Listing now represents water quality only at outfall 001 at Bethlehem Steel. All Ni sampling results met water quality criteria.
2375	MD-PATMH-Millenium-002	02130903	Aquatic Life and Wildlife	2	**Nickel**	Former ICS Listing - This listing represents the water quality collected near outfall 002 of what was formerly Millenium, now Cristal. This listing used to be on Category 4b. All nickel sampling results collected in 2013 met water quality criteria.
2376	MD-PATMH-Erachem-001	02130903	Aquatic Life and Wildlife	2	**Nickel**	Former ICS Listing - This listing represents the water quality collected near outfall 001 of Erachem Comilog. This listing used to be on Category 4b. All nickel sampling results collected in 2013 met water quality criteria.
2377	MD-PATMH-SparrowsPoint-014	02130903	Aquatic Life and Wildlife	2	**Nickel**	Former ICS Listing - This listing represents the water quality collected near outfall 014 of Bethlehem Steel. This listing used to be on Category 4b. All nickel sampling results collected in 2013 met water quality criteria.
2378	MD-PATMH-SparrowsPoint-021	02130903	Aquatic Life and Wildlife	2	**Nickel**	Former ICS Listing - This listing represents the water quality collected near outfall 021 of Bethlehem Steel. This listing used to be on Category 4b. All nickel sampling results collected in 2013 met water quality criteria.
172	MD-PATMH-SparrowsPoint-001	02130903	Aquatic Life and Wildlife	4b	**Cyanide**	This listing was split in 2014 to account for the different discharge outfalls from the former Bethlehem Steel Mill (ICS Listing). Listing now represents water quality only at outfall 001 at Bethlehem Steel. More investigation needed.
2379	MD-PATMH-SparrowsPoint-014	02130903	Aquatic Life and Wildlife	4b	**Cyanide**	This listing was created in 2014 from the split of the original 4b cyanide (ICS) listing for Bethlehem Steel. Listing now represents water quality at outfall 014 at Bethlehem Steel. More investigation needed.
2380	MD-PATMH-SparrowsPoint-021	02130903	Aquatic Life and Wildlife	4b	**Cyanide**	This listing was created in 2014 from the split of the original 4b cyanide (ICS) listing for Bethlehem Steel. Listing now represents water quality at outfall 021 at Bethlehem Steel. More investigation needed.

C.3.1 Total Maximum Daily Loads (TMDL)

Maryland continues to make progress completing TMDLs for waters listed as impaired on Category 5 of the IR. Total Maximum Daily Loads 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 Water Quality Standards. 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.

Reevaluating previously-developed nutrient TMDLs in Maryland's tidal waters in reference to the Chesapeake Bay TMDL

The completion of EPA's Chesapeake Bay TMDL in December 2010 addressed nutrient and sediment impairments in 53 distinct water body segments in Maryland. With the approval of the Chesapeake Bay TMDL[31], 139 of Maryland's water body-designated use-pollutant combinations were moved from Category 5 to Category 4a. In other cases, the Chesapeake Bay TMDL also covered tidal waters addressed by previously approved nutrient TMDLs. Since it has been demonstrated that the loads established in the Chesapeake Bay TMDL will fully address any local water quality impairments and given the numerous refinements in recent years in the development of Chesapeake Bay water quality criteria, modeling frameworks, assessment methodologies and water quality monitoring, it is appropriate to reevaluate whether these previous tidal nutrient TMDLs should be superseded by the Chesapeake Bay TMDLs for the corresponding Bay Water Quality Segments.

Maryland is re-examining these older tidal nutrient TMDLs in comparison to the new Chesapeake Bay nutrient TMDLs to determine which should be considered the TMDL of record. The final decisions will be captured in a rationale document that will undergo a formal public review period.

To help explain some of the nutrient and sediment listing history of the Chesapeake Bay and its tidal tributaries, Maryland has included Part G and H of this report. Part G describes the listing changes that have been made to many Bay segments since 1996 and provides the Gunpowder River Oligohaline (GUNOH) segment as a specific example of how such changes were reflected in the IR. Part H provides tables showing the listing changes for all of the Chesapeake Bay and its tidal tributaries as well as how these changes affected MDE's Memorandum of Understanding (MOU) with EPA.

Table 25 lists the waterbodies with TMDLs completed since the last IR cycle.

[31] The Chesapeake Bay TMDL is actually made up of 92 TMDLs, one for each Bay segment (including those in VA, MD, DC, and DE). More than 92 water body-designated use-pollutant combinations (e.g. 139) are possible since each of the 92 segments has one or more applicable designated uses that are assessed by a separate set of dissolved oxygen or SAV criteria.

Table 25: Recently Approved TMDLs in Category 4a of the Integrated Report. This list does not include any TMDLs that were captured on the 2012 Integrated Report.

Cycle First Listed	Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Cause	Sources
1996	MD-02130203	Upper Pocomoke River	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Total Suspended Solids (TSS)	Crop Production (Crop Land or Dry Land)
1996	MD-02130203	Upper Pocomoke River	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Crop Production (Crop Land or Dry Land)
1998	MD-BACOH	BACOH - Back River Oligohaline	Chesapeake Bay segment	Aquatic Life and Wildlife	Polychlorinated biphenyls	Contaminated Sediments
2008	MD-BACOH	BACOH - Back River Oligohaline	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Contaminated Sediments
1998	MD-PATMH-BEAR_CREEK	PATMH - Patapsco River Mesohaline	Tidal subsegment	Aquatic Life and Wildlife	PCBs - sediments and fish tissue	Discharges from Municipal Separate Storm Sewer Systems (MS4)
1998	MD-PATMH-CURTIS_BAY_CREEK	PATMH - Patapsco River Mesohaline	Tidal subsegment	Aquatic Life and Wildlife	PCBs - sediments and fish tissue	Discharges from Municipal Separate Storm Sewer Systems (MS4)
1998	MD-PATMH-02130903	Baltimore Harbor Watershed	Tidal subsegment	Fishing	PCB in Fish Tissue	Discharges from Municipal Separate Storm Sewer Systems (MS4)
2002	MD-02130904-Lake_Roland	Jones Falls	Impoundments	Fishing	PCB in Fish Tissue	Upstream Sources
1996	MD-02130907-Liberty_Reservoir	Liberty Reservoir	Impoundments	Aquatic Life and Wildlife	Phosphorus (Total)	Crop Production (Crop Land or Dry Land)
1996	MD-02130907-Liberty_Reservoir	Liberty Reservoir	Impoundments	Aquatic Life and Wildlife	Sedimentation/siltation	Crop Production (Crop Land or Dry Land)
1996	MD-02140202	Potomac River Montgomery County	Non-tidal 8-digit watershed	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	Cause	Sources
1996	MD-02140206	Rock Creek	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Discharges from Municipal Separate Storm Sewer Systems (MS4)
1996	MD-02140302	Lower Monocacy River	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Crop Production (Crop Land or Dry Land)
1996	MD-02140303	Upper Monocacy River	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Crop Production (Crop Land or Dry Land)
1996	MD-02140304	Double Pipe Creek	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Agriculture
1996	MD-02140305	Catoctin Creek	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Crop Production (Crop Land or Dry Land)
1996	MD-02140502	Antietam Creek	Non-tidal 8-digit watershed	Aquatic Life and Wildlife	Phosphorus (Total)	Crop Production (Crop Land or Dry Land)
1996	MD-02130102-T-ASSAWOMAN_BAY	Assawoman Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Upstream Source
1996	MD-02130102-T-GREYS_CREEK	Assawoman Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Upstream Source
1996	MD-02130103-T-ISLE_OF_WIGHT_BAY	Isle of Wight Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Agriculture
1996	MD-02130103-T-MANKLIN_CREEK	Isle of Wight Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Agriculture
1996	MD-02130104-T	Sinepuxent Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Urban Runoff/Storm Sewers

Cycle First Listed	Assessment Unit ID	Basin Name	Water Type Detail	Designated Use	Cause	Sources
1996	MD-02130105-T-MARSHALL_CREEK	Newport Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Agriculture
1996	MD-02130106-T	Chincoteague Bay	Coastal Bay	Aquatic Life and Wildlife	Nitrogen (Total)	Upstream Source
1996	MD-02130102-T-ASSAWOMAN_BAY	Assawoman Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Upstream Source
1996	MD-02130102-T-GREYS_CREEK	Assawoman Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Upstream Source
1996	MD-02130103-T-ISLE_OF_WIGHT_BAY	Isle of Wight Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Urban Runoff/Storm Sewers
1996	MD-02130103-T-MANKLIN_CREEK	Isle of Wight Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Urban Runoff/Storm Sewers
1996	MD-02130104-T	Sinepuxent Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Urban Runoff/Storm Sewers
1996	MD-02130105-T-MARSHALL_CREEK	Newport Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Agriculture
1996	MD-02130106-T	Chincoteague Bay	Coastal Bay	Aquatic Life and Wildlife	Phosphorus (Total)	Upstream Source
2002	MD-ELKOH	ELKOH - Elk River Oligohaline	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Non-regulated watershed runoff
2002	MD-C&DOH	C&DOH – C&D Canal Oligohaline	Chesapeake Bay segment	Fishing	PCB in Fish Tissue	Non-regulated watershed runoff

Table 26 and 27 lists those waters for which TMDLs will likely be initiated over the next two years.

Table 26: Anticipated Submissions to Address Category 5 Integrated Report Listings in FFY 2014.

Listing Year	Listed Waterbody	Impairing Substance	1998 MOU Count	2012 303(d) List Count
1996	Assawoman Bay (open water and Greys Creek)	Nutrients	1	4
1996	Isle of Wight Bay (open water and Manklin Creek)	Nutrients	1	4
1996	Sinepuxent Bay	Nutrients	1	2
1996	Newport Bay, Marshall Creek	Nutrients		2
1996	Chincoteague Bay	Nutrients	1	2
2002	Anacostia River	Heptachlor epoxide		1
2006	Patuxent River lower	Non-tidal Biological		1
2004	Rocky Gorge Dam	Mercury in Fish Tissue		1
2010	Youghiogheny River Lake	Mercury in Fish Tissue		1
2008	Upper North Branch Potomac River	Manganese		4
2006	Upper Monocacy River	Non-tidal Biological*		1
2002	Middle Chester River	Non-tidal Biological*		1
2002	Bush River	Non-tidal Biological*		1
2002	Potomac River – Allegany County	Non-tidal Biological*		1
2004	Aberdeen Proving Grounds	Non-tidal Biological*		1
2002	Swan Creek	Non-tidal Biological*		1
2004	Loch Raven Reservoir	Non-tidal Biological*		1
2004	South Branch Patapsco River	Non-tidal Biological*		1
2002	Magothy River	Non-tidal Biological*		1
2002	South River	Non-tidal Biological*		1
2002	Other West Chesapeake Bay	Non-tidal Biological*		1
2002	Patuxent River Middle	Non-tidal Biological*		1
2006	Patuxent River Upper	Non-tidal Biological*		1
2002	St. Mary's River	Non-tidal Biological*		1
2002	Mattawoman Creek	Non-tidal Biological*		1
2004	Piscataway Creek	Non-tidal Biological*		1
2002	Antietam Creek	Non-tidal Biological*		1
2004	Conococheague Creek	Non-tidal Biological*		1
2006	Licking Creek	Non-tidal Biological*		1
2002	Little Tonoloway Creek	Non-tidal Biological*		1
2002	Town Creek	Non-tidal Biological*		1
2002	Georges Creek	Non-tidal Biological*		1
2004	Upper North Branch Potomac River	Non-tidal Biological*		1
2002	Youghiogheny River	Non-tidal Biological*		1
2002	Lower Susquehanna River	PCBs		1
2006	Magothy River	PCBs		1
2002	Upper and Lower Elk River	PCBs		1
2002	Back Creek/C&D Canal Oligohaline	PCBs		1
1998	Edgewater Village Lake	Nutrients	1	1
Total for 1998 MOU			**5**	
Total Listings Addressed from 2012 303(d) List				**51**

*These biological listings (cause unknown) will be addressed by the BSID analysis to identify the specific stressors causing biological community degradation.

Table 27: Anticipated Submissions to Address Category 5 Integrated Report Listings in FFY 2015.

Listing Year	Listed Waterbody	Impairing Substance	1998 MOU Count	2012 303(d) List Count
2006	West River	PCBs		1
2002	South River MH	PCBs		1
2006	Severn River MH	PCBs		1
2006	Gunpowder River	PCBs		1
2008	Bird River	PCBs		1
2008	Potomac River Montgomery County	PCBs		1
2010	Gwynns Falls	Chlorides		1
2012	Back River	Chlorides		1
Total for 1998 MOU				
Total Listings Addressed from 2012 303(d) List (1996/1998/2002/2004/2006/2008/2010/2012)				**8**

C.3.2 Assessment Summary

The summary tables provided in this section are submitted for consistency with EPA guidance and to help EPA fulfill its mandate to provide nationwide assessment results. The reader is cautioned against using these numbers to track statewide progress with respect to water quality between the periods of 2008-2010 and 2012 on. Beginning with the 2012 IR, Maryland used the 1:24,000 scale National Hydrography Dataset (NHD) to calculate waterbody sizes.[32] In contrast, the waterbody sizes used for the 2008 and 2010 IR cycles were calculated using the 1:100,000 scale NHD coverage. This, by itself, causes discrepancies in the total stream miles, estuarine square mileage, and impoundment acreage represented. In addition, in some cases, the water body size reported in Category 1 or 2 (unimpaired status) can increase or decrease cycle to cycle simply because assessments were corrected or made with better data and instrumentation. Other useful water quality tracking information can be found at Maryland's BayStat Program website (http://www.baystat.maryland.gov/) which provides information not only for water quality tracking but also information and progress related to water quality implementation.

Table 28: Size of Surface Water Assigned to Reporting Categories.

Waterbody Type	Category							Total in State	Total Assessed
	1	2	3	4a	4b	4c	5		
River/stream miles	0	6517.17	2294.90	4477.33	0	0	5895.89	19,185.29	16,890.39
Lake/pond acres	0	1201.83	531.04	12951.52	0	0	5339.43	21,876.08	19,492.78
Estuarine square miles	0	0	43.05	843.97	0	0	1567.71	2,454.73	2,411.68
Ocean square miles	0	0	107.39	0	0	0	0	107.39	0.00
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. For the purposes of this table, water body sizes were not double-counted. If a water body was listed in Category 5 for one pollutant and Category 2 for another, the water body size was assigned to Category 5 to represent a worst-case scenario. In the case where a water body was listed in Categories 4a, 4b, and 4c for different pollutants, the water body size defaulted to Category 4a.

C.3.3 Split and Aggregated Water Body Segments

The State has split or aggregated water bodies/assessment units where data and information are supportive. For example, a listing originally may have been made for a large watershed but now, more detailed information is available which demonstrates that the impairment is limited to smaller hydrologically distinct stream segments. In these cases, the State will split this watershed into several segment scale listings that better align with the actual assessment information. This occurred in the 2014 IR with the low pH assessments in the Casselman River and Youghiogheny River watersheds. A summary of how these assessment units were split during the 2014 cycle is included in Table 29 and 30. This scenario also occurred with the pH listing for Aaron Run (Savage River watershed) that was previously mentioned in Section C.3 and Table 22. However, the split for Aaron Run was caused by having assessment data for only a portion of the entire assessment unit. A summary of this split is shown in Table 31.

[32] Although converting to the 1:24,000 scale NHD made it harder to track progress between IR cycles, the benefits of a higher resolution stream scale enable greater mapping capabilities and increased geographic precision.

Table 29: Newly Split Assessment Unit (2014 Integrated Report) - Youghiogheny River pH impairments.

Former (2012) Assessment Unit ID	Pollutant	Category	New (2014) Split Assessment Unit ID	Rationale
MD-05020201-Multiple_segments2	low pH	4a	MD-050202010019-UT_Glade_Run	pH listing split into distinct stream segments to match the actual spatial scale assessed and addressed by the TMDL. No other changes made.
			MD-050202010016-UT_Little_Bear_Creek	
			MD-050202010016-UT_Bear_Creek	
			MD-050202010021-UT_Mill_Run	
			MD-050202010019-NorthBranch_Laurel_Run	
			MD-050202010019-Buffalo_Run1	
			MD-050202010005-Cherry_Bottom_Run	
			MD-050202010017-Trap_Run	
			MD-050202010014-White_Rock_Run	
			MD-050202010014-White_Rock_Glade	
			MD-050202010010-Ned_Run	
			MD-050202010010-Muddy_Creek	
			MD-050202010008-Toliver_Run	
			MD-050202010009-Murley_Run	
			MD-050202010008-Millers_Run	
			MD-050202010009-Herrington_Run	
			MD-050202010017-Laurel_Run	
			MD-050202010005-Snowy_Creek	

Table 30: Newly Split Assessment Unit (2014 Integrated Report) - Casselman River pH impairments.

Former (2012) Assessment Unit ID	Pollutant	Category	New (2014) Split Assessment Unit ID	Rationale
MD-05020204-Multiple_segments	low pH	4a	MD-050202040035-Meadow_Run	This pH listing was split into distinct stream segments to match the actual spatial scale assessed and addressed by the TMDL. No other changes were made.
			MD-050202040034-Little_Shade_Run	
			MD-050202040033-Little_Laurel_Run	
			MD-050202040031-SouthBranch_Casselman_River1	
			MD-050202040034-Spiker_Run	
			MD-050202040032-Tarkiln_Run	
			MD-050202040032-Alexander_Run	
			MD-050202040030-NorthBranch_Casselman_River	

Table 31: Newly split assessment unit (2014 Integrated Report) - Aaron Run (Savage River Watershed) pH impairment.

Former (2012) Assessment Unit ID	Pollutant	Category	New (2014) Split Assessment Unit ID	2014 Category	Rationale
MD-021410060075-Aaron_Run	low pH	4a	MD-021410060075-Aaron_Run_Mainstem	2	The mainstem of Aaron Run was delisted (2014) after extensive restoration efforts and monitoring showed that pH criteria were being met along the entire length. Two side tributaries have not yet been sampled and were split out from this listing.
			MD-021410060075-UTAaron_Run1	4a	This side tributary to Aaron Run was split out from the mainstem low pH assessment record (2014) to reflect the fact that this segment requires more data to confirm delisting.
			MD-021410060075-UTAaron_Run2	4a	This side tributary to Aaron Run was split out from the mainstem low pH assessment record (2014) to reflect the fact that this segment requires more data to confirm delisting.

Other assessment units were also split for similar reasons and were mentioned in previous tables 21, 23, and 24.

C.3.4 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 and as Maryland utilizes the newer salinity-based segmentation. Comparatively, the Coastal Bays fall behind the Chesapeake in terms of public awareness and resource allocation for monitoring and assessment activities. For additional details on Chesapeake Bay assessments, please see http://www.mde.maryland.gov/assets/document/2008%20Ambient%20Water%20Criteria.pdf.

Tables 32 and 33 show the size of estuarine waters assigned to each category for each pollutant. For the 2014 cycle, these numbers were calculated in the same fashion as they were for the 2012 cycle. For nutrient listings, the entire size of a Chesapeake Bay segment was assigned to one category, defaulting to the least desirable category (in this order, 5, 4A, 3, 2, 1). In other words, regardless of the magnitude of impairment for that segment, a segment's whole size will be reported in Category 5 for nutrients (TP or TN) if any percentage of the segment fails to meet the applicable water quality criterion.

Table 32: 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							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Arsenic		0.96					
BOD, Biochemical oxygen demand				0.09			
Cadmium		51.21					
Chlordane				36.99			
Chlorpyrifos		48.73					
Chromium		44.53					
Copper		89.02	5.81		Point*		
Cyanide					Point*		
Debris/Floatables/Trash				0.09			
Estuarine Bioassessments		938.50	213.52				1188.69
Enteroccoccus				0.69			4.27
Fecal coliform		131.34	0.34	51.06			31.58
Heptachlor epoxide							0.085
Lead		53.12					1.30
Mercury in Fish Tissue		324.91	83.12				
Nickel		4.32			Point*		
Nitrogen (Total)			82.30	2368.92			
Oil spill - PAHs					0.33		
PCBs		61.99	88.22	436.69			481.05
Phosphorus (Total)			82.30	2264.29			97.36
Selenium		0.03					

Size of Estuarine Area (sq. miles) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Silver		0.96					
Total Suspended Solids (TSS)**		165.41	106.57	410.97			
Toxics							2.00
Zinc		13.42					7.40

Point* - 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.
**The total size of areas assessed for TSS do not total the area assessed for the Shallow Water designated use (DU) due to TSS listings for the aquatic life DU.

Table 33: Size of Estuarine Waters in Linear Distance per Category According to Pollutant.

Size of Estuarine Linear Distance (shoreline distance in miles) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Debris/Floatables/Trash							9.5
Enterococcus		1.03	0.45	0.22			
Fecal coliform		0.01					

Table 34 depicts the status of estuarine waters with respect to different designated uses. Similar to Table 28, the numbers provided for the open water, deep water, and deep channel designated uses are calculated using a binary method. Instead of calculating the percent-area-impaired using data supplied with the dissolved oxygen assessments, Maryland used the 'impaired or not' approach to determine the column in which a water-segment's size should be placed. This approach simplifies the calculations and improves general understanding of the geographic scope of impairment.

Table 34: Designated Use Support Summary for Maryland's Estuarine Waters.

Designated Use		Size of Estuarine Waters (square miles)				
		State Total	Total Assessed	Supporting - Attaining WQ Standards	Not Supporting - Not Attaining WQ Standards	Insufficient Data and Information
Aquatic Life and Wildlife		2,451.2	2,251.4	921.2	1,330.2	198.2
Fishing		2,451.2	975.4	61.99	913.415	171.34
Water Contact Recreation	General Recreational Waters	2,451.2	6.4	1.4	4.963	2,444.8
	Public Beaches*	160	160	157	1	2
Shellfish Harvesting		2,136.2	2,136.2	2,053.2	82.6	0
Migratory Spawning and Nursery**		1,338.8	1,256.5	0	1,256.5	82.3
Shallow Water SAV**		667.6	639.2	243.3	395.9	28.5
Open Water**		2,342.3	2,260.0	0	2,260.0	82.3
Deep Water**		1,402.1	1,402.1	0	1,402.1	0.0
Deep Channel**		1,329.7	1,329.7	0	1,329.7	0.0

*Public Beach results are reported as the number of beaches, not as surface area or linear extent of water affected.

**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. For the Deep Channel statistics, a small change in calculation was made for the PATMH segment. The size previously used for PATMH was 4.44 sq miles. However, to be more consistent with the way other segments were calculated (for deep channel statistics), this assessment was given the full PATMH size (36.15 square miles).

Table 35: Size of Estuarine Waters Impaired by Various Sources.

Waterbody Type - Estuary	
Sources	Water Size in Square Miles
Agriculture	479.00
Channel Erosion/Incision from Upstream Hydromodifications	0.09
Contaminated Sediments	325.93
Discharges from Municipal Separate Storm Sewer Systems (MS4)	30.83
Innappropriate Waste Disposal	9.59
Industrial Point Source Discharge	2.90
Livestock (Grazing or Feeding Operations)	18.44

Waterbody Type - Estuary	
Sources	**Water Size in Square Miles**
Manure Runoff	17.28
Municipal Point Source Discharges	42.40
On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)	3.62
Pipeline Breaks	0.33
Source Unknown	2153.20
Upstream Source	439.54
Upstream/Downstream Source	12.84
Urban Runoff/Storm Sewers	37.11
Wastes from Pets	12.20
Wildlife Other than Waterfowl	0.21

Table 36: 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	2342.3 (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.3.4.1 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. Showing the strain of nutrient enrichment, the Coastal Bays exhibit high nitrate levels in the freshwater reaches of streams, excess algae, chronic brown tide blooms, macroalgae blooms, and incidents of low dissolved oxygen.

Like water quality, the status of Coastal Bays living resources is mixed. While the Bays still support diverse and abundant populations of fish and shellfish, human activities are affecting their numbers. Forage fish, the major prey item for gamefish, have been in steady decline since the 1980s and reports of fish kills, usually the result of low oxygen levels, are increasing. Hard clam densities are lower than historic levels but have been generally stable over the past 10 years. Blue crab populations are fluctuating but do not appear to be in decline, despite a relatively new parasite causing summer mortality in some areas. Oysters, which were historically abundant in the Coastal Bays, remain only as small, relict populations. Bay scallops have recently returned after being absent for many decades and are now found throughout the Bays, although numbers are low. Seagrass coverage has decreased in recent years after large increases were seen in the 1980s and 1990s.

In terms of overall water quality, living resources, and habitat conditions, the Bays were given the following ranking from best to worst: Sinepuxent Bay, Chincoteague Bay, Assawoman Bay, Isle of Wight Bay, Newport Bay, and St. Martin River. For more information, refer to the 2012 Coastal Bays Report Card (http://www.mdcoastalbays.org/pdf/report-card.pdf). The Maryland Department of the Environment 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:
http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/TMDL_final_MD_Coastal_Bays_nutrients.aspx.

C.3.4.2 2007 National Estuary Program Coastal Condition Report

In spring of 2007, the US Environmental Protection Agency (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: http://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 agriculturally 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.3.5 Lakes Assessment - Clean Water Act §314 (Clean Lakes) Report

In the federal Clean Water Act (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 requires 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 Clean Water Act of 2000 but no funds have yet been appropriated to states. The US Environmental Protection Agency 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 and higher priorities (e.g., Chesapeake Bay restoration, Total Maximum Daily Loads).

C.3.5.1 Trophic status

One measure of lake water quality is through classification by overall level of productivity ("trophic condition"). This measure often is based on relative nutrient levels which can affect not only biological community structure, but also certain physical characteristics of lakes:

- **oligotrophic lakes** - usually deep, with low levels of nutrients, plankton and low production rates - often serve well as drinking water sources or as lakes for boating or swimming, but having limited gamefish populations.
- **eutrophic lakes** - generally shallow, with high plankton levels and production rates - often supporting sportfishing for some species, but oxygen may be depleted below the thermocline and during periods of ice cover and may result in fish kills. Diurnal oxygen and pH levels may vary widely. Sportfishing for some fish species may be excellent, but water clarity will be reduced.

- **mesotrophic lakes** - have moderate productivity levels between the above two classifications and serve well as recreational lakes for fishing, boating and swimming activities.

Two other lake trophic classes not found in Maryland include: dystrophic or "bog" lakes characterized as having low nutrient levels, but very high color from humic materials and often acidified, and hypereutrophic lakes characterized by extremely high nutrient/productivity levels.

The most recent Statewide trophic survey of Maryland's significant, publicly-owned lakes was conducted in 1991 and 1993. For this survey, 58 lakes were identified as meeting the definition of significant, publicly-owned lakes. Since then, two other lakes have been added to this listing:

1. Big Piney Reservoir (Allegany Co.; Casselman River segment) - 110 ac. Frostburg water supply reservoir that was being rebuilt during this survey when public access was restricted, and
2. Lake Artemesia (Prince George's Co.; Anacostia River segment) - a recreational lake created from Metro construction.

In addition to publicly-owned lakes, water quality issues at a number of privately-owned lakes have been evaluated and water quality determined to be impaired. Several of these lakes have been addressed through TMDLs including: LaTrappe Pond, Lake Linganore, and Lake Lariat. Trophic condition has not been determined for these lakes.

Table 37 below provides the 8-digit basin code, surface area size, owner, and trophic status for each of the State's 60 significant, publicly-owned lakes. Table 38 provides an overall summary of the trophic status for Maryland's publicly-owned lakes.

Table 37: Trophic status of Maryland's significant, publicly-owned lakes.

BASIN	LAKE NAME	SIZE (acres)	OWNER/MANAGER	TROPHIC ASSESSMENT
02120204	Conowingo Pool	2,936.0	Exelon Generation Co.	Meso/Eutrophic
02130103	Bishopville Pond	5.7	Worcester Co.	Eutrophic
02130106	Big Mill Pond	60.2	Worcester Co.	Eutrophic
02130203	Adkins Pond	17.2	MD State Hwy/Wicomico Co.	Eutrophic
02130301	Coulbourn Pond	8.6	Wicomico Co.	Meso/Eutrophic
02130301	Mitchell Pond #2	8.6	City of Salisbury	Eutrophic
02130301	Mitchell Pond #3	5.8	City of Salisbury	Eutrophic
02130301	Schumaker Pond	48.6	City of Salisbury	Meso/Eutrophic
02130301	TonyTank Lake	42.0	Wicomico Co.	Eutrophic
02130301	TonyTank Pond	41.3	MD State Hwy Admin.	Eutrophic
02130303	Allen Pond	35.8	Somerset/Wicomico Co.	Meso/Eutrophic
02130304	Johnson Pond	104.0	City of Salisbury	Eutrophic
02130304	Leonards Mill Pond	45.9	Wicomico Co.	Eutrophic
02130306	Chambers Lake	9.4	Town of Federalsburg	Meso/Eutrophic
02130306	Smithville Lake	40.0	MD DNR	Meso/Eutrophic
02130405	Tuckahoe Lake	86.0	MD DNR	Eutrophic
02130503	Wye Mills Community Lake	61.5	MD DNR	Eutrophic
02130509	Urieville Community Lake	35.0	MD DNR	Meso/Eutrophic
02130510	Unicorn Mill Pond	48.0	MD DNR	Meso/Eutrophic
02130805	Loch Raven Reservoir	2,400.0	Baltimore City	Mesotrophic
02130806	Prettyboy Reservoir	1,500.0	Baltimore City	Mesotrophic
02130904	Lake Roland	100.0	Baltimore City	Eutrophic
02130907	Liberty Reservoir	3,106.0	Baltimore City	Mesotrophic
02130908	Piney Run Reservoir	298.0	Carroll Co.	Meso/Eutrophic
02131001	Lake Waterford	12.0	Anne Arundel Co.	Meso/Eutrophic
02131103	Allen Pond	9.5	City of Bowie	Eutrophic
02131104	Laurel Lake	12.0	City of Laurel	Meso/Eutrophic

BASIN	LAKE NAME	SIZE (acres)	OWNER/MANAGER	TROPHIC ASSESSMENT
02131105	Centennial Lake	50.0	Howard Co.	Eutrophic
02131105	Lake Elkhorn	49.0	Columbia Assn.	Eutrophic
02131105	Lake Kittamaqundi	107.0	Columbia Assn.	Eutrophic
02131105	Wilde Lake	23.0	Columbia Assn.	Eutrophic
02131107	Duckett Reservoir	773.0	Wash. Suburban Sanitary Comm.	Meso/Eutrophic
02131108	Triadelphia Reservoir	800.0	Wash. Suburban Sanitary Comm.	Mesotrophic
02140103	St. Mary's Lake	250.0	MD DNR	Meso/Eutrophic
02140107	Wheatley Lake	59.0	Charles Co.	Mesotrophic
02140111	Myrtle Grove Lake	23.0	MD DNR	Eutrophic
02140203	Cosca Lake	11.0	MD-NCPPC	Eutrophic
02140205	Greenbelt Lake	21.5	City of Greenbelt	Eutrophic
02140205	Pine Lake	5.0	MD-NCPPC	Meso/Eutrophic
02140205	Lake Artemesia	38.0	MD-NCPPC	Unknown
02140206	Lake Bernard Frank	56.0	MD-NCPPC	Eutrophic
02140206	Lake Needwood	74.0	MD-NCPPC	Eutrophic
02140208	Little Seneca Lake	505.0	Wash. Suburban Sanitary Comm.	Mesotrophic
02140208	Clopper Lake	90.0	MD DNR	Mesotrophic
02140303	Hunting Creek Lake	46.0	MD DNR	Mesotrophic
02140501	Big Pool (C&O Canal)	92.4	National Park Service	Meso/Eutrophic
02140502	City Park Lake	5.2	City of Hagerstown	Mesotrophic
02140502	Greenbrier Lake	27.0	MD DNR	Oligo/Mesotrophic
02140508	Blairs Valley Lake	32.2	MD DNR	Meso/Eutrophic
02141002	Lake Habeeb	208.5	MD DNR	Oligo/Mesotrophic
02141005	Wm. Jennings Randolph Reservoir	952.0	Army Corps of Engineers	Oligo/Mesotrophic
02141006	Savage River Reservoir	360.0	Upper Potomac River Assn.	Oligo/Mesotrophic
02141006	New Germany Lake	13.0	MD DNR	Meso/Eutrophic
05020201	Youghiogheny River Lake	593.0	Army Corps of Engineers	Meso/Eutrophic
05020201	Herrington Lake	41.5	MD DNR	Mesotrophic
05020202	Broadford Lake	138.0	Town of Oakland	Meso/Eutrophic
05020203	Deep Creek Lake	4,500.0	MD DNR	Oligo/Mesotrophic
05020204	Cunningham Lake	20.0	Univ. Maryland	Mesotrophic
05020204	Big Piney Reservoir	110.0	City of Frostburg	Unknown

Source: MD Department of the Environment, 1993; 1995

Table 38: Trophic Status Summary of Maryland's significant, publicly-owned lakes.

	Number of lakes	Lake size (acres)
Total lakes	60	21,167.6
Lakes assessed	58	21,009.6
Dystrophic	0	0.0
Oligotrophic	0	0.0
Oligotrophic-Mesotrophic	5	6,047.5
Mesotrophic	11	8,572.7
Mesotrophic-Eutrophic	19	5,380.0
Eutrophic	23	1,009.4
Hypereutrophic	0	0.0
Unknown	2	158.0

Source: MD Department of the Environment, 1993; 1995

C.3.5.2 Pollution control programs

Various existing point and nonpoint source management programs described in this report can be effective in managing pollutant inputs directly to lakes and to lake watersheds. Unlike other water types, lakes have features that complicate the water management process, but also provide more options than other water body types. Some of these factors include: “residence time” - the time it takes water to pass through a lake, seasonal stratification, and the ability, at some lakes, to control water levels by selectively bypassing certain layers.

Unless the impoundment is a run-of-the-river system, lakes (and estuaries) have a longer residence time than free-flowing streams, allowing organic and inorganic substances more time to interact with the biota (primary producers) and sediments. If the lakes are large enough to develop seasonal stratification, new water masses develop, in-lake residence time is modified, and water movements altered. The ability to manage water levels and withdrawals provides management options, but adds to the complexity of managing lake waters for the best possible uses.

Most lakes in Maryland do not have a comprehensive lake or watershed management plan that addresses both point and nonpoint source pollution, land cover, or appropriate management options. In most instances, pollutant sources do not directly discharge to a lake but instead discharge to the lake's upstream watershed. While large water supply systems invest in lake management plans, often their effectiveness in addressing pollution sources varies since lake watershed areas often are not controlled by the lake owners. Effective lake management plans require a cooperative relationship with upstream land managers (public agencies and private land owners) in order to develop agreements which address land use, pollution control and funding priorities so as to protect lake resources.

C.3.5.3 Lake Restoration Programs

One aspect of the now un-funded §314 Clean Lakes Program was to provide grants for lake restoration activities. After the Clean Lakes Program was de-authorized in 1994, restoration funding for lakes was added to the list of fundable activities for the §319 Nonpoint Source Program. Grant requirements, priorities and limited funding in this program, however, do not allow for much needed in-lake reclamation activities (e.g., removal/dredging of excess sediments and nutrients, aquatic vegetation control, aquatic and wildlife habitat enhancement, and shoreline stabilization).

Without a directed management program and federal funding support and with comparatively low priority for accessing State water management funding, current lake restoration activities are generally initiated by lake managers (often the owners). With few lake management plans in place, there is often little planning activity or actual effort to address lake water issues until they become severe (and more difficult and costly to address). Lake managers can take advantage of expert resources available from various State agencies (DNR, MDA, MDE), federal agencies (EPA, US Dept. Agriculture) and non-governmental organizations (e.g, North American Lake Management Society; regional lake management organizations in PA and VA) to assist in developing lake management plans and finding available funding sources.

C.3.5.4 Acidification of lakes

Poorly buffered lakes or lakes in mining areas are subject to acidification due to atmospheric deposition or through acid mine drainage. Although several of Maryland's significant, publicly-owned lakes receive acid mine drainage or naturally acidic drainage from free-flowing tributaries (Deep Creek Lake, Jennings Randolph Reservoir), dilution and natural buffering prevent these lakes from becoming acidified.

With support from the US Department of Interior's Office of Surface Mining Reclamation and Enforcement, the MD Bureau of Mines has completed several projects in Cherry Creek (tributary to Deep Creek Lake in Garrett Co.) to remediate high acidity due to acid mine drainage (AMD). Completion of these AMD projects has measurably reduced mineral acidity, though natural organic acidity from the wetlands remain. It is worth noting however, that even prior to installing the acid remediation projects; the acidic inflow to Deep Creek Lake was quickly buffered by a natural limestone layer. Because of this, even in an acidic state, the water quality of Cherry Creek is not a threat to water quality of Deep Creek Lake.

Wm. Jennings Randolph Reservoir (Garrett Co.; Upper North Branch Potomac River segment) receives acid mine drainage from numerous tributaries that drain directly to the lake and also from tributaries well upstream of the lake (in both Maryland and West Virginia). Constructed primarily to manage flows for downstream water quality, the lake volume varies considerably. Although the lake was designed to manage an expected acidic layer, data show that acidic stratification did not occur. The lowest pH levels in the lake are rarely acidic and water quality below the dam is good enough to support a trout hatchery in the tailwaters of the dam. As AMD is managed upstream of the lake, pH levels should only improve, helping to increase productivity and support a robust sport fishery.

Information about acidification in small lakes and privately-owned lakes is not widely known, but water quality impacts can be significant and restoration can be successful. Lake Louise (Garrett Co.; Casselman River segment), a privately-owned, 30-acre lake, had a renowned trout fishery. In the 1970s, sulphide-bearing fill material was used in the construction of Interstate 68 through the upper lake watershed. Acidic leachate from this material entered tributaries to the lake, and within two years, caused severe ecosystem degradation and loss of the sport fishery. In the 1990s, the State Highway Administration installed a passive treatment system in the upper lake watershed in an effort to reduce the acidic runoff. In 1999, following restoration of water quality in the lake, an aquatic resource restoration program was implemented to re-establish the aquatic community and sport fishery. More information on this restoration project can be found at: http://www.hpl.umces.edu/ERI/lakes.html.

C.3.5.5 Lake Status and Trends

Maryland agencies do not include lakes in their ambient monitoring programs, although contaminants in selected fish species are tested in some reservoirs on a cyclical basis (MDE). Infrequent sampling is done to address fish kills and algal bloom complaints (DNR, MDE) and some water sampling is done to provide input for pollutant loading models (Total Maximum Daily Loads, MDE). Some water supply reservoirs have routine water monitoring programs in their lakes (e.g., Baltimore City, Washington Suburban Sanitary Commission reservoirs) and, in a few cases, local agencies and citizen groups will monitor particular lakes. Based on available data, a summary of the status of Maryland lakes and reservoirs is given in Table 39.

Table 39: Designated use support summary for Maryland's lakes and reservoirs (acres), 2014.

Designated Use	Size of Impoundments (acres)				
	Total Impoundment Acres	Total Assessed	Supporting - Attaining WQ Standards	Not Supporting - Not Attaining WQ Standards	Insufficient Data and Information
Aquatic Life and Wildlife	21,876.0	13,765.1	4,775.0	8,990.1	8,110.9
Fishing	21,876.0	18,849.7	5,185.9	13,663.8	198.4

Water Contact Recreation	General Recreational Waters	21,876.0	3,039.4	3,039	0	18,836.6
	Public Beaches*	27	27	27	0	0

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

C.3.5.5.1 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 40). 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. Other prevalent lake impairments include high levels of mercury in fish tissue, PCBs in fish tissue, and other contamination by metals.

Table 40: Impoundment acreage assigned to Categories according to the pollutant assessed.

Size of Impoundments (acres) per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Arsenic		3,708.0					
Cadmium		3,708.0					
Chlordane		98.0					
Chromium (total)		5,113.0					
Chromium, hexavalent		1,508.0					
Copper		3,708.0					
Fecal Coliform		3,039.4					
Lead		6,621.0					
Mercury in Fish Tissue		8,490.3		8,226.4			2,290.4
Nickel		3,708.0					
Nitrogen (Total)		27.0					
PCB in Fish Tissue		12,785.1	198.4	98.0	3,147.0		3,049.0
Phosphorus (Total)		4,775.0	3207.36	8,990.1			
Sedimentation/Siltation		281.0	33.0	6,485.3			
Selenium		3,708.0					
Zinc		1,508.0					

The Department has found elevated concentrations of mercury and PCBs in fish tissue at a number of publicly and privately-owned lakes throughout Maryland. To protect public health, the Department publishes fish-consumption advisories that provide recommended meal limits for certain fish found to have high levels of these contaminants. For more information on fish consumption advisories please visit: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/index.aspx. Table 41 shows the predominant sources of pollutants to impaired lakes.

Table 41: The total size of impoundments impaired by various sources, 2014.

Waterbody Type - Impoundment	
Sources	**Water Size in Acres**
Agriculture	4,535.2
Atmospheric Depositon - Toxics	9,861.8
Contaminated Sediments	3,039.4
Crop Production (Crop Land or Dry Land)	4,362.0
Municipal Point Source Discharges	170.9
Source Unknown	664.7
Upstream Source	98.0
Urban Runoff/Storm Sewers	2,331.0

The Baltimore City water supply reservoirs (Loch Raven, Prettyboy, Liberty Reservoirs), are still in various states of eutrophication and need both improvement and continued protection. Sedimentation is monitored periodically to assess the practical storage capacity of these systems - last reported as: Loch Raven Reservoir losing about 11 percent of its original volume followed by Prettyboy Reservoir (losing 7.5 percent), and Liberty Reservoir (losing 3.3 percent) (Baltimore Metropolitan Council 2004). Finally, of increasing concern are the rising levels of chlorides and conductivity found at lake tributary stations and in the treated water at the Ashburton (Liberty) and Montebello (Loch Raven) treatment plants. It is believed that road salt is one of the largest contributors to this trend.

C.3.5.5.2 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 was completed in 2007 and again in 2012. Prior to both 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 late summer with one additional lake being sampled as a replicate for QC purposes. Water, sediment and biological samples were sent to national labs for analysis and field data were submitted to EPA. For the 2012 survey season, roughly 100 lakes in Maryland were included in the nationwide pool from which only nine were actually sampled. More information on the national survey can be found at http://water.epa.gov/type/lakes/lakessurvey_index.cfm.

C.3.5.5.3 Total Maximum Daily Loads for Lakes

MDE has completed thirty eight (38) TMDLs for various lake-pollutant combinations in Maryland through July 2014. These TMDLs addressed substances including: methylmercury, phosphorus, chlordane, PCBs, and sediments (Section F.4). Another five (5) lake-pollutant combinations are currently identified as impaired and need TMDLs for the pollutants mercury and PCBs.

C.3.6 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 MD 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. Worth noting for the 2014 IR, Maryland has also now integrated biological stream data from specific counties (Baltimore and Frederick) to provide better sampling resolution for stream bioassessments. The summary tables below therefore reflect the data supplied from this wide variety of sources. For a summary of organizations that supplied water quality data please see Table 3.

Table 42 provides the results from statewide probabilistic biological sampling in first through fourth order streams. These results incorporate biological monitoring performed by the Maryland Biological Stream Survey (DNR), Baltimore County, and Frederick County.

Table 42: 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 43 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:
http://www.mde.state.md.us/programs/Water/TMDL/Pages/Programs/WaterPrograms/tmdl/bsid_studies.aspx.

Table 43: 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	Integrated Report Category	Attributable Risk
Aberdeen Proving Grounds	Phosphorus	5	90%
	Channelization	4c	67%
Antietam Creek	Sediments	4a	45%
	Phosphorus	4a	20%
	Sulfates	5	15%
	Channelization	4c	24%
	No Riparian Buffer	4c	24%
Baltimore Harbor	Sediments	5	59%
	Chlorides	5	79%
	Sulfates	5	29%
	Channelization	4c	37%
	No Riparian Buffer	4c	28%
Bush River	Sediments	5	31%
	Chlorides	5	95%
	Sulfates	5	58%
	Channelization	4c	59%
	No Riparian Buffer	4c	75%
Conococheague Creek	Sediments	4a	84%
	Phosphorus	5	97%
	Chlorides	5	93%
	Sulfates	5	85%
Georges Creek	Sediments	4a	37%
	Chlorides	5	24%
	Low pH	4a	34%
Licking Creek	Low pH	5	93%
Little Tonoloway Creek	Low pH	5	32%
	Chlorides	5	44%
	Sediments	5	57%
Loch Raven Reservoir	Phosphorus	5	45%
	Sulfates	5	23%
	Chloride	5	26%
	No Riparian Buffer	4c	36%
Lower Wicomico River	Phosphorus	5	80%
Magothy River	Chlorides	5	42%
Mattawoman Creek	Low pH	5	31%
	Chlorides	5	32%
Middle Chester River	Phosphorus	4a	79%
Patuxent River Lower	Sediments	5	73%
Patuxent River Middle	Sediments	5	68%
	Sulfates	5	63%

8-digit watersheds that were previously in Category 5 based on impaired biological communities (cause unknown)	Stressors Identified through BSID Analysis	Integrated Report Category	Attributable Risk
Patuxent River Upper	Sediments	4a	66%
	Chlorides	5	22%
	Sulfates	5	22%
St. Mary's River	Low pH	5	64%
South River	Sediments	5	54%
	Chlorides	5	42%
	Lack of Riparian Buffer	4c	60%
Swan Creek	Phosphorus	4a	47%
	Sediments	5	61%
Upper Monocacy River	Phosphorus	4a	39%
	Sediments	4a	51%
Other West Chesapeake Bay	Sediments	5	72%
Youghiogheny River	Sediments	4a	35%
	Low pH	4a	32%
	No Riparian Buffer	4c	30%

C.3.6.1 Overall Non-tidal River and Stream Assessment Results

The following tables present statewide assessment summaries on the wide range of pollutants and sources to non-tidal flowing waters. Much of the data used for these assessments is from state-led monitoring efforts but increasingly more data from federal agencies, counties, non-profits, 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 44 – 46 provide statewide assessment data for non-tidal rivers and streams.

Table 44: Extent of River/Stream Miles assigned to each category according to the pollutant assessed.

Number of River Miles per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Aluminum		160.10		26.20			
Ammonia		317.43					
Arsenic		663.70					
BOD, Biochemical oxygen demand		132.17		277.52			
BOD, carbonaceous		447.14		72.08			
BOD, nitrogenous		447.14		72.08			
Cadmium		1235.53					
Cause Unknown/Combination Benthic and Fish Bioassessments		4918.08	1867.14				1599.62
Channelization						1827.56	
Chlordane		48.03					

Number of River Miles per Category according to Pollutant Type							
	Category on the Integrated List						
Cause	**Cat. 1**	**Cat. 2**	**Cat. 3**	**Cat. 4a**	**Cat. 4b**	**Cat. 4c**	**Cat. 5**
Chlorides							2421.47
Chromium (total)		292.42					
Chromium, hexavalent		266.00					
Chromium, trivalent		105.28					
Copper		684.57					
Cyanide		98.39					
Debris/Floatables/Trash				277.52			
Enterococcus		6.78		383.94			67.31
Escherichia coli		491.23	613.33	3450.48			
Fecal coliform		563.23	569.13	368.23			
Heptachlor Epoxide							21.49
Iron		126.14		58.51			
Lack of Riparian Buffer						1565.08	
Lead		764.27					
Manganese		186.30					
Mercury		477.40					
Mercury in Fish Tissue		247.01	56.23				151.70
Nickel		663.70					
Nitrogen (Total)		1545.66	243.26	277.52			
PCB in Fish Tissue		78.84	176.72				228.28
PCBs - water				39.50			
pH, High		4.70	12.70				143.22
pH, Low		1197.60		236.42	1.05		144.16
Phosphorus (Total)		4034.86	243.26	3071.03			551.88
Selenium		663.70					
Silver		186.30					
Sulfates							1941.68
Temperature, Water		45.92	42.70				65.08
Total Suspended Solids (TSS)		851.66		6102.28			1578.80
Zinc		910.11					

Table 45: Designated Use Support Summary for Non-tidal Rivers and Streams.

Designated Use		Size of River/Stream Miles				
		Total River miles	Total Assessed	Supporting - Attaining WQ Standards	Not Supporting - Not Attaining WQ Standards	Insufficient Data and Information
Aquatic Life and Wildlife		19,127.0	17,013.3	7,273.5	9,739.8	2,132.0
Fishing		19,127.0	435.6	109.52	326.1	18,691.4
Water Contact Recreation	General Recreation Waters	19,127.0	5,331.2	1,061.2	4,270.0	13,795.8
	Public Beaches*	2	2	2	0	0
Agricultural Water Use		19,127.0	19,127.0	19,127.0	0	0
Industrial Water Use		19,127.0	19,127.0	19,127.0	0	0
Public Water Supply		8,154.0	8,154.0	8,154.0	0	0

*Data on public beaches is measured as a beach count rather than as stream mileage.

Table 46: Summary of Sizes of Riverine Waters Impaired by Various Sources.

Waterbody Type - River	
Sources	**Water Size in Miles**
Acid Mine Drainage	272.25
Agriculture	3,506.65
Anthropogenic Changes to Stream Channel	425.74
Anthropogenic Land Use Changes	122.13
Atmospheric Deposition - Acidity	181.77
Atmospheric Deposition - Toxics	123.67
Combined Sewer Overflows	205.66
Contaminated Sediments	156.74
Crop Production (Crop Land or Dry Land)	2,609.20
Discharges from Municipal Separate Storm Sewer Systems (MS4)	383.94
Inappropriate Waste Disposal	277.52
Lack of riparian buffer and upstream impoundments	1.05
Livestock (Grazing or Feeding Operations)	2,163.49
Loss of Riparian Habitat	337.02
Manure Runoff	481.08
Municipal (Urbanized High Density Area)	774.55
Municipal Point Source Discharges	72.08
On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)	71.67
Post-development Erosion and Sedimentation	53.10
Sanitary Sewer Overflows (Collection System Failures)	914.89
Source Unknown	2168.53
Urban Development in Riparian Buffer	441.58
Urban Runoff/Storm Sewers	3414.12
Wastes from Pets	879.76

C.4 Wetlands Program

C.4.1 Wetland Monitoring Strategy

MDE completed the project to develop a wetland monitoring strategy. The report contains background information on goals and objectives; discussions and decisions made to date; pilot project summaries that may guide strategy development; and other related monitoring efforts. 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 Clean Water Act requirements.

MDE and DNR developed a draft classification system in 2007 to present to the Wetland Work Group. The classification is a modified version of the Hydrogeomorphic (HGM) classification, which can also be translated into the classification system used for wildlife habitats. A unique addition is the designation of a separate class for wetlands that are constructed, whether for mitigation, restoration, or water quality improvement. The class is under consideration to recognize that newly established wetlands are often built for a specific purpose, are built in a disturbed area, and are in an early successional stage. Comparison of these wetlands with a more mature natural system, at least for an initial period, may incorrectly indicate that these wetlands are in poor condition or not performing desired functions. The creation of a separate class prevents this problem. The draft classification was completed in 2007.

There are multiple objectives for Maryland's wetland monitoring and assessment program (shown below), which will be related to other regulatory and non-regulatory wetland management programs. Monitoring will be designed to assess both wetland condition and wetland function and to:

1) Meet 305(b) reporting requirements;
2) Improve existing wetland and waterway regulatory programs;
3) Provide additional information for targeting wetland/waterway restoration and protection efforts;
4) Comply with TMDL requirements, if applicable;
5) Develop use designations and water quality standards for wetlands;
6) Assist in evaluating the effectiveness of compensatory mitigation and voluntary restoration projects;
7) Improve our ability to comprehensively assess landscape and watershed function;
8) Develop the capability to study and assess the status of wetland condition over time; and,
9) Make wetland condition and functional value information available for use in federal, State, local and citizen group-driven natural resource conservation and restoration efforts (examples include TMDL implementation plans, Green Infrastructure Assessment, Strategic Forest Lands Assessment, etc.).

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 water quality standards specific to wetlands. The final Maryland Wetland Monitoring Strategy was completed in September of 2010 (http://www.mde.maryland.gov/programs/Water/WetlandsandWaterways/AboutWetlands/Documents/w ww.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 http://www.mde.maryland.gov/programs/water/wetlandsandwaterways/aboutwetlands/pages/programs/waterprograms/wetlands_waterways/about_wetlands/monitoring.aspx.

C.4.2 National Wetland Condition Assessment

MDE is participating in the National Wetland Condition Assessment, part of the National Aquatic Resources Survey. Data collection and analysis began in 2011 at 27 sites in Maryland, primarily tidal wetlands. The report of results is under preparation by EPA. For more information about this assessment please visit: http://water.epa.gov/type/wetlands/assessment/survey/.

C.4.3 Future Work and Needs

MDE continues attempts to improve assessment of mitigation sites to determine if they are on the proper trajectory to replace lost wetland acreage and functions. In addition, MDE submitted a State Wetland Program Development Grant in 2014 to develop, with other State agencies (DNR, MD Department of Agriculture, and State Highway Administration) a Wetland Program Plan to identify actions the State will undertake over the next several years. Tasks to be addressed will include those related to regulatory purposes, monitoring and assessment, voluntary restoration, preservation, and the development of wetland water quality standards.

Due to expected increases in proposals to restore or enhance wetlands to meet watershed restoration objectives in the Chesapeake and Coastal Bays, MDE needs to advance its capabilities and provide additional guidance to applicants regarding restoration proposals. As "living shorelines" are the preferred method of shoreline stabilization, additional monitoring is needed to determine if current siting and design guidance are resulting in establishment of successful tidal wetlands. Assessments are needed for assessing both adverse impacts and benefits of restoration projects when the projects are proposed in regulated resources. While the stream restoration guidance will greatly aid in review and design of stream restoration projects, a parallel guidance document for adjacent wetlands is lacking. MDE will be investigating approaches to be used or adapted for regulatory review.

C.5 Trend Monitoring

Although water quality trend results are not used in the State's water quality assessment methodologies or listing process they can be a useful tool for measuring incremental improvements in water quality. Typically, such datasets must be collected over sufficiently long temporal periods so as not to draw conclusions from changes caused by natural variability.

Since 1985, USGS has been collecting data from approximately 30 non-tidal monitoring sites throughout the Chesapeake Bay watershed in order to measure large scale trends in nutrient and sediment loading. Over the last 30-year period (1985-2012), USGS has measured statistically significant decreases in the concentration of nitrogen at 70% of the stations while measuring an increase at only 10% (the remaining 20% did not exhibit significant trends). Results were similar for phosphorus levels with 73% of sites showing improving trends, 13% showing degrading trends, and another 13% of sites which did not exhibit a significant trend. For suspended sediments, improving trends were seen at only 28% of sites with an equal percentage of sites showing degrading (increasing) sediment levels (44% of sites did not exhibit a significant trend). USGS also conducted an analysis on the 10 year trends for these three parameters. As expected, there was a greater proportion of sites that did not exhibit a significant trend over this time frame. It is possible that this was due to having a smaller sample size which was not as representative of the full range of natural variability. However, for those trends that were significant, for nitrogen and phosphorus, a greater proportion of sites showed improving (decreasing levels) rather than degrading trends (increasing levels). On the other hand, 10-year trends for suspended sediment showed a greater proportion of sites with degrading conditions (44% of sites) versus improving conditions (10% of sites).

Reported water quality implementation efforts and land use information can also be used for modeling/estimating water quality trends. Although this information is not a direct calculation of water quality trends, it does provide useful information on expected water quality changes based on the various pollution reduction practices implemented. Specifically, implementation practices reported to the Chesapeake Bay Program by federal, state, and local partners was input into the Chesapeake Bay Watershed model to develop estimates of nitrogen and phosphorus reductions. These estimates revealed that:

- From 1985 to 2013, the wastewater sector reported a 63% reduction, the agricultural sector reported a 39% reduction, and the urban sector reported a 17% increase in nitrogen loadings.
- Overall, when comparing to the baseline year of 2009, Maryland has achieved 41% of its nitrogen reduction goal as assigned by the Phase II WIP.
- From 1985 to 2013, the wastewater sector reported a 74% reduction, the agricultural sector reported a 25% reduction and the urban sector reported a 12% reduction in phosphorus loadings.
- Overall, when comparing to the baseline year of 2009, Maryland has achieved 62% of its phosphorus reduction goal as assigned by the Phase II WIP.
- From 1985 to 2013, there has been a 69% (1.2 million lbs) increase in nitrogen loads coming from septic systems. This represents an increase in the proportion of Maryland's nitrogen load that comes from septic systems from 2% (in 1985) to 6% of the total load (in 2013).

Based on the Phase II WIP allocations, much of the progress needed to reduce wastewater sector nutrient discharges has already been made. The remainder of the progress will need to occur in the urban stormwater and agricultural sectors for Maryland to be able to meet its nutrient goals and have capacity for growth.

C.6 Public Health Issues

C.6.1 Waterborne Disease

In the report "Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water - United States, 2003-2004" (Centers for Disease Control 2006), data was summarized from the Waterborne Disease and Outbreak Surveillance System, a system that tracks the occurrences and causes of waterborne disease and outbreaks associated with recreational waters (both natural and artificial (e.g., pool, spa) waters are included). During 2003 and 2004, waterborne disease and outbreaks associated with recreational water were reported by more than half of the states.

One bacterial outbreak of gastroenteritis in an unnamed lake in Maryland in July 2003 resulted in 65 people reporting an illness. In this case, both Shigella and Plesiomonas was determined to be the cause associated with fecal accidents (5 - 10 diapers were reportedly retrieved from the lake each week) and sewage contamination as the source of the bacterial contamination.

This report also identified illnesses due to the naturally-occurring aquatic bacteria, Vibrio sp. Cases associated with recreational water (no evidence that contact with seafood or marine life might have caused infection) were found in 16 States. Five cases of illness were reported from Vibrio sp. infections with one death in Maryland waters in 2003-2004. These entailed three different Vibrio species isolated from these occurrences, including: Vibrio alginolyticus (2 cases, 1 death); Vibrio parahaemolyticus (1 case), Vibrio vulnificus (2 cases). In this report, nearly all Vibrio patients reported that they were exposed to coastal recreational water mostly during the summer and most frequently during July and August. Activities associated with Vibrio infections included swimming, diving, or wading in water, walking or falling on the shore or rocks and boating, skiing, or surfing.

C.6.1.1 Research Summary

In 2006, US Environmental Protection Agency's (EPA) Office of Research and Development and Office of Water published a series of papers summarizing the research conducted on waterborne disease in the last 10 years. The work includes research supported by EPA and others and is limited to gastrointestinal illness as the health effect of concern. 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. In response, EPA, CDC, and other authors produced a series of papers that reviews the state of the science, methods to make a national estimate of waterborne disease, models that estimate waterborne illness, and recommendations to fill existing data gaps. The papers represent the most comprehensive review conducted in the last 25 years and the first publication of modeling information that estimates waterborne illness on a national level. The papers have been published and are online at: http://www.epa.gov/nheerl/articles/2006/waterborne_disease.html.

C.6.2 Drinking Water

The Maryland Department of the Environment (MDE) is charged with ensuring that all Marylanders have a safe and adequate supply of drinking water. The Department has programs to 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 programs, go to http://www.mde.state.md.us/programs/Water/Water_Supply/Pages/Programs/WaterPrograms/water_supply/index.aspx.

C.6.3 Shellfish Harvesting Area Closures

Maryland's Chesapeake Bay waters have long been known for their plentiful shellfish. The Maryland Department of the Environment is responsible for regulating shellfish harvesting waters so as to protect this valuable resource and safeguard public health.

Shellfish include clams, oysters, and mussels. The term shellfish does not include crabs, lobsters, or shrimp. Shellfish are filter-feeding animals: they strain the surrounding water through their gills which trap and transfer food particles to their digestive tract. If the water is contaminated with disease-causing bacteria, the bacteria are also trapped and consumed as food. If shellfish are harvested from waters which the Department has restricted (closed) and eaten raw or partially cooked, they have the potential to cause illness. Therefore, it is mandatory for oysters and clams to be harvested from approved (open) shellfish waters only.

Shellfish harvesting waters which are open or approved for harvesting are those where harvesting is permitted anytime during the shellfish season. Areas which are conditionally approved mean that shellfish harvesting is permitted except for the three days following a rain event of greater than one inch in a twenty-four hour period. Runoff from such a rainfall can carry bacteria into surface waters from adjacent land. Information about which areas have conditional closures is updated daily on the web and via a phone message. Click http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/harvesting_notices/index.aspx to find out which conditional closures are in effect or call 1-800-541-1210.

The Department of the Environment 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: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/pop_up/shellfishmaps.aspx.

C.6.4 Toxic Contaminants Fish Consumption Advisories

The Maryland Department of the Environment (MDE) is responsible for monitoring and evaluating contaminant levels in 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 recreationally caught fish, shellfish, and crab species in Maryland (http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Pages/citizensinfocenter/fishandshellfish/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

The Maryland Department of the Environment 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 four 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 (http://www.mde.state.md.us/programs/Water/FishandShellfish/RiskBasedScreeningofMetals/Pages/ShellfishRisk.aspx) are the basis for the fish consumption guidelines (find our guidelines at: http://www.mde.state.md.us/programs/Marylander/CitizensInfoCenterHome/Documents/Fish%20Consumption%20Docs/Maryland_Fish_Advisories_2014_Web_bluecatedit.pdf).

The types of fish sampled include important predatory game species (such as small mouth bass and striped bass), common recreational panfish species (white perch, bluegill, crappie) as well as bottom dwelling accumulator species with relatively high fat content (such as carp, catfish and American eel). Also, periodically, MDE conducts intensive surveys of contaminant levels in selected species in specific water bodies. Past targets of intensive surveys conducted in Patapsco River/Baltimore Harbor included: white perch, channel catfish, eel, and striped bass.

C.6.4.2 Shellfish Monitoring

Since the 1960s, the Maryland Department of the Environment has been 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, the bay-wide monitoring is conducted every three years. This allows MDE to devote its limited resources toward intensive surveys.

During the last monitoring season, MDE collected and tested 500 oysters from 20 locations within the Maryland portion of the Chesapeake Bay. While there were 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.6.5 Harmful Algal Blooms

Algae are a natural and critical part of our Chesapeake and Coastal Bays ecosystems. Algae, like land plants, capture the sun's energy and support the larger food web that leads to fish and shellfish. They occur in size range from tiny microscopic cells floating in the water column (phytoplankton) to large mats of visible "macroalgae" that grow on bottom sediments.

Algae may become harmful if they occur in an unnaturally high abundance or if they produce a toxin. A high abundance of algae can block sunlight to underwater bay grasses, consume oxygen in the water leading to fish kills, produce surface scum and odors, and interfere with the feeding of shellfish and other organisms that filter water to obtain their food. Some algal species can also produce chemicals that are toxic to humans and aquatic life. Fortunately, of the more than 700 species of algae in Chesapeake Bay, less than 2 percent of them are believed to have the ability to produce toxic substances.

Both the Departments of Environment and Natural Resources respond to reports of fish kills and nuisance algae blooms (http://www.mde.maryland.gov/programs/water/319nonpointsource/pages/mdfishkills.aspx and http://www.dnr.state.md.us/bay/hab/). In the three year period from 2007 to 2009, the State identified and investigated 12 HAB events where significant risk to human health from contacting or ingesting water existed, 31 fish kills associated with toxic algae, and 33 fish kills associated with oxygen deprivation caused directly by non-toxic algal blooms. An additional 40 fish kills occurred that were attributed to low dissolved oxygen with indirect links to algae and nutrient enrichment. Both MDE and DNR will continue to work with the Bay Program to develop, where appropriate, standards or other measures to protect both human health and aquatic life from harmful algal blooms.

C.6.6 Bathing Beach Closures

In October 2000, the U.S. Environmental Protection Agency (EPA) passed the Beaches Environmental Assessment and Coastal Health (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, http://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 water quality standards 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.

The Maryland Department of the Environment 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 (http://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 or by downloading a smartphone application from the following web page (http://www.marylandhealthybeaches.org/notification.aspx).

C.7 Invasive aquatic species

'New' species of viruses, animals, and everything in-between (e.g., amphibians, reptiles, birds, insects, plants, fish, shellfish, even jellyfish) 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 (e.g., grass carp, mute swans, and nutria) 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.

Some of the many aquatic invasive species that have recently consumed a significant level of state and federal agency resources include:

- mute swans (*Cygnus olor*)
- nutria (*Myocaster coypus*)
- zebra mussels (*Dreissena polymorpha*)
- Hydrilla (*Hydrilla verticillata*)
- water chestnut (*Trapa patens*)
- phragmites (*Phragmites australis*)
- purple loosestrife (*Lythrum salicaria*)
- wavyleaf basketgrass (*Oplismenus hirtellus ssp. undulatifolius*)
- Chinese mitten crab (*Eriocheir sinensis*)
- several species of crayfish
- snakehead (*Channa argus*)
- Didymo (*Didymosphenia Geminata*)
- Blue catfish (*Ictalurus furcatus*)
- Flathead catfish (*Pylodictis olivaris*)

Information about these and other invasive species are available online from the Department of Natural Resources (http://www.dnr.state.md.us/invasives/), the Smithsonian Research Center, and the US Department of Interior's Fish and Wildlife Service and Geological Survey.

In 2007, the Department of Natural Resources created an Invasive Species Matrix Team to study and direct scientifically-based policy and management responses to the ecological, economic, and public health threats of invasive species in Maryland's native ecosystems (contact Jonathan McKnight at: 410-

260-8539; mailto: jonathan.mcknight@maryland.gov or Dr. Ron Klauda at: 410-260-8615; mailto: ron.klauda@maryland.gov). Specific objectives of this intra-agency team are to:

- Provide recommendations to the Secretary of Natural Resources on invasive species policies and regulations.
- Develop a framework for surveillance and monitoring programs designed to detect invasive species introductions and track their dispersal.
- Coordinate rapid response efforts when new invasive species are detected.
- Recommend agency actions and public education programs to prevent new introductions and control the increase/spread of invasive species into non-infested landscapes/waters.
- Develop a list of non-native species introductions into Maryland.
- Share and interpret data, knowledge, and experience on invasive species within Maryland, as well as other state, local, interstate, and federal agencies.
- Develop an Invasive Species Management Plan for Maryland, in cooperation with other organizations, that provides a coordinated, multi-agency strategy to achieve the objectives listed above.

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 Maryland Department of the Environment (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 ground water. Since the development of the original strategy, a variety of state programs at MDE, the Maryland Department of Agriculture (MDA) and the Maryland Department of Natural Resources (DNR) have endeavored to protect ground water resources and characterize the quality and quantity of these resources.

Programs to better understand and manage this critical resource must be strengthened to ensure that an adequate supply of groundwater is available for existing and future generations. Continuation and enhancement of programs that protect this resource must remain a priority, yet the financial support for this important program is often overlooked. In order to ensure the long-term viability of Maryland's groundwater resource, MDE will need additional resources to facilitate a better understanding and implement a comprehensive strategy for the protection of this critical resource.

The most recent groundwater protection report provides an overview of the Fiscal Year 2013 activities and accomplishments of state programs that are designed to implement Maryland's Comprehensive Ground Water Protection Strategy. Highlights of groundwater management initiatives coordinated by the State during fiscal year 2013 (July 1, 2012 – June 30, 2013) include:

- As part of the Fractured Rock Water Supply Study, four reports were published, including the Fractured Rock Science Plan. Two other reports assessed factors affecting well yield in the fractured rock areas of Maryland and the impacts of water withdrawals on the hydroecological integrity of fractured rock streams. The fourth report is a statistical classification of fractured rock catchments (groups of watersheds) into hydrogeologic regions, based on climatic, topographic, and geologic variables. Lack of funding in FY2013 precluded any significant activity on the Coastal Plain Groundwater Study.
- Work continued under the Marcellus Shale Safe Drilling Initiative to determine whether and how gas production from the Marcellus Shale can be accomplished without unacceptable risk. MDE contracted with the University of Maryland Center for Environmental Science, Appalachian Laboratory, to survey best practices for Marcellus Shale drilling. A suite of best practices suitable for Maryland was presented in a report of recommendations to MDE.
- The USGS published a study on groundwater impacts from the Pearce Creek Dredge Material Containment Area (DMCA) in Cecil County. The study concluded that the dredge spoils disposal site has degraded water quality in nearby residential wells. The Cecil County Department of Health is working to test potentially affected residential wells to determine if the water is acceptable for drinking and other household uses. Additionally, MDE is working with the US

Army Corps of Engineers to study the influence of the Courthouse Point Dredge Material Disposal Area, also in Cecil County, on groundwater quality.

- MDE worked with contractors to develop wellhead protection plans for 20 communities with drinking water wells that are vulnerable to contamination. Recommended actions for source protection include outreach measures, land ordinances, agricultural best management practices, and protection of undeveloped lands.
- MDE published a final regulation that requires nitrogen-removal technology for all on-site sewage disposal systems serving new construction on land draining to the Chesapeake Bay and Atlantic Coastal Bays, or in other areas impaired by nitrogen. On-site sewage disposal systems each discharge an average of 23 pounds of nitrogen per year to groundwater. Systems with the best available nitrogen removal technology will produce half as much pollution as their traditional counterparts.
- Work on the recommendations made by the Governor's Advisory Committee on the Management and Protection of the State's Water Resources (Wolman Commission) came to a halt due to lack of funding.

Those stakeholders interested in the full groundwater report can send an email request to Lyn Poorman of the Water Supply Program at lyn.poorman@maryland.gov.

PART E: PUBLIC PARTICIPATION

MDE utilizes a public participation process for Integrated Report (IR) similar to that used for promulgation of new regulations. The Administrative Procedures Act mandates that a minimum of 45 days from the date of publication in the Maryland Register must be allowed for the adoption of new regulations [see Annotated Code of Maryland, State Government Article, § 10-111(a)]. Thirty of those 45 days must be available for public review and comment. The Department originally granted 31 business days (47 total days) for public review of the draft 2014 Integrated Report of Surface Water Quality. This review period was later extended by an additional two weeks (10 business days) to allow additional time for review and comment. Besides posting an announcement in the Maryland Register (on August 8, 2014), MDE also posted announcements through the following outlets:

- The MDE home web page,
- MDE's Integrated Report web page,
- Several of MDE's social media outlets (e.g. Facebook),
- the Maryland Water Monitoring Council Announcement web page (http://mddnr.chesapeakebay.net/MWMC/MWMC2010/announcements.asp),
- Informed the Maryland State Water Quality Advisory Committee (SWQAC), and
- Targeted emails to the TMDL contact list (approximately 555 contacts) which includes representatives of federal, state, and local government, academia, and other non-government organizations.

The draft Integrated Report is made available in both electronic and hard copy format to the public via the Internet (http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/2014IR.aspx) and by special request to Matthew Stover at matthew.stover@maryland.gov or 410-537-3611. *Please note that the Department charges a fee for printing and shipping hard-copy reports.*

During the open comment period for the IR, an informational public meeting was held at MDE's headquarters to facilitate dialogue between MDE and stakeholders concerning the format, structure, and content of the draft IR. MDE also engaged interstate river basin commissions, non-government organizations (NGOs), and watershed councils during the public comment period and offered to give full presentations on the Maryland Integrated Report if requested (none were requested).

All comments or questions were directed in writing to the Department. All comments submitted during the public review period are fully addressed below in the comment response section included with this final Integrated Report submitted for EPA approval.

E.1 Informational Public Meeting Announcement

Informational Public Meeting Announcement:
Maryland's Draft 2014 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 2014 IR for public review and comment. The public review period will run from **August 8 to September 24, 2014**. The Draft IR is being posted on MDE's website at http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/2014IR.aspx. Hard copies of the Draft IR may be requested by calling Mr. Matthew Stover at (410) 537-3611. *Please note that the Department charges a fee to cover printing and shipping costs.*

The Department is hosting an informational public meeting and conference call in Baltimore at 6pm on September 8, 2014. Any hearing impaired person may request an interpreter to be present at the meeting by giving five (5) working days notice to Matthew Stover at matthew.stover@maryland.gov or by calling (410) 537- 3611. Anyone wanting to participate in this meeting via conference call should also contact Matthew Stover, in advance, for instructions. Given enough interest, the Department may schedule additional meetings. Comments or questions may be directed in writing to Mr. Matthew Stover, MDE, Science Services Administration, 1800 Washington Blvd., Baltimore, Maryland 21230, emailed to matthew.stover@maryland.gov, or faxed to the attention of Mr. Matthew Stover at 410-537-3873 on or before **September 24, 2014**. 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: September 8, 2014
Start Time: 6:00 p.m.
Location: MDE Headquarters
Lobby Conference Rooms (*to the left after entering the front door*)
1800 Washington Blvd.
Baltimore MD, 21230
Parking: Red Lot, Front (south) of building

E.2 Attendance List from Informational Public Meeting

MDE

Integrated Report Public Meeting Sign-in Sheet
Baltimore, MD September 8, 2014 at 6 p.m.

Name	Address	Affiliation	email
Matt Stover	1800 Washington Blvd Baltimore, MD 21230	MDE	matthewstover@maryland.gov
DAVE THOMAS	4547 BONNIE BRANCH RD ELLICOTT CITY 21043	CBYCA	DMTPA@VERIZON.NET
Jon Jacobs	Washington, D.C. Alexandria, VA	Jacobs Stotsky PLLC	jjacobs@jjacobsstotsky.com
Jeff Reagan	8123 Elizabeth Rd Pasadena MD 21122	SCI	jr@mlsum.com
Colby Ferguson	3358 Davidsonville Road Davidsonville MD 21035	MFB	cferguson@mdfarmbureau.com
Lauren Leese	251 Najoles Rd Millersville, MD	MES	llees@menv.com
Susan Marklund	51 Block Oak Ct. Reisterstown, MD 21136	MDE	susan.marklund@maryland.gov
Steve Stewart		Balt. Co. EPS	sstewart@baltimorecountymd.gov
Farah Abi-Akar		MDE	farah.abi-akar@maryland.gov
Via Conference Call			
Barbara Beelar		Friends of Deep Creek Lake	friendsofdcl.org
Jim Long		Mattawoman Watershed Society	jplong@earthlink.net
Claudia Friedetzky		Sierra Club	claudia.friedetzky@mdsierra.org

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E.3 Comment-Response for the 2014 Integrated Report

Table 47: List of Commentors.

Author	Affiliation	Date Received	Comment Numbers
Jim Long & Claudia Friedetzky	Mattawoman Watershed Society & the Maryland Chapter of the Sierra Club	October 8, 2014	1-10
Michelle Ashworth submitted on behalf of Julie Pippel, MAMWA President	AquaLaw PLC submitted comments on behalf of Maryland Association of Municipal Wastewater Agencies, Inc. (MAMWA)	October 8, 2014	11
Submitted by Jennifer Chavez on behalf of multiple Riverkeepers	EarthJustice submitted comments on behalf of Baltimore Harbor Waterkeeper/Blue Water Baltimore, Gunpowder Riverkeeper, Potomac Riverkeeper, Upper Potomac Riverkeeper, Anacostia Riverkeeper, Choptank Riverkeeper, Miles-Wye Riverkeeper, and Midshore Riverkeeper Conservancy	October 8, 2014	12-18
Doug Myers	Chesapeake Bay Foundation	October 8, 2014	19-21
Miyoko Sakashita	Center for Biological Diversity	October 8, 2014	22-24
Don Haynes	Mid-Atlantic Council of Trout Unlimited	October 8, 2014	25
Sherm Garrison	Maryland Department of Natural Resources	October 8, 2014	26-35
Jon Jacobs, Dana Stotsky, and David Flores	Jacobs Stotsky PLLC and Baltimore Harbor Waterkeeper/Blue Water Baltimore	October 8, 2014	36-44
Submitted by Pamela Marks on behalf of William Wrightson	Comments submitted by Beveridge & Diamond, P.C. on behalf of a Private Citizen	October 8, 2014	45-49
Maria Garcia	United States Environmental Protection Agency	October 8, 2014	50-52

Mattawoman Watershed Society (MWS) & Sierra Club (Maryland Chapter), P.O. Box 201, Bryans Road, MD 20616, Jim Long MWS President and Claudia Friedetzky, Conservation Representative.

MWS and Sierra Club Condensed and Paraphrased Comment 1: We take this opportunity to request that we be listed as parties of record who will receive notice at the email addresses below of any future data calls for the Integrated Report (IR); who will receive public notice for comment on the Triennial Review; and who will receive public notice for comment on the local-versus-Bay TMDL issue.

MDE Response: MDE has added these email addresses to the list serve used for IR data solicitations, Triennial Review notifications, and notifications for comment on the local-versus-Bay TMDL issue.

MWS and Sierra Club Condensed and Paraphrased Comment 2: In the draft IR, a number of listings in Category 5 for "biological impairment (cause unknown)" have been removed when a specific cause or causes have been implicated through MDE's Biological Stressor Identification Analysis (BSID). In these cases, the biological impairment has been replaced with a new listing in Category 5, with the particular stressor or stressors given as the cause for the impact to the Designated Use (e.g., Aquatic Life & Wildlife). We applaud this progress in identifying causes for biological impairment. However, we have concern that by removing the listing for biological impairment entirely, the book appears to be closed in seeking additional stressors. In an urbanizing watershed like Mattawoman's, for example, it seems likely that additional stressors associated with urban runoff may be present. These include, for example, heavy metals, disturbances in hydrology and temperature, alteration of carbon influxes, and leakage from a sewer line with serious inflow and infiltration problems that runs along much of the length of the nontidal river. In particular, in the BSID analysis that identified the stressors of chlorides and pH, it was acknowledged that metal concentrations could increase as a result of low pH, but metals appear not to have been analyzed. We recommend that a way be found to maintain a listing for general biological impairment until additional progress is able to exhaust the more likely causes of the impairment.

MDE Response: MDE acknowledges the commentors' concern but wishes to clarify that the water quality status (in the Integrated Report) of surface waters is always open to re-evaluation when any new data, information, assessment methods, or standards become available. MDE also acknowledges that the BSID analyses do not necessarily address every potential pollutant possible as this list would be impractical and cost-prohibitive. However, the BSID analyses do cover a wide cross-section of pollutants that are most commonly found in watersheds with a range of land use types (including urban). Also, for several of the pollution types mentioned by the commentors (specifically bacteria-sewer line and temperature), the State already has other monitoring mechanisms in place (e.g. sewer overflows are required to be reported to MDE by the waste collection system authority) which will address these issues. Even so, MDE is willing to work with the commentors to determine what gaps exist in monitoring and assessment and to address these gaps with additional efforts, if necessary.

MWS and Sierra Club Condensed and Paraphrased Comment 3: The commentors note that the report contains an inconsistency for when a water body is to be listed for bacteria in the absence of bacteria monitoring. In one portion of the draft document (page 41) it says that "if any water body segment has received three or more spills greater than 30,000 gallons over the last 5 years, that water body will be considered impaired and in another portion (page 101) of the draft report it states that "…if any water body segment has received three or more spills greater than 30,000 gallons over a 12-month period that water body will be considered impaired." Which of these assessment periods apply?

MDE Response: Both parts of the report have been corrected to read "…if any water body segment has received three or more spills of greater than 30,000 gallons within the previous 5-year assessment period, that water body will be considered impaired."

MWS and Sierra Club Condensed and Paraphrased Comment 4: The commentors are confused about the meaning of listing a water body for impairment due to bacteria in Table 17, but excluding it from the 303(d) list of impaired waters in Category 5. The description of Table 17 (p. 101) states: "Table

16 and 17 describe the pertinent overflow events. Though not all of these bacterial impairments are captured in the IR database, these tables serve as record of their impairment." We recommend that the rationale be given in the final report for excluding from Category 5 those water bodies, like Mattawoman Creek, that are subject to chronic sewage overflows and that are listed in Table 17.

MDE Response: After considering these comments and the many factors (e.g. geographic scope, causes, existence of consent decrees and/or NPDES permits, availability of water quality data, etc) to involved when addressing combined sewer overflows (CSO) and sanitary sewer overflows (SSO), the Department agrees it is necessary to revisit and clarify the CSO/SSO listing methodology. In many cases, listing on Category 5 and requiring the development of a TMDL is not the best use of Departmental resources in reducing the number of overflows. Instead, consent decrees, permit conditions or other legally binding agreements and associated requirements/timelines yield the best results. Working cooperatively with responsible parties and targeted use of the Department's capital funding programs in these areas is also an effective approach. In preparation for the 2016 IR cycle, MDE will revisit this process to clarify solutions and next steps for CSO/SSO impacted waters. The Department will then use the draft 2016 IR to seek public review and feedback on this updated methodology. We look forward to your continued review and comments during this period.

MWS and Sierra Club Comment 5: *Text describing antidegradation as a component of Water Pollution Control Programs is misleading.* The commentors are perplexed by statements in the IR at Part B.2.2, p. 26, concerning Tier II Waters and Antidegradation. The carefully parsed language in this paragraph, with phrases such as "continues to implement antidegradation regulations" and "aims to protect high quality waters" appears to disguise the case that, in fact, enforceable regulations are evidently not implemented. As evidence, consider the recent issuance of a wetland permit and Water Quality Certification for Waldorf Crossing (since renamed Waldorf Station), a project on Mattawoman Creek in Charles County at the county line with Prince George's County. The entire 144 acre project lies within a Tier II catchment of the Mattawoman, yet no antidegradation review appears to have been considered, despite new discharges from a massive increase in impervious surface. *We recommend clarifying the text in this section to better inform the public on the true situation vis a vis MDE's readiness to enforce the requirement that for Tier II stream segments*: "… antidegradation policy and implementation methods shall, at a minimum, be consistent with: …(1) Existing instream uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." [40 CFR 131.12(a) and (a)1]

MDE Response: MDE respectfully disagrees with the commentors that the language in Section B.2.2 is meant to disguise, mislead, or otherwise obfuscate how MDE implements Maryland antidegradation policy. The purpose of Section B.2.2 in this report was simply to raise awareness that Maryland has an antidegradation policy and to provide interested readers with a link to more information. There are numerous fine details of how the antidegradation regulations are implemented which cannot be covered within the Integrated Report, due to both space and time limitations. The commentors are encouraged to contact Gary Setzer (Program Manager of the Wetlands and Waterways Program) at gary.setzer@maryland.gov or 410-537-3744 for more information about the specific Wetlands and Waterways permit and certification issuance referenced in the comment. In addition, the commentors are encouraged to contact Angel Valdez (Lead on the State's antidegradation policy and implementation) at angel.valdez@maryland.gov or 410-537-3606 for more information about the antidegradation policy and how it is implemented.

MWS and Sierra Club Comment 6: *Absence of numerical or narrative criteria in Water Quality Standards (WQSs) for listed causes of impairments.* The replacement of a listing for biological impairment with a listing for a specific biological stressor will in principle lead to a TMDL for that stressing pollutant. While the replacement represents progress, we take this opportunity to note that enforcement of a TMDL for certain stressors may be hampered by an absence in COMAR of either a numeric or narrative Water Quality Standard for important stressors. A case in point is the new listing of Mattawoman Creek for chlorides. COMAR gives no standard for chloride concentration. Similarly, for all the effort to reduce nutrients to the Bay, and given the many TMDLs for nutrients approved for specific subwatersheds, COMAR gives no standards for total nitrogen or total phosphorus. We support mentioning this absence, as is done in Part A, p. 20: Various measures of nitrogen and phosphorus as nutrients have not been defined in terms of criteria, although exceedance of oxygen criteria or nuisance levels of algae are attributed to high nutrients levels. The IR may be an appropriate venue to communicate to the public the rationale for why "nutrients have not been defined in terms of criteria" in Maryland, as well as why other stressors that are listed as causes for impairment (such as chlorides) also have no numeric criteria in COMAR.

MDE Response: The commentor is correct that Maryland has impairments for pollutants such as chlorides and nutrients, for which there are no currently established numeric water quality criteria. However, it should be noted, that in all cases, narrative criteria still apply which provide that "The waters of this State may not be polluted by: …substances attributed to sewage, industrial waste or other waste…that interfere directly or indirectly with designated uses or … are harmful to human, plant, or aquatic life." (COMAR 26.08.02.03). It should also be noted that although numeric water quality criteria may not be available for these specific parameters, the Department has the authority to develop TMDLs based on ecologically relevant thresholds and to enforce effluent limits under the National Pollution Discharge Elimination System (NPDES) based on the waste load allocations specified in these TMDLs.

In the case of nutrients, the State has used dissolved oxygen and chlorophyll a levels as effective surrogates for assessing nutrient impairments and developing enforceable TMDLs (e.g. the Chesapeake Bay TMDLs). In reference to chlorides, MDE is currently in the process of developing numeric chloride criteria. Regarding the commentors' suggestion to use the IR as the vehicle for communicating on criteria development subjects, MDE respectfully disagrees. The IR's primary purpose is to report on the water quality status of all of Maryland's waters and not to discuss the intricacies of antidegradation policy or water quality standards development. A more appropriate venue for such a discussion would be during the Triennial Review period, within which changes to water quality standards can be proposed and discussed. As mentioned previously, MDE will make sure that the commentors are notified when this period is initiated.

MWS and Sierra Club Comment 7: The IR discusses the unresolved interplay between the Bay-wide TMDL and previously established local nutrient-TMDLs. The commentors recommend that a reference be provided for the surprising assertion: “Since it has been demonstrated that the loads established in the Chesapeake Bay TMDL will fully address any local water quality impairments…” [Part C.3.1, p. 112].

MDE Response: For clarity it should be noted that the quote referenced by the commentors refers to nutrient- and sediment-related local listings for tidal waters which drain to the Chesapeake Bay. The Chesapeake Bay TMDL can be accessed at: http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html. The introduction to the Chesapeake Bay TMDLs says "The [Chesapeake Bay] TMDL – the largest ever developed by EPA – identifies the necessary pollution reductions of nitrogen, phosphorus and sediment across Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia and sets pollution limits necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayments." Additionally Section 9.1 of the Bay TMDL states that “Tables 9-1, 9-2, and 9-3 provide the annual total nitrogen, total phosphorus, and total suspended solids (sediment) allocations, respectively, for the watershed areas draining to each of the 92 Chesapeake Bay segments necessary to meet their applicable WQS.” Finally, Appendix M and the associated excel documents provided as part of the Chesapeake Bay TMDL demonstrate that each tidal river and embayment of the Chesapeake Bay was assessed at the segment level (local). This is evidenced by the fact that each segment reaches dissolved oxygen criteria attainment at unique loading levels, reflecting segment-specific nutrient dynamics and circulation patterns taken into consideration within the Chesapeake Bay Water Quality/Sediment Transport Model. Appendix M can be accessed at: http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html.

MWS and Sierra Club Condensed and Paraphrased Comment 8: The commentors note that abundance and species-richness of the estuarine fish community in Mattawoman Creek has declined since approximately 2000 constituting non-support of the aquatic life use and more specifically, the open water fish and shellfish designated use. The commentors also provided assessment information on dissolved oxygen levels from continuously monitored sites in the tidal portion of Mattawoman Creek.

MDE Response: MDE thanks the commentors for providing information on use attainment and dissolved oxygen levels. MDE agrees with the commentors that Mattawoman Creek’s open water fish and shellfish use (as subcategory use under aquatic life) is impaired, as is evidenced by the low dissolved oxygen levels found in this water segment. As such, Mattawoman Creek is listed as impaired for total phosphorus and total nitrogen on the 2014 Integrated Report. The Department also agrees that the losses of aquatic life do give reason for concern. By implementing the Chesapeake Bay Watershed Implementation Plans (WIPs) and the Municipal Separate Stormwater System Permits (MS4), the Department expects that significant reductions will be made to a variety of pollutants that ultimately cause these losses.

MWS and Sierra Club Condensed and Paraphrased Comment 9: The commentors provided a table summarizing numerous violations of pH criteria in Mattawoman Creek’s tidal waters, exceeding both the acidic and basic thresholds.

MDE Response: MDE appreciates the commentors bringing this information to light. MDE requests that the commentors provide the raw data as well as any quality assurance (e.g. QAPP) information so that the Department can evaluate this data for the next (2016) Integrated Report.

MWS and Sierra Club Condensed and Paraphrased Comment 10: The commentors provided other data which supported the Departments impairment listings for chlorides and pH in the nontidal portion of the Mattawoman Creek.

MDE Response: MDE appreciates the commentor's efforts to independently assess water quality in Mattawoman Creek and is interested in working with the commentors to incorporate their data into statewide assessments.

Maryland Association of Municipal Wastewater Agencies, Inc. (MAMWA), 145 N. Hickory Avenue, Bel Air, Maryland 21014, Julie Pippel MAMWA President.

MAMWA Condensed Comment 11: At Part C.2 of the Draft Report (Assessment Methodologies Overview), MDE proposes to "clarify" when fish tissue concentration will be used for assessment versus water column data. According to MDE, fish tissue concentrations will supersede water column data for assessment of the fishing designated use when the information is available because it will "represent a more direct measure of the exposure level to humans." MDE references the full toxics methodology, found in a separate document dated September 18, 2013.

Although MAMWA has no general objection to use of a consumption approach for assessment of the fishing designated use, we are concerned that MDE's PCB threshold for fish of 39 ppb (parts per billion) (less than ½ of the 88 ppb used for the 2007 Lower Potomac TMDL) would be a change to the adopted water quality criterion without the required rulemaking procedures. We appreciate MDE explaining informally that it since the TMDL was written, it has updated the average weight per individual and the meal size used in the threshold calculation. However, we understand that the State's current water quality standards (COMAR 26.08.02.03-2, Numerical Criteria for Toxic Substances in Surface Waters) were based on different weight and meal size figures. Perhaps this explains the difference between the proposed threshold and the concentration used for the Lower Potomac TMDL as well.

If this is the case, the Department's decision to change the underlying components of the calculation used to determine the 0.00064 μg/L water column concentration is effectively a back-door way to change the State's water quality standards, without subjecting it to public review and comment. MAMWA relies upon the triennial review process to ensure that we are kept abreast of updates that could have significant impacts on our wastewater treatment plant NPDES permits. We request that MDE not make revisions outside of this process.

MDE Response: After further review, MDE has decided not to change the toxics assessment methodology with respect to using fish consumption data to supersede water column data when evaluating support of the organism-consumption (fishing) use. Regardless, MDE's intent with this assessment methodology change was not to initiate a back-door water quality criterion change. In all cases, MDE strives to have a rigorous public outreach and participation process for the Triennial Review which includes a non-regulatory Advanced Notice of Public Rule-Making (ANPRM), a formal Notice of Proposed Action (where regulation changes are proposed and public comments are considered) and Notice of Final Action.

The commentor is correct that the PCB threshold[33] used for assessing fish tissue consumption has been revised to better protect public health through the issuance of advisories. However, it should be noted that this threshold is not directly related to the human health criterion and was developed based on Maryland-specific bioaccumulation factors.[34] MDE has no immediate intention of revising the PCB water column criteria (0.00064µg/l, as in Code of Maryland Regulations 26.08.02.03-2) for the protection of human health related to the consumption of organisms. This formally adopted criterion remains in force, regardless of any changes to the fish tissue threshold and will be used for assessment when data are available.

Comments submitted on behalf of Baltimore Harbor Waterkeeper/Blue Water Baltimore, Gunpowder Riverkeeper, Potomac Riverkeeper, Upper Potomac Riverkeeper, Anacostia Riverkeeper, Choptank Riverkeeper, Miles-Wye Riverkeeper, and Midshore Riverkeeper Conservancy by Jennifer Chavez, Staff Attorney at EarthJustice, 1625 Mass. Ave., NW, Ste. 702, Washington, D.C. 20036.

Background to Comments from EarthJustice: The commenters highlight the re-classification of 139 water-body-designated use-pollutant combinations (53 separate Chesapeake Bay segments in Maryland) from Category 5 to Category 4a on Maryland's 2012 Integrated Report based on the 2010 approval of the Chesapeake Bay TMDLs. The commenters claim that this re-classification is not justified because the Chesapeake Bay TMDLs have several technical faults and instead, these tidal tributaries should each receive an additional "local" TMDL. MDE notes that, per EPA guidance, waterbody-designated use-pollutant combinations for which there is an approved TMDL, may be placed in Part 4a of Maryland's Integrated Report. There are hundreds of TMDLs established for Maryland waters. Nothing in the statute, regulations or guidance suggests that MDE must reconsider the sufficiency of every TMDL during each Section 303(d) listing cycle. These 139 waterbody-designated use-pollutant combinations each have an approved TMDL established as part of the Chesapeake Bay TMDLs and therefore meet the criteria for being placed in Part 4a of Maryland's Integrated Report. Nevertheless, in the interest of transparency, MDE will respond to the various technical comments submitted by the commenters.

EarthJustice Condensed and Paraphrased Comment 12: The commenters suggest that the calibration data used to develop the Bay TMDLs was not sufficient to meet federal requirements. They point to the Port Tobacco River, a segment which had a TMDL established in 1999 and is also covered by a TMDL established as part of the Chesapeake Bay TMDLs (2010). The commenters assert that the 1999 Port Tobacco River Nutrients TMDL used a "fine-grained level" of monitoring data that is lacking in the corresponding 2010 Port Tobacco River TMDL (established as part of the Chesapeake Bay TMDL) and which the commenters believe is also lacking in the TMDLs for the other Chesapeake Bay segments.

[33] The PCB fish consumption threshold, currently set at 39 ppb, is not a criterion but has been used as a water quality endpoint for protecting human health.
[34] The water column human health criterion was developed by EPA as a nationally recommended water quality criterion.

MDE Response: MDE believes that all of the Chesapeake Bay TMDLs incorporated sufficient monitoring data to meet all federal requirements. EPA's regulations and guidance do not require a specific resolution of data; but instead state that TMDLs should be developed based on the best available science and data.

The Chesapeake Bay Water Quality and Sediment Transport Model (WQSTM), used to develop the Bay TMDLs, incorporated tidal monitoring with a very high temporal and vertical profile resolution. There are 162 long-term tidal water quality monitoring stations, with one or more located in each water quality monitoring segment for which a TMDL was developed. These monitoring stations have almost 30 years of data covering a range of water quality and hydrologic conditions. Data is collected at each station at monthly and bimonthly rates with multiple readings at one meter depth intervals (Keisman and Shenk 2012). This data represents the best available science and data for the Chesapeake Bay segments.

While the commenters might assert that the data used for the 1999 Port Tobacco River Nutrients TMDL provided better spatial resolution, the Bay TMDLs included many more data points offering a higher degree of temporal and vertical resolution throughout the Bay and its tributaries. Irrespective of these opposing views, MDE strongly believes the "best available data" was included in the modeling tools.

EarthJustice Condensed and Paraphrased Comment 13: The commenters assert that since the critical conditions for the Chesapeake Bay TMDLs were applied uniformly to all tidal tributaries, they did not take into account local conditions and therefore do not fulfill federal requirements for TMDLs.

MDE Response: MDE's position is that the Bay TMDLs meet the federal requirements for assessing critical period. The approach to the critical period selection is discussed in detail in Appendix G of the Bay TMDL. The appendix states that, "EPA does not have specific guidance or regulations on how to determine critical period. EPA only requires that critical conditions and seasonal variations are considered [40 CFR 130.7(c)(1)]." In assessing critical conditions, the Chesapeake Bay Program Partnership considered over 30 years of streamflow data in the bay's major tributaries to identify a period when high flows (high flows strongly correlate to discharges of elevated nutrients to the Bay) were representative of a ten-year return period. The selection of a 10-year return period is consistent with the return period of other TMDLs that had been previously developed by the Chesapeake Bay Partnership jurisdictions and across the nation. The Bay Program Partnership ultimately decided on the years 1993 to 1995, choosing a three-year critical period to correspond with the bay's water quality assessment methodologies. The TMDL allocations for each of the 92 (53 in Maryland) segments were evaluated for water quality attainment under the 1993 to 1995 critical hydrologic condition. Each of the 92 Bay water quality segments; including, where applicable, open water, deep water and deep channels; were assessed for water quality attainment thus explicitly including and accounting for local water quality conditions. To the extent the commenter points to the 1999 Port Tobacco River TMDL by way of comparison, many of the previous TMDLs for nutrients that were developed in the early 2000's did not incorporate the same range of hydrologic and climatic conditions as were simulated in the development of the Chesapeake Bay TMDLs.

EarthJustice Condensed and Paraphrased Comment 14: The commenters suggest that the Bay TMDLs do not meet TMDL requirements because they treat waste load allocations (WLA) from minor municipal[35] dischargers in aggregate, rather than assigning individual allocations. They further highlight the apparent lack of stringency of the WLAs set by the Chesapeake Bay TMDLs by citing an example from the Port Tobacco River TMDL (approved in 1999). Based on this, the commenters contend that the Chesapeake Bay TMDLs do not, "establish an adequate regulatory basis for fully protective effluent limits".

MDE Response: MDE believes that the Chesapeake Bay TMDLs assign allocations to facilities in a way that is protective of applicable water quality standards. For minor wastewater point sources, current MDE practice is to assign an aggregate allocation. It is true that some of the earlier TMDLs, such as the Port Tobacco nutrients TMDL, were developed prior to the use of this practice. However, MDE believes that the use of aggregate allocations allows for much needed flexibility so that loads and subsequently implementation resources can be applied in the most cost-efficient manner possible. Ultimately, the effluent limits incorporated into an NPDES permit must be consistent with the aggregate allocation and also ensure that the discharge will not result in a violation of water quality standards in the receiving water body. Therefore, water quality and aquatic life immediately downstream of an individual plant's discharge will still be protected via the actual permitting process for these surface water discharges.

The commenters cite the difference in the daily nitrogen WLA for the LaPlata WWTP between the 1999 Port Tobacco River nutrient TMDL and the 2010 Chesapeake Bay TMDL for Port Tobacco River, noting that the newer TMDL allows a greater daily WLA. This they pose as an example of how the Chesapeake Bay TMDLs lack specificity at the local scale. However, the commenters should be careful not to use apparent stringency as a surrogate for evaluating the accuracy of each given TMDL. Both of the aforementioned TMDLs used local data for calibration, considerations of critical conditions, and provide for the protection of local water quality. The 2010 Port Tobacco River TMDL, developed as part of the Bay TMDLs, used the latest water quality standards, water quality data, modeling techniques, and logical framework in developing WLAs, load allocations (LA), and the overall segment-specific TMDL and, in so doing, met all regulatory requirements under the Clean Water Act.

EarthJustice Condensed and Paraphrased Comment 15: The commenters state that MDE must evaluate if it is necessary to develop additional TMDLs, supplemental to the Bay TMDLs, in each of Maryland's tidal tributaries in order to meet water quality endpoints. The commenters state that MDE did not perform this mandatory analysis, and has provided no assurance in the Integrated Report that federal regulations have been satisfied. To support this assertion, the commenters point to the 2008 Scientific and Technical Advisory Committee Chesapeake Bay Watershed Model Phase 5 Review report (STAC report), saying that it determined that the model resolution was too coarse for developing tidal tributary TMDLs.

MDE Response: Where a TMDL has been established and approved, nothing requires MDE to re-evaluate the sufficiency of that TMDL each listing cycle. That being said, as a general matter, MDE agrees that it is responsible for evaluating whether a TMDL is protective of water quality in its intended water body. However, MDE has already determined that the Chesapeake Bay TMDLs are protective of local water quality, both through its role as a Chesapeake Bay Program partner and through its technical

[35] Minor municipal dischargers are defined as those with flow capacities of less than 0.5 million gallons of wastewater per day (MGD).

oversight of the Chesapeake Bay TMDLs development process. MDE was an active participant in the technical development of the Bay TMDLs as evidenced by its participation in the many policy setting and technical workgroups leading up to the issuance of the Bay TMDLs, by its efforts to compile the best available data to inform the Bay TMDLs and by its active role in the review of the report. Through these efforts, MDE provided valuable oversight to the TMDL development process, ensuring that Maryland's water quality was evaluated fully and appropriately. A thorough technical explanation of how local water quality was assessed is provided, in Section 6 of the Chesapeake Bay TMDL report, and MDE has reviewed this report and agrees with its conclusions.

MDE did not describe the technical documentation of the Bay TMDLs in the 2012 or 2014 Integrated Report because this is not the traditional avenue for discussing the technical validity of a TMDL. Discussions like these generally happen in a TMDL Report, in its appendices, in its comment-response document, in its EPA Decision Rationale and during the public meetings leading up to its submission to EPA.

Finally, in response to the comment about the STAC report, MDE does not agree with the commenter's interpretation of the report findings. The STAC report does not indicate that the Phase 5 model is inappropriate for developing tidal tributary TMDLs. The "scale of information" issue, rather, refers to the river segment scale, not the bay segment scale at which the Bay TMDLs were developed. The river segment is the smallest level of segmentation in the Phase 5 Model. Each bay segment, on the other hand, comprises the drainage area to a tidal tributary, and is typically composed of multiple river segments.

EarthJustice Condensed and Paraphrased Comment 16: "In the 2012 IR MDE asserted that "if a pre-existing TMDL was developed using standards, models or data that have since been revised, updated or replaced by those used in the Bay TMDL, then the Bay TMDL will replace the previous TMDL. There is no basis for determining that existing TMDLs will be scrapped simply because different standards, models, or data have been employed in later overlapping TMDLs. Even where updated models or newer data are used in later overlapping TMDLs (such as the Chesapeake Bay TMDLs), MDE would still need to show that the later modeling was informed by robust local information, and that more stringent limitations are required under the overlapping TMDL, before concluding that the local TMDL should be displaced."

MDE Response: If previous TMDLs were developed using water quality standards that have since been updated, these TMDLs could be replaced with newer TMDLs. Further, if new and better models are available, which provide a more accurate representation of the system in question, then previous TMDLs developed with older data and models could be replaced with new TMDLs. There again, accuracy, and not stringency, is the goal for water quality modeling. As techniques improve and become more robust, thereby encompassing more compartments, parameters, forcing functions, and data that represents the various states of the system in question, models and resultant TMDL estimates become more accurate. Though still considered draft, EPA has issued guidance regarding considerations for revising and withdrawing TMDLs. This guidance document can be accessed at: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/Draft-TMDL_32212.pdf.

MDE ensured, as the 2010 Chesapeake Bay TMDLs were being developed, that local water quality would be protected by these TMDLs. Nonetheless, until the older tidal nutrient TMDLs can be re-evaluated, water bodies such as the Port Tobacco River, which have both an older nutrients TMDL and a newer Chesapeake Bay nutrients TMDL, will have two valid TMDLs. A re-evaluation of the older TMDLs would determine whether these older TMDLs are still applicable, accurate, and protective. If one or more of these conditions are not met for a specific older TMDL, MDE may recommend vacating, leaving the Chesapeake Bay TMDLs the sole TMDLs in force (for these areas). Of course, any such process would be undertaken with full public review and opportunity to comment.

EarthJustice Condensed and Paraphrased Comment 17: The commenter states that MDE's reevaluation of existing TMDLs should be disclosed through the Integrated Report and not in a separate document or process.

MDE Response: MDE respectfully disagrees with this assertion. There are numerous ways that a TMDL can be superseded or withdrawn and that process need not occur in connection with the IR. Indeed, nothing requires MDE to re-evaluate the sufficiency of each TMDL each listing cycle as part of the IR. What is required is that any document proposing to replace or vacate a TMDL must be made available to the public, through a formal public review process, before it is submitted to EPA. Regardless of what instrument MDE ultimately uses to propose such changes, MDE will engage stakeholders to ensure that Maryland's water resources are being managed in the best manner possible.

EarthJustice Condensed and Paraphrased Comment 18: The commenters conclude by requesting that MDE revisit the technical basis for re-classifying the 139 water body-designated use-pollutant combinations that went from Category 5 to Category 4a.

MDE Response: MDE respectfully declines this request as it feels that the technical documentation included with the Chesapeake Bay TMDLs adequately justifies this reclassification and meets all regulatory requirements for TMDLs.

The Chesapeake Bay TMDL represents the largest effort of its kind to date, and it is with great excitement that we are undertaking the next step, and an even more daunting task—implementation of the TMDL across seven jurisdictions and 64,000 square miles of watershed. Already two statewide implementation plans have been developed for Maryland, with a third one, the Phase III WIP, scheduled for completion in 2018. These plans have offered successively more detail as better data, science and modeling methods become available. The Phase III WIP will be the most comprehensive yet.

The CBP partnership is currently working on updates to its full suite of the modeling tools, including the Chesapeake Bay Airshed Model, Watershed Model, WQSTM, Scenario Builder, and the Chesapeake Assessment and Scenario Tool (CAST). For instance, for the WQSTM, CBP partners are working to extend the WQSTM simulation period beyond 2005 out to 2011 and to incorporate over a decade's worth of data from the shallow-water portions of the tidal tributaries, in order to more accurately predict water quality response in important tidal habitats. The partnership is also making important changes to the Watershed Model, including updated land use classes, refinements to transport processes and incorporating the effects of groundwater lag times.

As the Phase III WIP process moves forward, MDE and CBP have been actively reaching out to stakeholders. Throughout 2014, MDE worked with the Harry R. Hughes Center for Agro-Ecology to conduct a series of regional workshops to engage local partners. The center will continue its stakeholder outreach throughout the project. CBP is also conducting a separate stakeholder assessment, where it will solicit feedback from outreach interested parties. Specific information about how to get involved, can be obtained through Jim George (jim.george@maryland.gov) in MDE's Water Quality Protection and Restoration Program.

MDE and the Chesapeake Bay Program also encourage stakeholders to get involved by collecting and submitting water quality data. The South River Federation has been routinely collecting and submitting water quality data, including dissolved oxygen and water clarity, to the Chesapeake Bay Program. This data was used in the 2014 Integrated Report assessment for the South River. EPA has recently awarded a six-year cooperative agreement to the Alliance for Chesapeake Bay to directly support integrating citizen monitoring and other non-traditional water quality monitoring partners (e.g., watershed organizations, Riverkeepers, Waterkeepers, municipal authorities, counties, cities) into the CBP partnership's tidal and watershed monitoring networks.

In summary, MDE believes that the Chesapeake Bay TMDL, and its related suite of modeling tools, provided a level of sophistication that was theretofore unseen. As Maryland continues to implement and refine its restoration strategies, MDE believes that this framework will be critical in driving sustainable improvements in water quality.

Chesapeake Bay Foundation, Inc. (CBF), 145 6 Herndon Avenue, Annapolis, MD 21403, Doug Myers, Maryland Senior Scientist.

CBF Condensed and Paraphrased Comment 19: The commentor states the concern that "local nutrient TMDLs [for impaired stream segments, listed at the 8-digit scale]…may not adequately consider the unique circumstances within the portions of those watershed[s] containing impoundments." Higgins Millpond, in the Transquaking watershed, is cited specifically, with reference to harmful algal blooms (HAB).

MDE Response: The commentors are correct that TMDLs developed for riverine systems (as in the cited case, the Transquaking) are not generally meant to address the impoundments within a watershed. Separate TMDLs are developed for riverine systems and impoundments due to different water quality endpoints, and pollutant transport and fate dynamics. In the case of the Transquaking River TMDL, it was developed to be protective of the river, and was not intended to address any potential impairment in Higgins Millpond (which has not yet been listed as impaired) or other impounded waters.

The Department acknowledges the occurrence of HABs in Higgins Millpond and feels it necessary to give this scenario more thought and study prior to creating an impairment listing. Part of the reason for this is that Maryland does not currently have an established HAB water quality criterion or assessment methodology. Another important consideration is that Higgins Millpond is a privately-owned impoundment. Historically, the State has managed "significant, publicly owned lakes" under CWA

§303(d); these lakes are characterized as being greater than five acres in surface area, being publicly owned, and having public access, providing public benefit and being available for other public uses (e.g., fishing or water supply). There are currently fifty-eight impoundments in Maryland meeting these conditions. The Department does not, by policy, rule out managing lakes not on this list, and has done so under specific conditions in the past. The Department is initiating the process of developing a guidance document to clarify this issue. Regardless of these deliberations, MDE encourages the commentor or others who might have such data to submit it, along with quality assurance project plan information to MDE for consideration in the 2016 Integrated Report.

CBF Condensed and Paraphrased Comment 20: The commentor states that the IR "…does not distinguish water bodies to the level of geographic distinctness" that can resolve the differences between flowing and impounded systems.

MDE Response: MDE respectfully disagrees with this comment since there are numerous examples, throughout the IR, of water quality assessments which separately address impoundments and flowing bodies of water. For example, the IR includes water body-specific assessments for 47 different impoundments, all of which exist in watersheds that also contain flowing waters. In addition, MDE has completed 38 TMDLs specifically for impoundments. In all cases, the water quality status of these impoundments was addressed separately from the flowing waters and has even been displayed separately in the mapping resources provided on MDE's Water Quality Mapping Center (http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/ImpairmentMaps.aspx). The IR can therefore include impairment listings at several appropriate scales (e.g. impoundments, estuarine embayments, 8-digit watersheds, stream segments, etc) provided that adequate data are available for a conclusive assessment.

CBF Comment 21: The commentor "requests that the [IR] re-examine watersheds with impoundments and any finer resolution data that may exist within impoundments to get a better handle on this mechanism of pollution.

MDE Response: Pursuant to the requirements under Section 303(d) of the Clean Water Act, MDE will gladly accept and evaluate all readily available data for such water bodies so as to improve assessment resolution and confidence. MDE encourages the commentor and any others who might have data for unassessed impoundments (as well as other unassessed water bodies) to submit this data to Matthew Stover at matthew.stover@maryland.gov so that this data can be evaluated during the Integrated Report process.

Center for Biological Diversity (CBD), 351 California Street, Suite 600, San Francisco, CA 94104, Miyoko Sakashita, Oceans Program Director, miyoko@biologicaldiversity.org

CBD Comment 22: Maryland identified four waterbodies for low-pH impairments due to atmospheric deposition. It is unclear if two of these listings, St. Mary's River (MD-02140103) and Mattawoman Creek (MD-02140111), could be for measurements at the mouth of these waterbodies that open into

Chesapeake Bay. It would be helpful if the integrated report identified that these low-pH conditions may in part be due to ocean acidification. Are low-pH 303d listings attributable in part to ocean acidification?

MDE Response: The two new pH impairment listings referenced by the commentor cover the non-tidal flowing portions of these watersheds which are, in most cases, well upstream of the mouth of these water bodies. These new impairment listings were based on the biological stressor identification (BSID) analyses which identified low pH as a major stressor to these waters. The BSID analyses do not differentiate between the types of acidic atmospheric influences (e.g. sulfur dioxides, nitrogen oxides, carbon dioxide) that could be causing the low pH impairment. However, since these impairments are in non-tidal waters the Department feels that the most likely cause for the low pH is the deposition of sulfur dioxides and nitrogen oxides and the poor buffering capacity of these watersheds. If additional information becomes available which establishes the specific cause for low pH, MDE will be sure to evaluate and include this in the Integrated Report. The BSID analyses for St. Mary's River and Mattawoman Creek can be accessed at: http://www.mde.state.md.us/programs/Water/TMDL/Documents/BSID_Reports/St_Marys_BSID_Report_031314.pdf and http://www.mde.state.md.us/programs/Water/TMDL/Documents/BSID_Reports/Mattawoman_BSID_Final_031314.pdf, respectively.

CBD Condensed Comment 23: It is unclear if Maryland has evaluated all readily available information and data for coastal impairments related to ocean acidification. Maryland should obtain and evaluate all relevant parameters of ocean acidification data available from the various organizations that serve as clearinghouses for ocean acidification data, especially those that are specific to Maryland's waters. Maryland has an independent duty to evaluate ocean acidification during its water quality assessment (Environmental Protection Agency 2010).

MDE Response: In accordance with Section 130.7(B)(5) of the Clean Water Act Maryland compiles and assesses all existing and readily available water quality-related data and information in the process of developing the Integrated Report. Maryland has reviewed the extensive data collected for the Chesapeake Bay and coastal waters (data collected by DNR). At this time, all data indicates that Maryland's water quality criteria for pH are being attained. In the future, MDE will continue to review data for Maryland's waters to determine if the pH criteria are met and if the aquatic life use is supported. As always, the Department appreciates the information that the commentor provided and encourages the commentor to continue to submit information that may be helpful in making water quality impairment determinations.

Worth noting, Maryland recently passed House Bill 118 during the 2014 legislative session. This bill established a state task force specifically to look into the effects of ocean acidification in Maryland and to make recommendations to the governor for strategies to mitigate the effects of acidification on state waters and resources. One of the important recommendations from this task force will be to improve Maryland's existing monitoring infrastructure (e.g. sample additional parameters) to better capture the potential effects from ocean acidification. More information on this task force and the final report are available at: http://mddnr.chesapeakebay.net/mdoatf/index.cfm.

CBD Condensed and Paraphrased Comment 24: The commentor states their concern that Atlantic shellfish are at risk due to ocean acidification. The commentor cites several studies of the impacts of acidifying waters on marine organisms as well as the documented impacts to shellfish in the Pacific Northwest as supporting evidence. Based on this evidence, the commentor recommends that Maryland should list its waters as threatened or impaired under the Clean Water Act.

MDE Response: MDE agrees with the commentor that there is a growing body of evidence supporting the relationship between increased levels of atmospheric carbon dioxide and ocean acidification (OA). However, MDE reviewed the articles cited by CBD and determined that none of them provided sufficient information (e.g. appropriate spatial scale, field studies demonstrating the condition of natural populations in Maryland waters) to show that Maryland's waters (specifically) are failing to attain (or will not be attaining by the next listing cycle) Maryland's water quality standards. Even the study by Waldbusser et al. (2011) on the native eastern oyster (*Crassostrea virginica*) acknowledges the difficulties in establishing causality between ocean acidification and the decline of the oyster in the Chesapeake Bay. In addition, the Fincham article (Chesapeake Quarterly 2012) cited by the commentor makes no conclusive statements that OA has reduced oyster harvesting in Maryland waters. Regardless, MDE will continue to review data for Maryland's waters to determine if the pH criteria are met and if the aquatic life use is supported. If CBD can provide Maryland-specific information in the future, this would be helpful in making water quality impairment determinations.

Mid-Atlantic Council Trout Unlimited (TU), P.O. Box 2865, Wheaton, MD 20915, Don Haynes, Chair of the Mid Atlantic Council.

TU Comment 25: The Mid Atlantic Council of Trout Unlimited is writing to express our support for the addition of temperature impairments for Use III (-P) streams to the 2014 Integrated Report. The Mid-Atlantic Council of Trout Unlimited represents 7 chapters and more than 2500 members in Maryland whose mission is the preservation and enhancement of trout waters in Maryland. Maryland has some outstanding natural trout waters that are a great attraction for tourism, a boon to local economies and a source of great enjoyment for many Maryland citizens.

The limiting factor in most of our stream resources for trout is temperature and listing Use III waters that are impaired for temperature will afford protection for these valuable streams. We congratulate the Department for its efforts to identify and list impairments for Use III streams. Many Use III streams do not meet the temperature standard for the Use Classification. Listing them as impaired for temperature is a good start at affording protection for them. Presumably, the development of TMDL's will follow and will provide strategies for mitigating the temperature impairments.

The methodology for assessing temperature impairments for Use III streams is a good start for developing criteria. We look forward to continuing discussions on the assessment methodology with the Department. We think that the extent of occurrence of temperatures that exceed the standard is as important as the time of exceedance, and we look forward to the opportunity to work with the

Department to refine the criteria in the future. In the meantime we fully support the inclusion of temperature impairments for Use III waters.

MDE Response: MDE appreciates the commentor's support in using this new temperature methodology to assess Maryland's Use III (and III-P) streams for the Integrated Report. The Department looks forward to working with the commentor and others to improve this methodology as new information becomes available. Regarding TMDLs, MDE will be researching how best to approach these listings whether it is through TMDL development or some other straight-to-implementation approach.

Maryland Department of Natural Resources. (DNR), 580 Taylor Avenue, Annapolis, MD 21401, Sherm Garrison, Biologist.

DNR Comment 26: The commentor suggested several formatting and grammatical improvements to the report.

MDE Response: These improvements were made.

DNR Comment 27: The commentor is curious as to when MDE stops making changes to the continuously updated listings?

MDE Response: As a general rule, the Department makes most changes to the listings by September 1 on the odd numbered year leading up to the submission of an Integrated Report. For example, for the 2014 Integrated Report (which was due to EPA in April of 2014), the Department made most of the changes to listings by September 1, 2013. However, there are often extenuating circumstances with any number of datasets/assessments that may require later changes to the Integrated Report prior to submission to EPA. In addition, changes can also be made in response to public comment. It should be noted that, even in cases where data was submitted too late to be included in one particular Integrated Report, it will be considered for use during the following Integrated Reporting cycle. Thus the process of compiling data and constructing the Integrated Report is essentially continuous from one report to the next.

DNR Comment 28: The source of previous listings is sometimes identified as "305(b)" (e.g., "2011 305(b) report") or "IR" (e.g.,"2012 IR") - Shouldn't this all be "IR"?

MDE Response: Maryland is required to submit odd-year (e.g. 2011, 2013, 2015) 305(b) updates to EPA in April of the year between Integrated Reporting cycles. Occasionally, the Department makes updates to listings during this process. The commentor is correct that this could be considered just a part of the Integrated Report process.

DNR Comment 29: The commentor references notes included in the actual assessment records (Part F) that state, "...certain areas of the watershed are meeting bacteria standards for the water contact use." and which have an assessment unit identification of "BasinCode-Multiple_segments" (e.g. "MD-02130304-multiple_segments_2". The commentor asks if the locations of these segments defined elsewhere?

MDE Response: The locations of these segments cannot be adequately defined in the tabular format of Part F. For this reason, the Department publishes and makes available a geographic information system coverage that depicts the extent of assessment records such as this. This coverage is available at: http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/WaterQuality.aspx or alternatively at: http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/ImpairmentMaps.aspx.

DNR Condensed and Paraphrased Comment 30: The commentor references the MD-NANTF-CHERRY_BEACH listing in Part F.2 (page 5) which has notes stating that this site is no "longer designated as a beach. Wicomico County HD will no longer be monitoring this site." The commentor also highlights the listing for assessment unit MD-CHOOH-Choptank_Marine_Beach on page 9 as it represents a similar scenario. The commentor inquires as to whether these beach assessment records (which are no longer designated as beaches) will be removed in future Integrated Reports or will these records continue to exist in the report with text describing that they will not be monitored in the future?

MDE Response: In total, there are ten assessment records (including MD-NANTF-Cherry_Beach and MD-CHOOH-Choptank_Marine_Beach) which represent waters that are no longer classified as beaches. Six of these are in Category 2, three are in Category 3, and one is in Category 4a. Listings such as these will likely remain on future reports so as to memorialize the assessment that was completed and to acknowledge that future monitoring is a low priority.

DNR Comment 31: The commentor highlights several Eastern Shore Chesapeake Bay segment assessment records which have the Migratory Spawning and Nursery (MSN) designated use where the notes state, "MSN designated use cannot be evaluated until the assessment methodology for the 7-day and 1-day dissolved oxygen criteria is established by EPA." The commentor suggests that MDE clarify that the "…criteria is established by "... EPA Chesapeake Bay Program".

MDE Response: In actuality, Maryland has already adopted (into Code of Maryland Regulations (COMAR)) a 7-day and 1-day water quality criterion for dissolved oxygen for the migratory spawning and nursery designated use. See COMAR 26.08.02.03-3 (http://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.02.03-3.htm). However, the Chesapeake Bay Program partnership (of which Maryland is a partner) is still working on developing an appropriate assessment methodology for how to assess these high frequency dissolved oxygen criteria

DNR Paraphrased Comment 32: The commentor references the Category 3 assessment for MD-02130404-Mainstem (Upper Choptank River) for PCB in Fish Tissue. For this assessment the note states, "One 5-fish composite of American eel shows level above threshold. Need data on non-migratory species to confirm impairment." The commentor inquires about what will happen with this listing, if after additional data collection, other non-migratory species do not have high body burden. Would the

Department list this water body on Category 5 (impaired, requires a TMDL) solely based on the eels information? If so, why wouldn't the Department list this water body as impaired now (based on American eel data)?

MDE Response: As described in the Toxics Assessment Methodology, "Species used to determine impairment should be representative of the water body. Migratory and transient species may be used if they are the dominant recreational species, but should only be used in conjunction with resident species, especially in the case of tidal tributaries of the Chesapeake Bay." (See http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/ToxicsAM2014.pdf). Since American eel are migratory and may not represent the local water quality of the Upper Choptank River, it is unlikely that the Department would classify the Upper Choptank as impaired (based on only the eel data). Additionally, eel are not the dominant recreational species for this water body further justifying this decision. However, the Department will continue to maintain a fish consumption advisory for American eel caught from the Upper Choptank but will classify the Upper Choptank, for the purposes of the Integrated Report, according to the fish tissue results obtained from fish that better represent local water quality conditions.

DNR Comment 33: The commentor highlights the assessment record for MD-TANMH-LAWS_UPPERTHOROFARE which has notes that state that this water body-pollutant combination was "Relisted". Does this mean that this record was delisted after the TMDL was approved? And now data show this segment is failing criteria again? The commentor notes that text describing "relisting" shows up in a handful of other assessment records as well. The commentor also asks whether the Department believes that relisting" may become more common over time?

MDE Response: The commentor is correct that where the term "relisted" has been used, it describes cases where a water body-pollutant combination went from an assessment of impairment (on one IR) to being assessed as meeting standards and then back to being assessed as impaired. Of course, these assessment changes happened over the course of multiple Integrated Reporting cycles and most frequently occur with assessments of bacteria levels in shellfish harvesting areas. As to whether this scenario will occur with more frequency over time, it is difficult to predict. It is possible that as water bodies approach attainment of water quality standards, they may 'flip-flop' more frequently as climatic and system variability play larger roles in meeting water quality criteria thresholds.

DNR Comment 34: The commentor suggested that, with respect to water quality trends discussion, it would certainly be appropriate to present findings from MBSS to show whether we think overall stream health is changing.

MDE Response: The Department agrees with the commentors suggestion and looks forward to reviewing the results of the current ongoing round of MBSS sampling which is conducting biological sampling at sites that were previously sampled in 1995, 1996, and 1997.

DNR Comment 35: The commentor states that "there is likely a need to have information about what exactly we monitor for and how often. For example, is there a routine fish tissue monitoring program in an area? Where all do we monitor chlordane? Do we only sample if someone finds a problem?" This information doesn't appear to be covered in the report.

MDE Response: The commentor is correct that much of this information is not available in the Integrated Report. Instead, much of this information can be found in the State's Comprehensive Water Monitoring Strategy which is incorporated by reference. However, the Department will consider this suggestion in the next Integrated Reporting cycle (2016).

Comments submitted by Jon Jacobs and Dana Stotsky of Jacobs Stotsky, PLLC, 1629 K Street, N.W., Ste. 300, Washington, D.C. 20006; and by David Flores of Blue Water Baltimore/Baltimore (BWB) Harbor Waterkeeper, 3545 Belair Road, Baltimore, MD 21213.

BWB Comment 36: In MDE's *"Comment Response Document Regarding the Water Quality Analysis of Chromium in Northwest Branch and Bear Creek Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Baltimore City and Baltimore County, Maryland"* dated July 30, 2013, at Response 3, MDE states "Sediment samples are collected from the top 2 cm of bottom sediments using a sediment ponar grab sampler. These samples are representative of the active layer in which benthic organisms live and feed." Previously, MDE relied on two Johns Hopkins University ("JHU") studies to determine benthic health effects from chromium exposure. However, the two JHU studies took samples much lower, below 7 cm, from the sediment surface. Nonetheless, MDE relied on these two studies to conclude that "chromium is not a source of toxicity within the inhabitable zone of the sediment," presumably due to ubiquitous reduction of hexavalent chromium (Cr^{VI}) to trivalent chromium (Cr^{III}) resulting from uniformly high AVS levels. A 2009 study by Graham et al. ("Graham et al. 2009"), used the upper 2 to 4 cm of the sediment *(Graham, Andrew M., Amar R. Wadhawan, and Edward J. Bouwer. Chromium occurrence and speciation in Baltimore Harbor sediments and porewater, Baltimore, Maryland, USA." Environmental Toxicology and Chemistry 28.3 (2009): 471-480, 472.),* a 2008 JHU study by Watlington et al. ("Watlington et al. 2008 JHU") used the upper 7.5cm of sediment *(Wallington, K, Graham, A., Bouwer, E.J. (2008). Bioassay Testing of Baltimore Harbor Sediments Spiked with Cr(VI). By the Center for Contaminant Transport, Fate, and Remediation, Final Report for Honeywell International, Inc.);* and a 2009 study of Dundalk Marine Terminal by CH2MHill ("2009 DMT-ERA") used 15cm sections, down to a meter *(2009: Ecological Risk Assessment, Dundalk Marine Terminal, Baltimore Maryland, by CH2MHill, prepared for Honeywell International, Inc.).*

If the active layer is correctly identified as the top 2 cm of sediment, should MDE continue to rely on the two JHU (and CH2MHill) studies for delisting the Northwest Branch and Bear Creek portions of the Patapsco River?

MDE Response: Sediment samples from the top 2 cm of sediment are collected by MDE for characterization and assessment of sediment chemistry and application in laboratory sediment bioassays. These samples are representative of the active layer in which benthic organisms reside and are exposed to chemical contamination. All chromium sediment concentration data presented in this WQA including information from the CH2MHill study demonstrates that sediments are predominantly composed of Cr (III), the relatively non-toxic species of chromium.

The findings from several JHU studies, including the one cited in comment 34 (Watlington et al. 2008) presented in this WQA, provided additional scientific evidence that current levels of chromium in sediments are not responsible for toxicity thereby supporting the delisting of chromium. Since the objective of the Watlington et al. study was not to characterize chromium concentrations in sediments or measure toxicity to benthic organisms under baseline conditions, a sampling protocol to collect sediments within the top 2 cm was not required. The study demonstrated that toxicity did not occur at environmentally relevant levels when spiking Patapsco River sediments with increasing levels of chromium. Sediment samples within the active layer as defined by MDE were not required for these laboratory tests as baseline concentrations of chromium were being manipulated to determine at what levels an increase in toxicological response would be exhibited. If only the baseline condition was being assessed then a sediment sample within the top 2 cm of the sediment would have been warranted for consistency.

BWB Comment 37: As stated in MDE's 2013 *"Water Quality Analysis (WQA) of Chromium in Northwest Branch and Bear Creek Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Baltimore City and Baltimore County, Maryland"* ("2013 WQA," page 24), as well as in its responses to comments regarding the 2013 WQA, MDE presumes ubiquitously high levels of available Acid Volatile Sulfides ("AVS") throughout the Northwest Branch and Bear Creek.[36] Presence of high AVS levels implies ready reduction of Cr^{VI} to Cr^{III}. However, several studies indicate tremendous fluctuations in AVS availability. For example, the 2009 DMT-ERA study demonstrated that AVS levels within the same location can fluctuate dramatically between May and August of the same year. Table 4-5a (page 70) shows the drastic fluctuations in AVS (umoles/g) between May 2007 and August 2007 at each site. Specifically, some sites increased as much as twenty times, while others decreased as much as four times, from May to August 2007.

Does MDE recognize the relative or fluctuating AVS levels across the Harbor, as well as over the year (seasonality), and finally during 'wet weather' and other non-normal events at each site studied? Also, does MDE recognize relative or fluctuating manganese levels at each site studied over time? Finally, from the preceding paragraph, an increase of twenty times and a decrease of four times produces mathematically an eighty-fold change in AVS levels. Given this, should MDE continue to rely on its presumption of ubiquitously high levels of available AVS throughout the Northwest Branch and Bear Creek to support the delisting from Category 5?

MDE Response: MDE recognizes that AVS and manganese levels in Harbor sediments may vary over time due to factors such as microbial activity, deposition of organic matter, oxygenation in sediment, etc. However, this variability does not indicate whether these changes will influence chromium speciation in the sediments. As long as the reductant capacity associated with AVS, iron, and organic matter is sufficient to maintain chromium in trivalent form this variability will be of no consequence. All water column, porewater and sediment concentration data for chromium collected to date has established that Cr (III) is the predominant species of chromium in sediments. Therefore, any variability in reductant capacity does not result in a significant presence of Cr (VI) in sediments. MDE does not rely on the presumption of ubiquitously high levels of AVS to support the delisting from Category 5.

[36] "*Comment Response Document Regarding the Water Quality Analysis of Chromium in Northwest Branch and Bear Creek Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Baltimore City and Baltimore County, Maryland*" dated July 30, 2013, Responses 5 through 8.

The justification for delisting chromium is based on findings from several studies that demonstrate chromium is not a source of toxicity at environmentally relevant levels. Under these studies, laboratory bioassays have been conducted using sediment samples throughout the Harbor with widely varying levels of AVS demonstrating that present levels of chromium are not toxic to benthic organisms.

BWB Comment 38: Several studies mentioned by MDE, including the Watlington *et al.* 2008 JHU study, the Graham *et al.* 2009 study, and the Wadhawan *et al.* 2013 study *(Biogeochemical Controls on Hexavalent Chromium Formation in Estuarine Sediments, Environ Sci Technol, 47 (15):8220-8),* selected sediment sampling sites from eighty-one (81) pre-established sampling sites located across the Harbor, as originally surveyed and described in a 1997 Baker *et al.* study *(Spatial Mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System, Chesapeake Biological Laboratory, University of Maryland* (Figure 1, A-2, page 26)). In particular, sites BSM68 through BSM71 were based on re-sampled sites located near Fells Point (68 & 69), Harbor Point (70) and west of Locust Point (71).

Sites 68 through 71 have also been re-sampled for several subsequent studies. Looking to the historic 1996-97 AVS levels for the original sampling of these study sites, AVS levels at site 68 are much higher than the neighboring sites, including sites 70 and 71. However, looking at the levels measured in 2003-04 for the very same sites (again, by Baker *et al. in Review of chemical contaminants in the Sediments of Baltimore Harbor. 2004),* the AVS levels for site 68 are less than half that of 70 and 71. Finally, looking to the Watlington el *al.* 2008 JHU study, AVS levels at site 68 are the lowest of the sites studied (70 and 71 were not included). <u>This indicates wide variation in AVS levels over time, both within and among sites.</u>

How does MDE consider such AVS level fluctuation with regard to chromium speciation? Did MDE consider such AVS level variation in relation to high levels of chromium at Dundalk Marine Terminal, Harbor Point and Sparrows Point? Assuming MDE has considered the extreme variability of AVS levels, does MDE plan to survey AVS levels and AVS/SEM ratios in areas of known chromium sources such as Dundalk Marine Terminal, Harbor Point and Sparrows Point?

MDE Response: MDE recognizes that AVS levels will fluctuate spatially and temporally throughout the Baltimore Harbor. However, this variability does not indicate whether these changes will influence chromium speciation in the sediments. All water quality data for chromium collected to date within the Harbor (including Dundalk Marine Terminal, Harbor Point, and Sparrows Point) has established that Cr (III) is the predominant species of chromium in sediments and therefore any variability in AVS does not result in a significant presence of Cr (VI) in sediments. Please refer to the response to comment 35 for additional information. MDE does not plan to conduct additional surveys of AVS and AVS/SEM in the future as the WQA demonstrates that chromium is not a source of toxicity within the sediments of the Northwest Branch and Bear Creek even under conditions in which there is variability in AVS concentrations. Chromium water quality data is currently collected on a quarterly basis in Harbor Point by Honeywell as required under a consent decree. MDE plans to continue reviewing this data in the future to determine whether chromium remains at levels that do not impair these waters. An off-shore investigation of sediments in waters adjacent to Sparrows Point is also currently being conducted. MDE will review this data to assess the impairment status of these waters in the future. The responsible party for the Sparrows Point Industrial Area is required under consent decree to remediate all sources of chemical contamination. While the Dundalk Marine Terminal is not located within an impaired segment of the Tidal Patapsco River and does not require additional surveys on the part of MDE, Maryland Port Authority (MPA) and Honeywell are under consent decree to eliminate discharges of chromium from the terminal's stormwater infrastructure. MDE will review water quality data collected under the long term monitoring plan for this site to assess the impairment status of these waters as well.

BWB Comment 39: AVS variation over time, both within and among sites, directly affects reduction/attenuation of Cr^{VI} and sediment toxicity. For example, the Watlington *et al.* 2008 JHU study found that one of the spiked samples (site 68) caused measurable toxic effects in the bioassay measurements. The study dismissed the bioassay results at site 68 to be an anomaly. However, the authors made no mention of the fact that site 68 contained the lowest AVS levels — and highest porewater total chromium levels — of all sites in the study.

Similarly, the 2009 DMT-ERA study measured a subset of porewater samples following a "wet weather event." One such location, near the southeast corner of Dundalk Marine Terminal, was found to have 108 ug/L Cr^{VI}.[37] The authors in this study dismissed this as an anomaly due to the wet weather event. However, no mention was made of the low AVS levels for that sample. Moreover, no mention was made that the sampling location reflected some of the highest total chromium and manganese levels in the entire study.

Has MDE considered that such findings are not anomalous but are instead a likely result of low AVS level, high background chromium and/or high manganese levels? Further, has MDE considered that such "wet weather events" are the most common mechanism for resuspension of sediments?

Prior to these studies, in a 2006 consent decree — entered into by MDE, Honeywell International, Inc. ("Honeywell") and the Maryland Port Administration regarding chromium issues at Dundalk Marine Terminal — MDE expressed concern over releases from the site, and required "additional actions" regarding chromium transport in both stormwater and groundwater.[38] MDE further found that chromium leachate from the Chromite Ore Processing Residue ("COPR") was permeating groundwater and stormwater systems.

If MDE no longer considers stormwater flows, groundwater flows, and other wet weather events as potential mechanisms for chromium transport, what are the bases for MDE's shift from its prior determination?

MDE Response: The Watlington et al. 2008 study does not dismiss the bioassay results at site 68 or state that it is anomalous. The spiking concentration that elicited a significantly toxic response in test organisms occurred at a level that is not environmentally relevant. MDE acknowledges that this may have occurred due to the availability of Mn as an oxidant and insufficient reductant capacity to reduce all chromium within the spiked sediment. All sediment bioassays conducted under this study elicited some level of toxicological response to test organisms. The objective of this study was to examine whether the addition of chromium (at environmentally relevant levels) to Baltimore Harbor sediments would result in an increase in toxicological response to test organisms. Results of the study

[37] Site JMDMT-8, CH2MHill 2009 DMT-ERA, at 4-10.
[38] *State of Maryland v. Honeywell Int'l, Inc.*, Consent Decree (Cir. Ct. Balt. Cnty., Apr. 2006) at 3.

demonstrated that an increase in toxicological response did not occur at environmentally relevant levels; therefore, chromium is not responsible for toxicity within the sediments.

The Ecological Risk Assessment does not state that the station with elevated levels of Cr (VI) in porewater following a “wet weather event” is anomalous. The study explains that the finding does not indicate unacceptable risk as 1) the concentration is well below the acute criterion which is applicable for a discrete sample following a storm event, 2) Cr (VI) was not detected in adjacent stations, and 3) Cr (VI) is not persistent following a rain event based on numerous sample results from stations throughout the terminal over time. MDE acknowledges that a “wet weather event” could potentially result in the formation of Cr (VI) through resuspension and oxidation. However, based on all water quality data collected to date, Cr (VI) is either not detected or present at insignificant levels. Therefore, storm events do not result in the persistence of Cr (VI) in sediments.

MDE has not shifted its position regarding chromium transport mechanisms through stormwater, ground water and wet weather events as the consent decree for Dundalk Marine Terminal remains in place. The Land Management Administration (LMA) under MDE currently oversees the implementation of remediation measures to eliminate chromium transport from Dundalk Marine Terminal. A WQA must demonstrate that ambient concentrations of a contaminant do not impair the water column or sediments of a waterbody. While chromium transports into the waters of the Northwest Branch and Bear Creek tidal segments through groundwater and stormwater flows, the resulting ambient concentrations within the water column and sediments do not cause an impairment. This WQA clearly demonstrates that chromium is not a source of toxicity within sediments even with existing sources of chromium entering these waters.

BWB Comment 40: In MDE's *"Comment Response Document Regarding the Water Quality Analysis of Chromium in Northwest Branch and Bear Creek Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Baltimore City and Baltimore County, Maryland"* dated July 30, 2013, at Response 12, MDE states that "groundwater sources [of chromium] do not impact ambient water quality." However, results of the extensive hydro-geologic survey in the 1986 Allied Baltimore Works, Remedial Investigation Report, by NUS/Halliburton, demonstrated that groundwater flowed outward, radially in all directions from the Harbor Point site, and that the general trend of groundwater flow was directed from northwest to southeast (Sections 4 and 5). The accompanying hydro-geologic conductivity study further demonstrated that groundwater flow occurred through both the geologic formations (e.g., Patuxent) as well as subsurface sediments.

Similarly, the CH2MHill 2009 DMT-ERA study found “[a]reas of groundwater upwelling [which] were identified in the near shore environment...." (Section 2.3.1, pages 2-6). As discussed in Comment 4 above, the study also found a porewater concentration of 108 ug/L Cr^{VI} near the southeast corner of Dundalk Marine Terminal, following a "wet weather event" — presumably due to stormwater flows.

Currently, at the Harbor Point site, Honeywell attempts to maintain a constant negative wellhead gradient, thereby maintaining (on average) a higher water level outside the slurry wall than inside the slurry wall. Despite these attempts at controlling the gradient within the slurry wall, total chromium levels in groundwater wells have not decreased on average. According to the total chromium measurements in groundwater wells surrounding Harbor Point, current attempts to maintain the negative well head at the site have not reduced the groundwater chromium levels for more than half of the well locations. In fact, 5 out of 8 wells locations have demonstrated either increased chromium levels, or showed no statistically significant change (Baltimore Inner Harbor Environmental Media Monitoring Plan, Quarterly Report No. 93, Fourth Quarter 2012).

The proportion of Cr^{VI} at Harbor Point is staggeringly high. Approximately 80% of the chromium production at the Harbor Point/Baltimore Works site was in the toxic Cr^{VI} form, and the Chromite Ore Processing Residue content deposited at the site was comprised of nearly 20% Cr^{VI} by dry weight.[39][40] At Harbor Point, recently measured chromium levels in groundwater wells on the northeast and northwest corners of the site regularly exceed 2,000 parts per million ("ppm"), up to and exceeding 5,000 ppm — far higher than any of the experimental samples used in either the Wadhawan et al. 2013 study or the Watlington *et al.* 2008 JHU study.

Considering the high proportion of Cr^{VI} in the samples described above, does MDE consider groundwater releases via subsurface flows and upwelling as a potential source of Cr^{VI} at Harbor Point, Dundalk Marine Terminal, or Sparrows Point? If not, what are the bases for such a conclusion? Has MDE or other stakeholders tested the Cr^{VI} content of groundwater at Harbor Point?

MDE Response: MDE acknowledges that groundwater releases of chromium via subsurface flows and upwelling is a potential source of Cr (VI) within sediments. These sources are inherently accounted for when monitoring ambient sediment concentrations. All water quality data collected to date has established that Cr (VI) is either not detected or present at insignificant levels in sediment. Even if present, Cr (VI) does not persist in sediments due to the available reductant capacity. While groundwater releases may contain elevated levels of Cr (VI), it cannot be assumed that this will also result in elevated levels of Cr (VI) within sediments. The water quality data clearly indicates that any Cr (VI) entering the sediments is reduced to Cr (III).

BWB Comment 41: Previously reduced Cr^{VI} to Cr^{III} may be re-oxidized to toxic levels of Cr^{VI} under certain conditions. A site susceptible to wide AVS fluctuations, possessing high manganese levels, and subject to periodic oxygenation via resuspension of sediments, may experience reformation of Cr^{VI} at toxic levels. Cr^{VI} can be introduced via groundwater upwelling (as found in the 2009 DMT-ERA study), leaking from Harbor Point or Sparrows Point, or via oxidation, as described above — all potentially resulting in toxic levels.

Regularly measured groundwater has had chromium concentrations as high as 2,000 and 3,000 parts per million (or 2 to 3 million parts per billion) at the Harbor Point perimeter wells (Baltimore Inner Harbor Environmental Media Monitoring Plan, Quarterly Reports). Further, as cited in Comment 5 above, approximately 80% of the chromium production at the site was in the toxic Cr^{VI} form, and the Chromite Ore Processing Residue (COPR) content was comprised of nearly 20% Cr^{VI} by dry weight. Coupled with the non-reducing environments of subsurface sediments, the subsurface and groundwater chromium are very likely high in Cr^{VI}. Once transported and released into the Harbor, it will likely act as a Cr^{VI} spike, resulting in toxic levels of Cr^{VI}.
Has MDE considered the groundwater and subsurface flows of Cr^{VI}? Has MDE considered that introduction of these flows, coupled with the demonstrated drastic fluxes in AVS levels, as well as

[39] MDE, Facts About Allied/Honeywell Site at Inner Harbor
[40] 1986 Allied Baltimore Works, Remedial Investigation Report, by NUS/Halliburton

variable manganese levels in sediments are likely to cause toxic levels of Cr^{VI}? If MDE has either not considered the likely sources of Cr^{VI} at Harbor Point, Dundalk Marine Terminal, or Sparrows Point, or concludes that they are not likely sources, what bases does MDE use for these positions?

MDE Response: MDE acknowledges that groundwater and subsurface flows of chromium coupled with variability in levels of AVS and Mn in sediment is a potential source of Cr (VI) within sediments though all water quality data collected to date has demonstrated that Cr (VI) is either not detected or present at insignificant levels and will not persist within sediments. Please refer to the response to comment 5 for additional information. MDE does consider these sources and concludes that any chromium present in groundwater or subsurface flows does not result in levels of Cr (VI) within sediment that result in an impairment. The WQA has clearly demonstrated that chromium is not a source of toxicity within the sediments of the Northwest Branch and Bear Creek.

BWB Comment 42: Measured total chromium levels at Harbor Point far exceed the measured total chromium of the sampling locations in the three studies explicitly relied upon in the 2013 WQA, and the *DRAFT 2014 Integrated Report of Surface Water Quality.*

Sediment monitoring data at Harbor Point, produced by Honeywell pursuant to monitoring required under the 1989 Consent Decree for Baltimore Works/Harbor Point, demonstrate wide variation in chromium levels both over time and around the site (Baltimore Inner Harbor Environmental Media Monitoring Plan, Quarterly Reports). Between 2001 and 2012, total chromium ranged from 31 to 5,300 mg/kg across eight (8) sampling locations, with an average 600 mg/kg for eight locations. Five (5) of the eight (8) sites exceeded 1,000 mg/kg at least once during the period, and one site ("SED-6") had an average total chromium level of 1,759 mg/kg over the eleven (11) year period, with the highest measured level occurring in 2012.

These data stand in stark contrast to total chromium in the Wadhawan *et al.* 2013 study, the Graham *et al.* 2009 study, and the Watlington *et al.* 2008 JHU study. Total chromium in the Wadhawan et al. 2013 study ranged from 83.5 to 1274 mg/kg, with an average 411 mg/kg for ten (10) samples. Total chromium in the Graham *et al.* 2009 study ranged from 2.5 to 1,050 mg/kg, with an average 418 mg/kg for twenty-two (22) samples. Finally, total chromium in the Watlington *et al.* 2008 JHU study ranged from 126 to 823 mg/kg, with an average 344 mg/kg for five (5) samples.

The average chromium level at the Harbor Point locations is nearly fifty percent higher than that of the above sites. Further, the highest measured level (SED-6, 2012) is over four times greater than the highest measured level in any of the above studies. In light of this, has MDE considered that sediments at Harbor Point require further study to demonstrate that chromium *no longer* poses a threat as a contaminant justifying the Category 5 delisting for this waterway?

MDE Response: While total chromium concentrations in sediments at Harbor Point are higher than levels found at other sites throughout Northwest Branch and Bear Creek, total chromium sediment quality data alone does not indicate toxicity. In order to assess the potential toxicity of sediments, the concentrations of chromium species, Cr (VI) and Cr (III) must be quantified. If sediments are predominantly composed of Cr (III), the relatively non-toxic species, chromium is not a source of toxicity. The WQA clearly establishes that Cr (VI), the highly toxic species of chromium, is either not detected or present at insignificant levels within the sediments of Harbor Point. Therefore chromium is not a source of toxicity and the evidence presented within this WQA provides sufficient justification for delisting.

While MDE will not conduct further studies at Harbor Point, chromium water quality data is currently being collected on a quarterly basis by Honeywell as required under a consent decree. MDE plans to continue reviewing this data in the future to determine whether chromium remains at levels that do not impair these waters.

BWB Comment 43: In MDE's *"Comment Response Document Regarding the Water Quality Analysis of Chromium in Northwest Branch and Bear Creek Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment, Baltimore City and Baltimore County, Maryland"* dated July 30, 2013, at Response 5 (as well as Comments 8 & 10) MDE specifically cites to Amar Wadhawan's 2012 dissertation for the proposition that sediments within the Harbor, following resuspension and re-oxygenation, do not experience reoccurrence of Cr^{VI} due to oxidation of Cr^{III}.

The results of the dissertation were published in the Wadhawan *et al.* 2013 publication *(Biogeochemical Controls on Hexavalent Chromium Formation in Estuarine Sediments. Environ Sci Technol, 47 (15):8220-8).* The study used sediment samples experimentally spiked with Cr^{VI}. These samples were then allowed to completely reduce the Cr^{VI} into CrIII form, under anaerobic conditions. Once exposed to oxygen, the spiked samples demonstrated sharp and immediate increases in Cr^{VI} (i.e. re-oxidation of Cr^{III} occurred). Following this sharp increase, Cr^{VI} production plateaued in most of the experimental samples. Cr^{VI} reoccurrence ranged from 1 to 15% of total chromium. Further, manganese levels were found to be positively correlated with oxidation and Cr^{VI} reoccurrence.

MDE's conclusions focus not on the above findings, but on the results of an unspiked experimental control. The study cites to an experimental control showing that an unspiked sample, similarly exposed to oxygen, did not experience a significant reoccurrence of Cr^{VI} (an experimental control trial, across sampling locations, yielded inconclusive results). The experimental sample (DMT-207), as listed in the Wadhawan *et al.* 2013 study, was not listed in the sediment properties table (Table 1). The sample in question (DMT-207) is, however, listed in the Graham *et al.* 2009 study, which sampled sediments during 2005 and 2007. The actual sample used in the unspiked experimental control (DMT-207) had a relatively low total chromium level (68 mg/kg or 68 ppm), which is lower than any of the experimental samples involved in the spiked experiment, and twenty times lower than the highest reading for the same location as reported in September 2009, DMT-909. This raises the question of whether a negative result would have been found had sediments with higher chromium been used in the unspiked experimental control.

Such a discrepancy in background chromium levels in experimental samples creates serious doubt surrounding the presumption that resuspended/re-oxygenated sediments will not experience reoccurrence of Cr^{VI}. In fact, based on the experimental findings in the Wadhawan *et al.* 2013 study, the author concludes "Natural attenuation processes in reducing sediments would ensure that these sediments act as a sink for reduced Cr and Mn species and maintain Cr^{III} stability with respect to oxidation. **The same may not hold true for Mn-rich sediments and soils that are deficient in reductants. Such sediments and soils are amenable to Cr^{III} oxidation once the low reductant capacity is exhausted. Cr^{VI} attenuation through the application of *in situ* remedial practices merits caution in such reductant-deficient and Mn-rich environments. Therefore, regulatory policies should take**

into account the existing biogeochemical conditions and their long-term impact on Cr speciation while assessing the environmental risk of Cr." [Emphasis added].

Has MDE considered that the reoccurrence of Cr^{VI} due to oxidation may be dramatically increased in sediments near Harbor Point, Dundalk Marine Terminal or Sparrows Point? For sediments with high manganese levels? As observed in the various studies cited by MDE, as well as the mandatory monitoring data for sediment near Harbor Point, total chromium varies widely, and frequently exceeds 1,000 and 2,000 mg/kg (or ppm). If MDE is relying on experiments observing the reoccurrence of Cr^{VI} in resuspended/re-oxygenated sediments, do background levels of chromium in the experimental samples reflect the levels founds across the Harbor?

MDE Response: The commentor indicates that MDE's determination that existing chromium in the sediments of the Northwest Branch and Bear Creek will not form Cr (VI) when oxygenated is based solely on the findings of a single unspiked experimental control under the Wadhawan et al. 2013 study. The commentor is concerned that the level of chromium for this sample is relatively low in comparison to other sites and therefore not representative of conditions throughout the Northwest Branch and Bear Creek. This is not the case as unspiked experimental controls for sediments collected from all sites with widely varying chromium concentrations under this study were oxygenated and Cr (VI) was not formed in any sample test. MDE received confirmation of this through personal communication with the lead author of the study. Therefore MDE's argument is clearly supported by the findings of this study that chromium in sediments collected from throughout the Harbor with varying levels of chromium, AVS, and Mn will not form Cr (VI) when oxygenated.

BWB Comment 44: In its Draft 2014 Integrated Report of Surface Water Quality, MDE addresses data sources and minimum requirements. "Maryland has developed a two-tiered approach to data quality. Tier 1 data are used to determine impaired waters (e.g., Category 5 waters or the traditional 303(d) List) and are subject to the highest data quality standards…Tier 2 data are used to assess the general condition of surface waters in Maryland and may include volunteer monitoring, land use data, visual observations of water quality condition, or data not consistent with Maryland's Assessment Methodologies… However, Tier 2 data alone are not used to make impairment decisions (i.e., Category 5 listings requiring a TMDL) because the data are of insufficient quantity and/or quality for regulatory decision-making."

In light of the data requirements for Tier 1 data, and that MDE has based TMDL listing decisions on certain water quality data, how has MDE required such data to adhere to Quality Assurance Project Plan (QAPP) and/or MDE Quality Management Program standards and procedures?

MDE Response: As described in Part A.1 of the Draft Integrated Report, Maryland requires that water quality data submissions have a QAPP or similar type of documentation in order to have the dataset be considered as a Tier 1 dataset. However, just the existence of a QAPP or similar documentation does not guarantee classification as a Tier 1 dataset. Maryland reviews each dataset for quality assurance/quality control (QAQC) issues. If an abundance of such issues occur, which bring into question the reliability of the dataset, Maryland will classify that dataset as Tier 2 or not use it at all. Part of the QAQC process often requires a phone or in-person interview with the submitting person or organization. This process can help to familiarize state reviewers with the dataset and clarify any portions that are not covered in the QAPP documentation.

In the case of data used for the Baltimore Harbor chromium delistings, data and studies were reviewed by MDE staff to ensure that the data were of good quality and the studies made well-supported logical conclusions. In some cases, MDE even met face-to-face with the primary author(s) to discuss results. MDE staff determined that the peer-reviewed studies and other data used for the WQA provided a robust weight of evidence demonstrating that chromium was not a source of toxicity in the Northwest Branch or Bear Creek portions of Baltimore Harbor.

Comments submitted on behalf of William Wrightson (private citizen) by Pamela Marks, Principal at Beveridge & Diamond, P.C. 201 North Charles Street, Suite 2210, Baltimore, MD 21201.

Wrightson Condensed and Paraphrased Comment 45: The commentor provided information on the occurrence of high cell counts of the blue-green algae *Microcystis aeruginosa* and the presence of high levels of Microcystin toxin in Higgins Millpond and in the Transquaking River downstream of Higgins Millpond (all in Dorchester County). The "commentor notes that the 2014 Integrated Report does not address evidence of microcystis blooms in the Transquaking River and Higgins Mill Pond, the underlying nutrient loading issues, or the associated contact recreation and water quality impairments of Higgins Mill Pond."

The commenter requests confirmation of this point for clarity, to avoid any implication that the (Integrated) report reflects any comprehensive assessment of the Transquaking River or Higgins Mill Pond.

MDE Response: As the commentor stated, the 2014 Integrated Report (IR) does not have an assessment record for Higgins Millpond. The Department acknowledges the occurrence of HABs in Higgins Millpond and downstream in Transquaking River[41] but feels it necessary to give this scenario more thought and study prior to creating an impairment listing. Part of the reason for this is that Maryland does not currently have an established HAB water quality criterion or assessment methodology. Another important consideration is that Higgins Millpond is a privately-owned impoundment. Regardless of these deliberations, MDE encourages the commentor or others who might have such data to submit it, along with quality assurance project plan information to MDE for consideration in the 2016 Integrated Report. Please also see response to Comment #17.

MDE would also like to clarify a portion of the comment that states "the Integrated Report does not address … the underlying nutrient loading issues…". The IR does include a reference to the approved nutrient (nitrogen and phosphorus) TMDL for the tidal portion of the Transquaking River. This TMDL, approved by EPA in 2000, addresses the nutrient loading issues for the tidal Transquaking River, though not necessarily for Higgins Millpond or the non-tidal flowing portions of the Transquaking River.

[41] Please note that the HAB occurrence in the Transquaking River is not characteristic of the flowing portion of Transquaking River and is more a result of the fact that Higgins Millpond is immediately upstream.

TMDLs are developed to address specific impairments in designated water quality limited segments (WQLS) at a specified scale; in this case, the TMDL was developed to meet water quality standards in the tidal Transquaking River. That being said, the fact that harmful algae blooms have occurred in Higgins Millpond and in the portion of Transquaking River immediately downstream of Higgins Millpond may be due to other reasons besides an inadequate TMDL. For example, even though a TMDL has been completed for the Transquaking River, implementation of that TMDL and therefore, actual nutrient reductions in the upstream watershed may not yet have occurred. The Department will continue to study this situation to determine the appropriate course of action regarding assessment for the Integrated Report.

Wrightson Condensed and Paraphrased Comment 46: The commenter recognizes that the geographic scale of the Bay Total Maximum Daily Load (TMDL) is such that the river and pond (Higgins Millpond) have not been examined individually. The data presented from Higgins Millpond illustrate that a serious issue exists that is not reflected in the TMDL assessment. The record for this TMDL report should reflect that this is the case, and that: 1) the report should not be read as a comprehensive determination as to all impairments in the Transquaking River, and 2) the report was not designed to address the water in Higgins Millpond because ponds have flows that greatly differ from the tidal streams (present below the pond's dam).

MDE Response: The Transquaking River nutrients TMDL was completed and approved in 2000 and Chesapeake Bay TMDLs addressing nutrients (nitrogen and phosphorus) and total suspended solids in Fishing Bay (FSBMH) were completed and approved in 2010. Nowhere within any of these TMDL reports, has it been implied that they address potential water quality issues in Higgins Millpond or in any other impoundments within the Transquaking River watershed. Consistent with how other impoundments have been addressed in the past, impoundments will be assessed and analyzed separately for water quality impairments and TMDL development due to their unique hydrologic characteristics that differentiate them from flowing streams and tidal waters. Thus, if Higgins Millpond should be listed as impaired in the future, it will be addressed through a separate analysis effort.

Wrightson Paraphrased Comment 47: Specifically regarding Part F.7, Category 5 Waters, Transquaking River: The discussion of an additional potential TMDL for the Transquaking River reflects consideration of some issues (Total Suspended Solids or TSS) in flowing waters but does not consider the full range of issues. For instance, it does not consider:

a. the presence of hazardous microcystis;
b. the proportion of the headwaters comprised of an industrial flow and that flow's contribution to conditions under which microcystis develops in and near the receiving pond;
c. the differential flow in dissimilar portions of the river system, and in particular the difference between the flowing tidal portions of the river below the dam, and the lentic ecosystem in Higgins Mill Pond above the dam; and
d. the full range of applicable water quality criteria.

In light of the above, please confirm that the following understanding is accurate: that the Integrated Report contents regarding the Transquaking River (including any identification of the impairment cause(s), the source(s) of the issue and the associated priority) address only TSS in flowing tidal waters and do not address nutrient loadings, microcystis, or Higgins Mill Pond.

MDE Response: MDE believes that the commentor is referencing the Category 5 total suspended solids (TSS) impairment to the non-tidal flowing portion of the Transquaking River (Higgins Millpond is not included in this impairment determination) that was first listed on the 2012 Integrated Report. This impairment has not yet been addressed by a TMDL. In addition to this listing, there is currently a Category 3 (insufficient information to assess) listing for TSS in the tidal Fishing Bay segment downstream of the Transquaking River. The Transquaking River nutrients (nitrogen and phosphorus) TMDL, approved in 2000, addressed a nutrient impairment in the tidal portion of the Transquaking River only. This TMDL was not designed to address potential nutrient-related issues (such as HABs) in Higgins Millpond, any other impoundment, or in non-tidal flowing waters within this watershed (Transquaking River). In summary, none of the assessments or TMDLs completed to date have addressed nutrients, or HABs in the non-tidal flowing waters or in any impoundment within the Transquaking River watershed. See previous responses.

Wrightson Comment 48: Regarding Part F3, Category 3 Waters (for Fishing Bay 1st through 4th order streams): Please confirm that this portion of the report does not reflect any assessment of the harmful algal blooms or whether water quality criteria are being achieved at Higgins Mill Pond, and confirm that discussions of 1st through 4th order streams do not include Higgins Mill Pond that has different flow conditions.

MDE Response: The assessment record referenced by the commentor for Fishing Bay (MD-02130307) addresses 1st through 4th order (Strahler stream order) flowing streams within the Fishing Bay watershed and not any lentic systems within the watershed.

Wrightson Comment 49: The “notes” for Fishing Bay Mesohaline contain the potential for confusion when it states that “This Ches. Bay tributary was never actually listed for nutrients.” Is this statement intended to refer only to the Fishing Bay area and not the Transquaking River? If so, the statement should be clarified and narrowed, because otherwise it conflicts with findings in the Transquaking River TMDL: “The Transquaking River was identified on the State’s 1996 list of WQLSs as impaired by nutrients (nitrogen and phosphorus).” Alternatively, the confusing (or erroneous) notation should be removed.

MDE Response: This note was clarified to state “The portion of Fishing Bay downstream of the Transquaking River has never been listed as impaired for nutrients. However, the impairment listings and TMDLs for the Transquaking and Chicamacomico Rivers still apply to these portions of the watershed.”

United States Environmental Protection Agency Region III (EPA), 1650 Arch Street, Philadelphia, PA 19103-2029, Maria Garcia, Office of Standards, Assessment, and TMDL (OSAT), garcia.maria@epa.gov

EPA Comment 50: EPA recently approved TMDLs for Nitrogen and Phosphorus for the waters of Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, and the Chincoteague Bay. Please revise the text in the main report (Table 26, page 115, Section C.3.4.1, Page 124) and Category Lists accordingly.

MDE Response: These parts of the report have been updated.

EPA Paraphrased Comment 51: The commentor notes that the main part of the document does not discuss the Fecal Coliform listings for Wye River and Kent Narrows which, as discussed in the notes of the listings, have been relisted in Category 4a.

MDE Response: Table 18 was added to the report along with text describing these types of assessment scenarios.

EPA Comment 52: In the Category 2 Table, on page 74 and 75, the BOD/Carbonaceous impairment appears to be listed twice. Is there a reason for this?

MDE Response: These are two different assessment records for Georges Creek, one for carbonaceous BOD and the other for nitrogenous BOD.