FINAL

2018/2020/2022 West Virginia Integrated Water Quality Monitoring and Assessment Report

Prepared to fulfill the requirements of Section 303(d) and 305(b) of the federal Clean Water Act and Chapter 22, Article 11, Section 28 of the West Virginia Water Pollution Control Act for the period of July 2016 through December 2020.

Prepared by the Division of Water and Waste Management

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1.0 INTRODUCTION

The federal Clean Water Act and 40CFR§130.8 contain requirements to report on the quality of a state's waters. Section 305(b) of the Clean Water Act requires a comprehensive biennial report. Section 303(d) requires, from time to time, a list of waters for which effluent limitations or other controls are not sufficient to meet water quality standards, referred to as impaired waters. Section 314 specifies that states will report an assessment of the water quality of all publicly owned lakes, including the status and trends of such water quality. In addition to federal requirements, West Virginia Code Chapter 22, Article 11, Section 28 also requires a biennial report of the quality of the state's waters. The United States Environmental Protection Agency (USEPA) has recommended these requirements be accomplished in a single report, referred to as an Integrated Report, which combines the comprehensive Section 305(b) report on water quality, the Section 303(d) list of waters that are not meeting water quality standards, and Section 314 assessment of publicly own lakes.

The WVDEP has prepared this Integrated Report to communicate the quality of the State's waters, as well as to explain the methods to assess and report on water quality. WVDEP will also be reporting results of the assessments to the USEPA through the recently developed Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS). To remain consistent with reporting through ATTAINS, this Integrated Report and data preparation have been organized differently. However, assessment methodologies have remained consistent with past reporting cycles in most instances, unless identified otherwise.

While Integrated Reports are normally published for two-year cycles, WVDEP encountered several circumstances that delayed the release of the 2018 and 2020 cycle reports. For this reason, WVDEP is taking advantage of an opportunity to publish a combined Integrated Report that covers three cycles: 2018, 2020, and 2022. This opportunity allows WVDEP to fulfill reporting requirements while streamlining the process to assess data, obtain input from the public, and obtain USEPA approval.

What is new?

Web-based Interactive Resources

ATTAINS is a relatively new internet-based data management system prepared by the USEPA to better track reported water quality, restoration planning, and implementation consistently across all regions and states. The data reported to USEPA through ATTAINS is made available through public information web applications such as How's My Waterway (https://mywaterway.epa.gov/). While these federal tracking systems and applications are undergoing continued development and maintenance, the best source of information regarding the WV water quality and restoration plans remains the WVDEP webpage. To help navigate the webpages and to provide an interactive platform to visualize the data presented in this Integrated Report, WVDEP has prepared a corresponding interactive ESRI StoryMap.

Assessment Units

The most significant change to the Integrated Report and assessment methodology is the creation of relatively static assessment units on which all assessments are conducted.

Previously, the Integrated Report presented impairment for individual bodies of water and indicated if the impairment/attainment status applied to the "entire length" of stream, "entire lake", or some portion of the stream or lake. The majority of listed streams were identified as impaired for their entire length. Segmentation occurred only in situations involving streams with impoundments, streams with more than one designated use (ex. partial trout streams), streams when knowledge of a specific pollutant source allowed clear distinction of impaired and unimpaired segments, or streams with multiple monitoring locations with differing results. In the latter scenario, if water quality results from one monitoring location indicated impairment, the stream was considered impaired until data sampled from a downstream or upstream monitoring station indicated attainment of the water quality criterion.

Using the previous strategy for stream segmentation, when new monitoring stations were added between reporting cycles, the segments of a water body could be re-delineated. Tracking changes in impairment or attainment of specific portions of a stream from one cycle to the next was challenging. Moving forward, the newly established assessment units will not be re-delineated between cycles. Instead, any data collected from an existing or new monitoring station anywhere on the assessment unit reach will be assessed to make impairment/attainment determinations. Every assessment unit in the state is tracked in ATTAINS, so understanding changes in assessment status will be more straightforward.

The newly established assessment units were delineated based on designated uses, existing impairments, drainage area size, upland land use, influence from tributaries, existing loading scenarios from TMDLs, and other site-specific considerations. This strategy for delineating relatively static assessment units will not only conform to data rules in ATTAINS but is also expected to align more appropriately with TMDL model predictions of impairment and attainment. See Section 8.0 TMDL Development Process for more information on how assessment units will be used in TMDLs.

In order to retain impairment status, and to ensure known water quality issues are addressed in the future, if a newly delineated assessment unit includes any segment previously identified as impaired, the entirety of the new assessment unit is considered impaired. There may be exceptions to this general rule when examining a scenario where the original impaired reach comprises a relatively insignificant length of the newly delineated assessment unit. A different attainment call may be made for an assessment unit, if supported by an examination of land use, pollutant sources, and historical data. These determinations are made on a case-by-case scenario. A crosswalk between the previously listed stream codes and new assessment unit identifiers (AUIDs) is provided in a Google Sheets workbook named "WV 2016_2022 AUID Crosswalk Final", downloadable at the following website under Supplemental Tables:

https://dep.wv.gov/wwe/watershed/ir/pages/303d_305b.aspx

Assessment units are identified alphanumerically based on coding from a 1:24,000 scale stream layer obtained and adapted from the National Hydrography Dataset (NHD). WVDEP has joined data from this

refined stream layer to existing stream codes and names originally derived from a 1:100,000 scale stream layer. As a result, the coding system used to identify streams/stream reaches is different. There were approximately 12,000 assessment units in the 2016 Integrated Report. In comparison using the new NHD 1:24,000 scale streamlines to derive the assessment units, there are now nearly 47,500 assessment units loaded to ATTAINS. Because the scales of the streamlines are so different, many more small streams are represented that have not been monitored or assessed. See Figure 1-1 to visualize the difference the change in streamline scales makes.

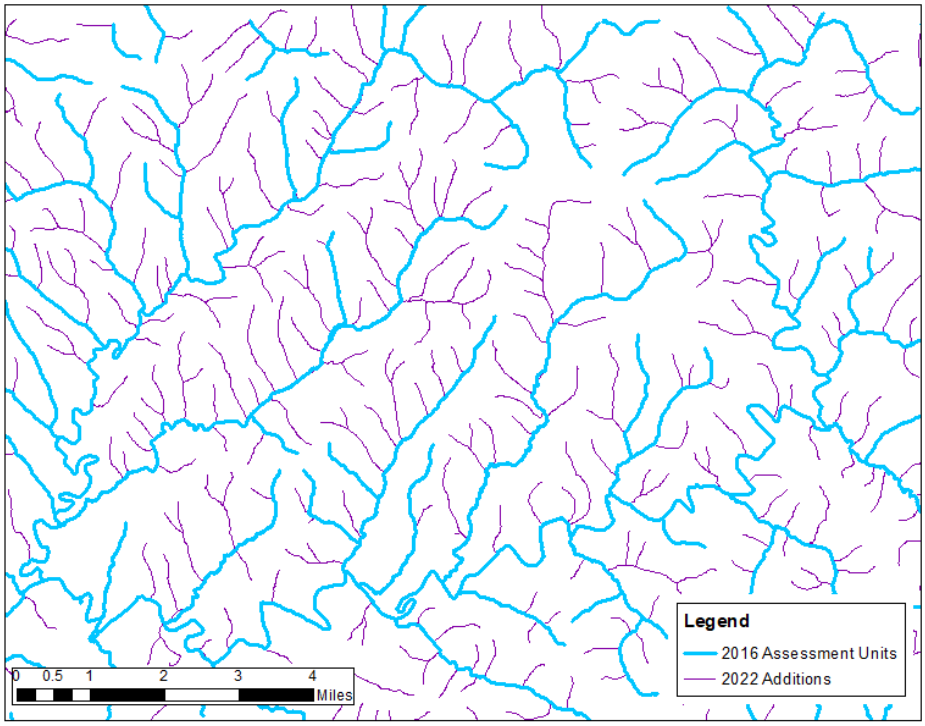


Figure 1-1: Comparison of the streamline resolution in the 2016 Integrated Report with additions for this Combined Integrated Report

Extended Assessment Periods for Combined Cycles

In order to complete a combined 2018/2020/2022 Integrated Report, assessments were conducted for data collected between July 1, 2012 and December 31, 2020 by the WVDEP's Division of Water and Waste Management Watershed Assessment Branch, as well as, other federal, state, private and nonprofit organizations. This assessment period was established based on the following rationale: an assessment period for the 2018 report would have normally included data collected through June 30, 2017. Following established protocols, any data collected up to five years prior to that date would be considered in assessment, so July 1, 2012 through June 30, 2017 for the 2018 cycle. To streamline data assessment, all data from July 1, 2012 through the 2022 cycle data cut-off date of December 31, 2020 were assessed at the same time. The 2022 cut-off date for data was established as a result of the monitoring delays due to COVID-19 pandemic travel restrictions. Data collected after December 31, 2020 were considered on a limited basis when additional data were needed to finalize an assessment decision (e.g., when a second

biological sample was required). A 2018, 2020, or 2022 cycle year designation for newly identified impairment assessment units was accomplished by examining the monitoring sample date range for each assessment unit.

Data Presentation

As noted previously, this report references a corresponding interactive ESRI StoryMap. With nearly 47,500 assessments units, the amount of data shown on a map of the entire state can be overwhelming. As demonstrated above, many new assessment units represent small unassessed streams and lakes. In addition, streams that were once identified as "entire length" have been segmented to create the static assessments units, even in situations where no monitoring stations exist. In total there are 40,529 unassessed assessment units. The ESRI StoryMap provides a layer of unassessed streams and a layer of unassessed lakes, focusing on the assessed stream and lake assessment units to display information regarding use attainment and impairment. The ESRI StoryMap can be accessed here:

https://2018-2022-combined-integrated-report-wvdep.hub.arcgis.com/

2.0 WATER QUALITY STANDARDS

Water quality standards are the basis of the assessment process. In West Virginia, the water quality standards are codified as 47CSR2 – Legislative Rules of the Department of Environmental Protection – Requirements Governing Water Quality Standards. Impairment assessments conducted for the Integrated Report are based only upon water quality standards that have received the EPA's approval and are currently considered effective for Clean Water Act purposes. Information regarding the Water Quality Standards can be found at: http://www.dep.wv.gov/WWE/Programs/wqs/Pages/default.aspx. Standards are expressed as numeric or narrative criteria.

ATTAINS uses the term "parameter" to refer to different criteria for which data are collected and assessed. When assessing parameters, WVDEP determines if a parameter is the cause of impairment for a water body or whether the parameter data meets water quality standards. In instances where too few data are available, it may not be possible to determine if a certain parameter is causing impairment or is attaining water quality standards. In those instances, WVDEP reports there were insufficient data to assess. If no data are available, a parameter will be reported as unassessed.

Every waterbody is assigned designated uses, described in detail beginning in Section 6.2 of 47CSR2 and summarized in Table 2-1. Each designated use has associated water quality criteria describing specific conditions required to ensure the waterbody can support that use. For example, Category B1 – Warm Water Fishery use requires pH remain within the range of 6.0 to 9.0 standard units. If water quality monitoring finds that the pH is below 6 or above 9, the waterbody is considered impaired, because it is not supporting its designated use. Section 5.0 Use Assessment Procedure provides more information on use attainment determination.

Table 2-1: West Virginia Water Use Designations

Category	Use Subcategory	Use Category	Description
A	Public Water	Human Health	Waters, after conventional treatment, used for human consumption.
B1	Warm Water Fishery	Aquatic Life	Propagation and maintenance of fish and other aquatic life in streams or stream segments which contain populations composed of all warm water aquatic life.
B2	Trout Waters	Aquatic Life	Propagation and maintenance of fish and other aquatic life in waters which sustain year-round trout populations. Excluded are those waters which receive annual stockings of trout, but which do not support year-round trout populations.
B4	Wetlands	Aquatic Life	Propagation and maintenance of fish and other aquatic life in wetlands, which generally include swamps, marshes, bogs, and similar areas.
C	Water Contact Recreation	Human Health	Swimming, fishing, water skiing, and certain types of pleasure boating, such as sailing in very small craft and outboard motorboats. In ATTAINS, Category C is split into subcategories: Water Contact Recreation - Recreation and Water Contact Recreation - Fish Consumption. The Fish Consumption subcategory applies specifically to those waters for which the State has published advisories limiting consumption, described in Section 5.7. This distinction is needed to inform How's My Waterway. The Fish Consumption subcategory is applied to all waters in the state in this reporting cycle.
D1	Irrigation	All Other	All stream segments used for irrigation.
D2	Livestock Watering	All Other	All stream segments used for livestock watering
D3	Wildlife	All Other	All stream segments and wetlands used by wildlife.
E1	Water Transport	All Other	All stream segments modified for water transport and having permanently maintained navigation aids.
E2	Cooling Water	All Other	All stream segments having one or more users for industrial cooling.
E3	Power Production	All Other	All stream segments extending from a point 500 feet upstream from the intake to a point one-half mile below the wastewater discharge point.
E4	Industrial	All Other	All stream segments with one or more industrial users; Does not include water for cooling.

Numeric water quality criteria consist of a concentration value, exposure duration and an allowable exceedance frequency. The water quality standards prescribe numeric criteria for all designated uses. For the B1, B4, and B2 Aquatic Life uses, there can be two forms of criteria for each parameter: an acute criterion that prevents lethality, and chronic criterion that prevents retardation of growth and reproduction. The numeric criteria for acute aquatic life protection are specified as one-hour average concentrations not to be exceeded more than once in a three-year period. The criteria for chronic aquatic life protection are

specified as four-day average concentrations not to be exceeded more than once in a three-year period. The exposure time criterion for human health protection (i.e., Category Uses A and C) is specified as an annual geometric mean and there are no allowable exceedances.

Narrative water quality criteria are also referred to as conditions not allowable (CNA). For example, the water quality standards contain a provision stating that wastes, present in any waters of the state, shall not adversely alter the integrity of the waters or cause significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems. WVDEP has a protocol to determine if waters exhibit conditions not allowable for the biological component (CNA-biological), which relies upon index of biological integrity for benthic macroinvertebrates referred to as the West Virginia Stream Condition Index (WVSCI). Narrative criteria are contained in 47CSR2. More information regarding the use of narrative criteria is contained in Section 5.0 Use Assessment Procedures section.

Ohio River Criteria

For the Ohio River, both Ohio River Valley Water Sanitation Commission (ORSANCO) and West Virginia water quality criteria were considered, as agreed upon in the ORSANCO Compact. Where both ORSANCO and West Virginia standards contain a criterion for a particular parameter, instream values were compared against the more stringent criterion. WVDEP supports ORSANCO's efforts to promote consistent decisions by the various jurisdictions with authority to develop 305(b) reports and 303(d) lists for the Ohio River. In support of those efforts, West Virginia has, and will continue to, work with ORSANCO and the other member states through a workgroup charged with improving consistency of 305(b) reporting among compact states. ORSANCO standards may be reviewed at:

http://www.orsanco.org/programs/pollution-control-standards/

3.0 WVDEP SURFACE WATER MONITORING

This section describes West Virginia's strategy to monitor and assess the surface waters of the state. The Watershed Assessment Branch is responsible for general water quality monitoring and assessing throughout the state. Visit the WV Integrated Report interactive ESRI StoryMap to see the monitoring station locations for the entire state. Planning and monitoring follow the watershed grouping framework, in which the state's 32 USGS 8-digit Hydrologic Unit Code (HUC) watersheds are organized into one of five groups, A-E (Figure 3-1).

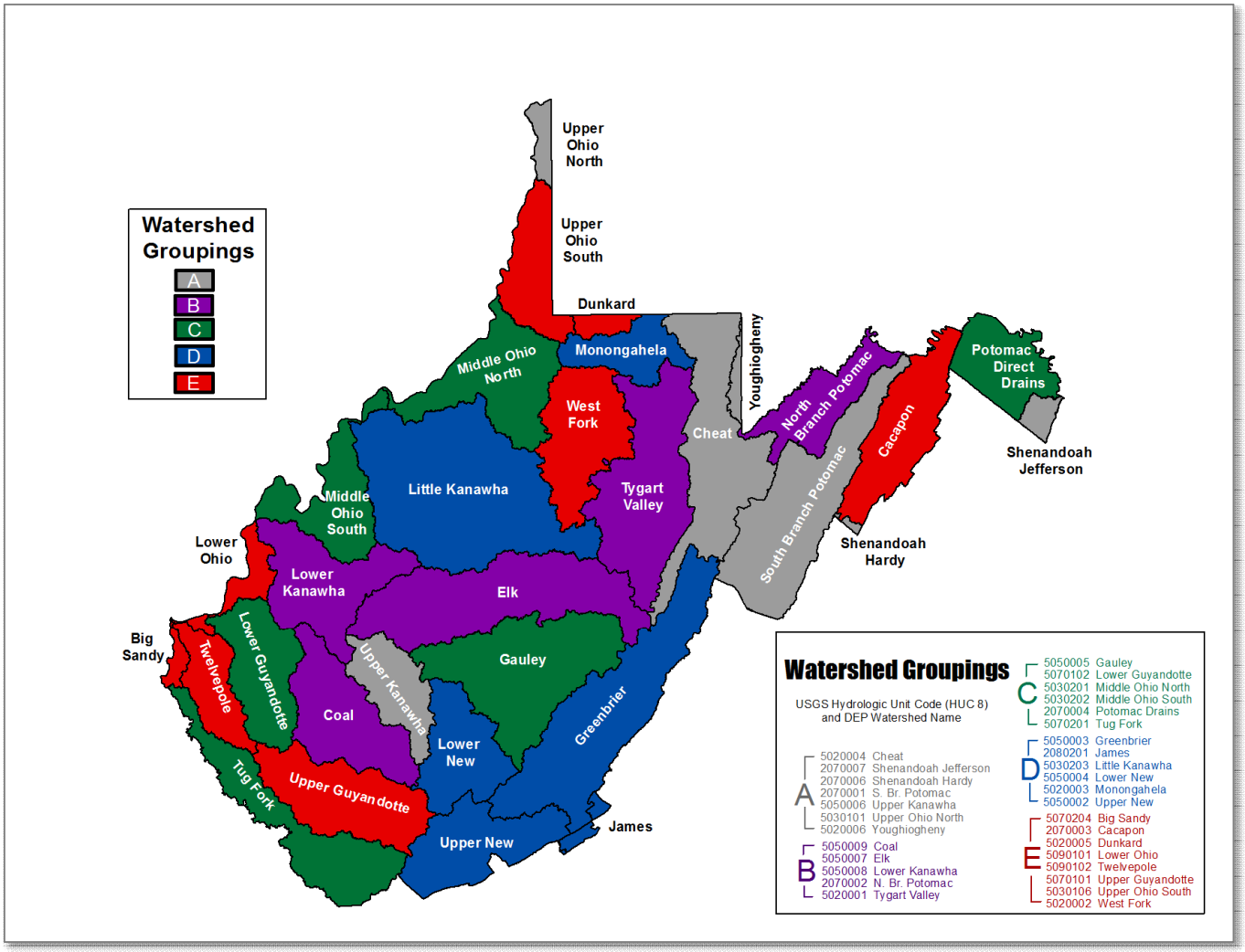


Figure 3-1: West Virginia Watershed Framework Groupings

Using the watershed framework, the focus of several monitoring programs rotates from one grouping to the next each year, while other programs retain a statewide focus every year. Given program goals and requirements, the schedule for monitoring has occasionally deviated from the rotating framework. This has occurred primarily in the pre-TMDL monitoring program when the priority or quantity of impairments on the 303d list influence a decision to target specific watersheds.

Table 3-1 provides a summary of monitoring activities that occurred during 2016-2020. The remainder of this section describes each Watershed Assessment Branch monitoring program in detail.

Table 3-1: Monitoring Activities from 2016 through 2020

Monitoring	Effort
Ambient	26 Ambient Sites are currently, and will continue to be, monitored monthly in the Monongahela River Basin Sites or bi-monthly for all other ambient sites. Ambient monitoring resulted in 881 samples being collected from 2016 through 2020.

Monitoring	Effort
Probabilistic	Probabilistic monitoring is conducted at random locations for statistical comparisons. A fourth round of probabilistic monitoring was completed in 2018, with the fifth round started in 2019. Probabilistic monitoring resulted in 299 samples collected from 278 streams within 32 major watersheds from 2016 through 2020.
Pre-TMDL	Pre-TMDL development monitoring was completed in the Upper Guyandotte River Watershed in 2016; for select streams in the Lower Ohio, Big Sandy, and Twelvepole Creek watersheds in 2017; in the Lower Guyandotte River Watershed in 2018; in the Tug Fork River Watershed in 2019 (additional monitoring for the Tug Fork River mainstem continued into 2020); and in the Little Kanawha River Watershed in 2020.
Targeted	Targeted Sampling was completed at 388 sites on 309 streams in 25 watersheds representing all five Hydrologic Groups (A-E) from 2016 through 2020.
Lakes	Seven lakes from Group A, 7 lakes from Group B, 9 lakes from Group C, and 7 lakes from Group D were sampled at one or more monitoring locations four times during the May – October assessment seasons in 2016, 2017, 2018, and 2019, respectively. A full round of lake monitoring was not conducted in 2020 due to COVID travel restrictions.
Continuous	Continuous water quality meters were deployed at 133 locations on 106 streams during the 2016-2020 term. Parameters measured include pH, temperature, conductivity, dissolved oxygen, and turbidity.
Long Term	Long Term Monitoring Sites (LTMS) – 318 sites were sampled during the 2016-2020 sampling seasons representing all five Hydrologic Groups.
Wetlands	WVDEP has completed 107 probabilistic West Virginia Wetland Rapid Assessment Method (WVWRAM) assessments during the first two years of its first 5-year-round of stratified probabilistic wetland monitoring.
Harmful Algal Bloom	Harmful Algal Bloom (HAB) monitoring occurs in response to a potential HAB sighting reported to the WVDEP. In addition, in the summer of 2019, the WVDEP Watershed Assessment Branch implemented a Harmful Algal Bloom Long-Term Trend Sampling program. In total, 15 sites were selected with an approximate statewide distribution, focusing on larger waterbodies including rivers, large streams, and lakes.
Filamentous Algae	WVDEP monitors numerous rivers in the state for filamentous algae blooms, including the Greenbrier River, Tygart River, South Branch Potomac River, and the Cacapon River. Monitoring generally occurs in late summer to early fall, when flows decrease, and temperatures begin to rise in the rivers.
Fish Tissue	Monitoring from 2016-2020 resulted in the analysis of 407 samples for PCBs and mercury, and 174 samples for selenium. These samples were collected from 27 HUC-8 watersheds representing 55 different waterbodies, including 11 lakes.

The Watershed Assessment Branch water quality data and biological data is currently available at: https://apps.dep.wv.gov/dwwm/wqdata/. Data from the Watershed Assessment Branch databases are also being prepared to share on the Water Quality Exchange (WQX) network. The WQX is a mechanism through which data partners can submit water quality data to the USEPA for public access through the Water Quality Portal. Currently, a limited amount of the Watershed Assessment Branch data has been uploaded to WQX.

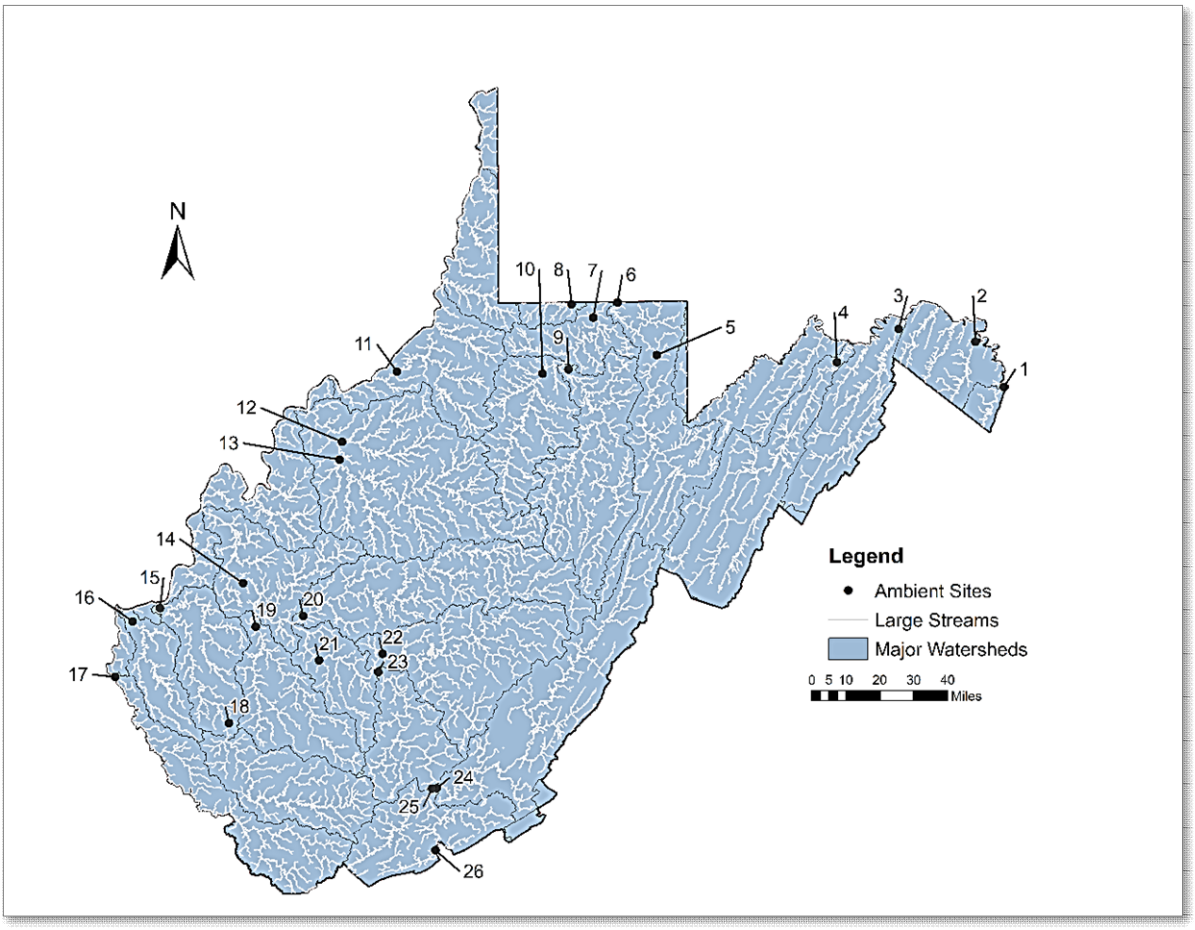
3.1 Streams and Rivers

West Virginia has a comprehensive strategy to monitor streams and rivers. The Watershed Assessment Branch utilizes a tiered approach, collecting data from long-term monitoring stations, targeted sites within watersheds on a rotating basin schedule, randomly selected sites, and sites chosen to further define impaired stream segments in support of TMDL development. The following paragraphs further describe these programs. For full details on monitoring programs, see the Watershed Assessment Branch Field Sampling Standard Operating Procedure at:

https://dep.wv.gov/WWE/watershed/Pages/WBSOPs.aspx.

Ambient Water Quality Monitoring Network

The ambient water quality monitoring network concept was established in the mid-1940s. The network currently consists of 26 fixed sites sampled monthly, bimonthly in the Monongahela River basin. Sampling stations are generally located near the mouths of the state's larger rivers and are co-located with USGS stream gages. Biological monitoring, using benthic macroinvertebrate communities, is conducted once annually at or near 20 of these stations. The data provides information for trend analyses, general water quality assessments, and pollutant loading calculations, and allows water resources managers to quickly gauge the health of the state's major waterways. Ambient water quality monitoring resulted in 881 samples being collected from 2016 through 2020. The sites are displayed on Figure 3-2 and listed below.



1. Shenandoah River at Harpers Ferry
2. Opequon Creek east of Bedington
3. Cacapon River near Great Cacapon
4. SB Potomac River near Springfield
5. Cheat River at Albright
6. Cheat River below Cheat Lake
7. Monongahela River in Star City
8. Dunkard Creek east of Pentress
9. Tygart Valley River at Colfax
10. West Fork River at Enterprise
11. Middle Island Creek at Arvilla
12. Hughes River west of Freeport
13. Little Kanawha River at Elizabeth
14. Kanawha River at Winfield
15. Guyandotte River at Huntington
16. Twelvepole Creek south of Ceredo
17. Tug Fork at Fort Gay
18. Guyandotte River at Pecks Mill
19. Coal River at Tornado
20. Elk River at Coonskin Park
21. Kanawha River at Chelyan
22. Gauley River at Beech Glen
23. New River above Gauley Bridge
24. Greenbrier River at Hinton
25. New River at Hinton
26. New River at Virginia State line

Figure 3-2: West Virginia Ambient Monitoring Sites

Probabilistic (Random) Sampling

In 1997, the Watershed Assessment Branch began sampling sites selected through the USEPA's random stratified procedure to better assess the ecological health of watersheds and ecoregions within the state. The data generated from this random stratified (also known as probabilistic) sampling effort allows the

WVDEP and the USEPA to make statistically valid assessments of aquatic integrity on a statewide basis, as well as make comparisons between watersheds and ecoregions. The data also assist with monitoring long-term trends in watershed and ecoregion health. The WVDEP has completed four rounds of probabilistic monitoring. WVDEP started a fifth round of probabilistic sampling in 2019. A full round of monitoring is normally conducted over a five-year period in order to characterize conditions in wadeable streams over a range of baseflow regimes and weather conditions. Probabilistic monitoring resulted in 299 samples being collected from 278 streams within 32 major watersheds from 2016 through 2020. Further details are provided in the Section 7.0 Probabilistic Data Summary.

Pre-Total Maximum Daily Load (TMDL) Development Monitoring

The primary objective of this major effort is to collect sufficient data for Total Maximum Daily Load (TMDL) modelers to develop stream restoration plans. Pre-TMDL monitoring has traditionally followed the 5-year framework cycle, (i.e., impaired streams from watersheds in Hydrologic Group A were sampled in the same year as sampling by other stakeholder agencies participating in the watershed management framework). The 303(d) list is the basis for initial site selection and additional sites are added to comprehensively assess tributary waters and allow identification of the suspected sources of impairment. More recently, to address impairments that have been listed for several years, watersheds were selected for TMDL development outside of the schedule established by the framework cycle.

Pre-TMDL development monitoring was completed for the Upper Guyandotte River Watershed in 2016; for select streams in the Lower Ohio River, Big Sandy River, and Twelvepole Creek Watersheds in 2017; and for the Lower Guyandotte Watershed in 2018. WVDEP monitoring for the Tug Fork River watershed was completed in 2019 for most streams, with the exception of the Tug Fork River mainstem. These sites were monitored for an extended period of time to coincide with a monitoring project in the seven largest tributaries draining from Kentucky into the Tug Fork River. Pre-TMDL monitoring began in the Little Kanawha River watershed (except Hughes River) in 2019. Due to travel restrictions resulting from the COVID-19 pandemic, sampling in most streams was extended to December 2020. Conforming to a revised assessment procedure for CNA-biological, additional benthic macroinvertebrate monitoring occurred in these watersheds beyond the scheduled pre-TMDL program timelines to obtain second samples where needed.

Pre-TMDL monitoring for the Cacapon River watershed commenced in June 2021 and should be completed in 2022. These data were not considered in this assessment cycle, except for instances to verify listing/delisting decisions based on third party monitoring data.

Pre-TMDL monitoring is intensive, consisting of monthly sampling for parameters of concern, which captures data under a variety of weather conditions and flow regimes. Pre-TMDL monitoring also includes an effort to locate the specific sources of impairment, with particular attention paid to identifying pollutant sources and land use stressors. For more information, see the TMDL Development Process section (link or reference?).

Targeted Monitoring

Targeted monitoring has been a component of West Virginia's assessment strategy since the Watershed Assessment Program's inception in late 1995. Streams are sampled on a five-year rotating basin approach. Sites are selected from the watersheds targeted for sampling each year, with each site subjected to a one-time evaluation of riparian and instream habitat, basic water quality parameters, and benthic macroinvertebrate communities.

Site selections are based on informational needs in the following areas:

- Impaired streams
- Reference streams (minimally impacted)
- Spatial trends (multiple sites on streams exceeding 15 miles in length)
- Areas of concern as identified by the public and stakeholders
- Previously unassessed streams

Targeted Sampling was completed at 388 sites on 309 streams in 25 watersheds, representing all five Hydrologic Groups (A-E) from 2016 through 2020.

Long Term Monitoring Sites (LTMS)

Data from LTMS are used to monitor water quality and habitat trends over time at targeted wadeable streams throughout the state. The stations represent a wide array of impairments commonly identified in WV (acid mine drainage, acid deposition, sediment, nutrient enrichment, etc.). Importantly, the network also includes streams that represent reference or best-attainable conditions.

Sampling frequency is variable. Most sites are sampled annually, while others are sampled every two to three years. Critical elements include habitat evaluations, benthic macroinvertebrate assemblages, on-site measurements, and water quality sampling. The sampling events take place between March and October, inclusive. Most sites are sampled once per year, however, a subset of the LTMS sites is sampled twice per year to document seasonal differences.

During the 2016-2020 sampling seasons, 318 LTMS sites were sampled representing all five Hydrologic Groups.

Continuous Monitoring

Deployable sondes are used for a variety of applications to provide more detailed information on a stream. These devices can capture conditions that may not be captured with grab samples, such as diurnal changes and episodic events and are used to support existing studies, such as TMDL development and trout stream determinations. As these units are frequently moved to meet the agency's needs, the number of sites is variable.

Sondes are typically programmed to record parameters hourly. However, if frequent fluctuations in water quality are suspected, parameters may be recorded at 30-minute or 15-minute intervals. Deployed sondes

are visited a minimum of once per month to download data, perform maintenance, and retrieve or replace the sonde. A critical element of data integrity is conducting discrete checks, wherein a second recently calibrated multi-probe meter is used to record field readings (temperature, pH, dissolved oxygen, and/or conductivity) immediately adjacent to the deployed unit. The discrete check provides a fresh baseline and aids in compensating for drift in the deployed unit's recordings.

Data recorded by deployable sondes were not included in the assessment effort for this IR, as processes to assure quality are still being finalized before developing an assessment methodology. Discrete samples collected during deployment and during monthly maintenance are included in assessments for the Integrated Report, with more than one collected at each site during a maintenance visit to ensure deployable data quality control. Only one representative sample for the site visit was assessed. To ensure no impairment was overlooked, both the highest and lowest pH sample were examined to select a representative sample, while the lowest dissolved oxygen data was considered.

Water quality meters were deployed at 133 locations on 106 streams during the 2016-2020 term. Parameters measured include pH, temperature, conductivity, and dissolved oxygen.

3.2 Lakes and Reservoirs

In 2006, WVDEP resumed a lake monitoring component that focuses on physicochemical water quality parameters. WVDEP added the collection of aquatic macroinvertebrates to the lake monitoring program in 2011.

The objectives of lake monitoring are to identify areas of impairment and to document recovery where abatement plans have been implemented. Sites are selected to update existing data or to address sites with little or no information. Lakes are sampled in accordance with the five-year hydrologic grouping watershed cycle. Seven lakes from Group A, 7 lakes from Group B, 9 lakes from Group C, and 7 lakes from Group D were sampled at one or more monitoring locations four times during the May - October assessment seasons in 2016, 2017, 2018, and 2019, respectively. A full round of lake monitoring was not conducted in 2020 due to COVID travel restrictions.

The number of sites per lake is proportional to the size and shape of the impoundment. One site is established at the deepest part of the impoundment and additional sites may be added to evaluate different arms of the lake or to provide longitudinal information. Each lake is sampled four times during the summer months (June - September or May - August), coinciding with the primary growing season in WV. Critical elements are vertical chemistry profiles for temperature, pH, dissolved oxygen, and conductivity (on-site measurements); nutrients, fecal coliform bacteria, and chlorophyll-a sampling; and Secchi depth.

Many of West Virginia's largest reservoirs are controlled by the U.S. Army Corps of Engineers. Although the Corps' primary mission is to manage structures to provide navigation and flood control, the agency is also committed to water quality management. Data generated by the Corps has been used for assessment purposes.

Additional lake information is available from the West Virginia Division of Natural Resources (DNR). The DNR, one of the signatory agencies in the Partnership for Statewide Watershed Management, conducts fish community surveys on many of the State's reservoirs.

3.3 Wetlands

WVDEP contributes to management of the State's wetlands. Wetlands are areas where the land is covered by shallow water, or the soil is saturated to the surface for at least two weeks during the growing season. Wetlands are wet enough to affect the types of soils and plants that can occur, but they may also be dry at certain times of the year. Some common names for different types of wetlands are swamp, marsh, and bog. According to the National Wetlands Inventory for WV in 2021, the current total acreage of wetlands within the state is approximately 111,000 acres and comprises less than one percent of the State's total acreage; yet wetlands are critical to the overall health of our state's aquatic resources by reducing the impacts of floods, providing baseflow to streams, reducing bank erosion, removing pollutants, processing excess nutrients, capturing sediment, and providing habitat to a high diversity of plants and animals. Management efforts are currently geared toward protection of wetlands by regulatory proceedings or acquisition. Permitting authority for activities impacting wetlands lies with the U. S. Army Corps of Engineers (Clean Water Act, Section 404). WVDEP supports protection through the Clean Water Act, Section 401 certification program.

WVDEP's Watershed Assessment Branch has developed functional and condition assessments for West Virginia's wetlands. The indices developed for assessment are used throughout the state to better describe the functions different wetlands provide along with their overall health or condition. The West Virginia Wetland Rapid Assessment Method (WVWRAM) includes desktop GIS Wetland Assessment Tool (level 1), and a rapid field assessment method (level 2). These two assessments enable calculation of debits and credits for wetland impacts and mitigation sites, as well as help to prioritize sites for land acquisition, restoration, and preservation. In 2022-2023, WVWRAM is expected to be incorporated into the WV Stream and Wetland Valuation Metric (SWVM), which is used by the U.S. Army Corp of Engineers (USACE) and the WV Inter-agency Review Team to assess impacts in West Virginia.

Statewide desktop GIS assessment of wetland function was completed in 2019 for all wetlands mapped in the National Wetlands Inventory (43,124 wetland complexes). These are preliminary scores which must be field verified for any wetlands entering the regulatory process. GIS-based wetland function scores are publicly available on the WVDEP GIS viewer at:

https://tagis.dep.wv.gov/wvdep_gis_viewer/

Targeted monitoring has been a component of West Virginia's wetland assessment strategy since WVWRAM sampling began in 2017. Sites are selected to meet a variety of informational needs. The following sites were sampled using WVWRAM (level 1 & 2) in 2017-2021:

45 reference wetlands (minimally impacted)
64 restored wetlands (pre-construction and/or post-construction data)
28 wetlands facing impacts (pre-impact data)
21 training sites

In 2020, the Watershed Assessment Branch began sampling wetland sites selected through the USEPA's random stratified (probabilistic) procedure. The data generated from this sampling effort allows the WVDEP and the USEPA to make statistically valid assessments of wetland conditions on a statewide

basis, as well as make comparisons between watersheds and ecoregions. This data also assists with monitoring long-term trends in wetland health. WVDEP has completed 107 probabilistic WVWRAM assessments during the first two years of its first 5-year-round of stratified random wetland monitoring.

3.4 Other Monitoring

When the need arises, WVDEP responds to specific conditions or pollutants of concern in any waterbody. The Watershed Assessment Branch may partner with other agencies to collect data to better understand threats to water quality standards and designated uses.

Harmful Algal Blooms

The focus of West Virginia's Harmful Algal Bloom Response Plan is on public recreational waters, although these principles and practices can apply to any body of water. A coordinated effort is crucial to successfully respond to harmful algal blooms (HABs) in West Virginia. Agencies primarily responsible for HAB response in West Virginia include West Virginia's Bureau for Public Health, WVDEP, Division of Natural Resources (DNR), and local health departments. Responsibilities of WVDEP in the development of this response plan include:

- Conduct sampling when blooms are sighted
- Report potential HAB to West Virginia's HAB mailbox at HAB@wv.gov
- Train partners/stakeholders in sampling protocols
- Conduct aerial surveillance to monitor HABs
- Maintain database of all reported HAB data
- Maintain website, reporting app, and interactive map of HAB advisories
- Provide outreach to the public about HABs
- Coordinate with the USACE on all USACE lakes

Sampling will be conducted on a case-by-case basis, depending on water conditions as algae starts to appear, especially during the peak recreational season. Samples should be collected and, if it is determined the algal bloom is dominated by potentially toxigenic genera of cyanobacteria, the site will be classified as a HAB with cyanotoxin analysis conducted. Initial testing is performed inhouse via an mBio/LightDeck analysis unit to quantitatively determine concentrations of microcystin and cylindrospermopsin. If the toxins are detected at levels of concern, or if the algae present can produce additional toxins beyond microcystin and cylindrospermopsin, the sample would be submitted to a lab for quantitative testing. The HAB location should be monitored closely and, if cyanotoxin concentrations are above the Public Health Watch Advisory threshold, the area would be sampled at least weekly. Sampling should continue until two consecutive results collected one week apart indicate that cyanotoxin concentrations are below the watch advisory threshold. However, monitoring may continue based on environmental conditions and relative health risk.

In the summer of 2019, the WVDEP Watershed Assessment Branch implemented a Harmful Algal Bloom Long-Term Trend Sampling program. In total, 15 sites were selected with an approximate statewide distribution, focusing on larger waterbodies including rivers, large streams, and impoundments (lakes). In 2021, three additional sites were established, and additional sites may be established as needed in the future. Sites were selected either due to a history of harmful algal blooms, a history of elevated nutrient concentrations, or neither HAB history nor history of elevated nutrients. These locations will be sampled multiple times per year for several years to attempt to determine trends in the occurrence of HABs in West Virginia. Sampling efforts consist of a visual survey for algae (including benthic/bottom substrate, water column, and water surface), collection and identification of algae present with emphasis on cyanobacteria, algal toxin testing via semi-quantitative methods (Abraxis field test strips) for microcystin and cylindrospermopsin, and water column nutrient concentration analysis. Nutrient samples were collected in accordance with Watershed Assessment Branch Standard Operating Procedures.

Filamentous Algae

Filamentous algae are connected algae cells that form long threads or filaments as the cells reproduce. When growth is excessive, large mats can form that stretch from the river bottom to the surface and cover significant portions of a river reach. The term “Filamentous Algae” refers to any number of species found in rivers and streams. There are numerous species of algae native to West Virginia that can be found at any one location. WVDEP is monitoring numerous rivers in the state for filamentous algae blooms, including the Greenbrier River, Tygart River, South Branch Potomac River, and the Cacapon River. Monitoring generally occurs in late summer to early fall when flows decrease and temperatures begin to rise in the rivers.

Fish tissue

In recent years, fish tissue analysis has been conducted annually, collecting fish from targeted sites on a 5-year rotation. Monitoring from 2016-2020 resulted in the analysis of 407 samples for PCBs and mercury, and 174 samples for selenium. These samples were collected from 27 HUC-8 watersheds representing 55 different waterbodies, including 11 lakes. All five Hydrologic Groups (A-E) were represented. In 2016 and 2017, WVDEP conducted a rigorous fish tissue evaluation of the Kanawha and Monongahela rivers with samples analyzed for mercury and PCBs, as well as dioxin at most Kanawha River sites.

4.0 THIRD PARTY MONITORING AND DATA

In addition to data collected by the WAB, the agency considered data from external sources for assessment. The agency sought water quality information from various state and federal agencies, including other WVDEP programs. Additionally, news releases and public notices requesting data submissions were published in state newspapers and on WVDEP Water and Waste Management’s website. Multiple requests for data were advertised to collect available data for each of the 2018, 2020, and 2022 reporting cycles.

WVDEP has developed guidance for those wishing to submit data to be assessed for 303(d) list development, including requirements for data assembly and submission, along with helpful internet links and a checklist for data submitters. The guidance is available at:

https://dep.wv.gov/WWE/watershed/IR/Documents/3rdPartyQAGuidelines_2021.pdf

Beyond requesting data from partners, WVDEP also obtained data from the USEPA Water Quality Portal for use in assessments. Data collected from July 1, 2015 through December 30, 2020 were downloaded from the Water Quality Portal. Data were examined to identify those for which water quality criteria exist. Stations data were plotted geospatially to associate the data with appropriate assessment units. Entities that provided information in response to the agency's request for data for the 2016 Section 303(d) list, or agencies whose data were obtained only from the Water Quality Portal (i.e., having a WQX prefix) are shown in Table 4-1.

Table 4-1: Data contributors for the 2016 303(d) List and Integrated Report

ORSANCO	US Forest Service
USACE	WV Department of Agriculture
West Virginia Conservation Agency	National Park Service
US Geological Survey	USEPA- Wheeling
Friends of Deckers Creek	Trout Unlimited
Blue Ridge Watershed Coalition	Davis Creek Watershed Association
Friends of Cheat	WQX-Watershed Improvement Branch: Friends of Blackwater
WQX-The Conservation Fund Freshwater Institute	WQX-Watershed Improvement Branch: Friends of Hughes River
WQX- Chesapeake Bay Program	WQX-Division of Surface water (Ohio)
WQX-Virginia Department of Environmental Quality	WQX-Chesapeake Bay Program
WQX-PA Department of Environmental Protection	WQX-Izaak Walton League of America

All readily available data were considered during the evaluation process. WVDEP's staff reviewed data from external sources to confirm collection methods, analytical methods, detection levels, quality assurance and quality control were consistent with approved procedures. In select instances, when contributors reported pH results collected using litmus paper opposed to a calibrated probe, pH data were excluded.

5.0 USE ASSESSMENT PROCEDURES

The primary focus of this report is assessing water quality data to determine if waters support their designated uses. The first step in assessing whether a waterbody is supporting its uses is to determine if monitored parameters meet water quality criteria. If any parameter measured in a waterbody is not meeting criteria protective of a designated use, then that waterbody will be categorized as impaired or "not supporting" its use. See Section 2.0 Water Quality Standards for more details on water quality standards.

Waters are placed in one of the five Overall Integrated Report (IR) Categories based on their level of designated use support. Table 5-1 provides details of each Overall IR Category.

Table 5-1: Overall Integrated Report Categories for West Virginia Waters

Category		Description
Category 1		Waters fully supporting all designated uses
Category 2		Waters fully supporting some designated uses, but insufficient or no information exists to assess the other designated uses
Category 3		Waters where insufficient or no information exists to determine if any of the uses are being met
Category 4		Waters impaired or threatened but do not need a total maximum daily load (TMDL)
	4a	Waters that already have an approved TMDL but are still not meeting standards
	4b	Waters that have other control mechanisms in place which are reasonably expected to return the water to meeting designated uses
	4c	Waters determined to be impaired, but not by a pollutant (e.g., low flow alteration)
Category 5		Waters assessed as impaired and are expected to need a TMDL

5.1 Assigning Overall Integrated Report Categories

Overall Integrated Report Category 1, 2, or 3

The guidelines used by WVDEP to demonstrate use support for streams (and subsequent classification into Categories 1, 2, or 3) vary for each of the designated uses. It is important to note that it is infeasible to regularly monitor many water quality standards in every location. When developing monitoring plans, WVDEP considers which pollutants are likely to occur in a waterbody and analyzes water quality for those pollutants. "Supporting" assessments for individual uses are made if certain mandatory (requisite) parameters have been monitored and those results demonstrate compliance with criteria. To demonstrate support, aquatic life uses (Warm Water Fisheries or Trout Waters) in wadeable streams require benthic macroinvertebrate monitoring and results showing a WVSCI score greater than or equal to 72. Public Water Supply and Water Contact Recreation uses require compliant fecal coliform monitoring and all other uses require compliant pH and dissolved oxygen monitoring. If monitoring results are available for "non-mandatory" (ancillary) parameters, they also must indicate compliance with any criteria prescribed for the use.

Stream segments where mandatory parameters indicate support of all designated uses are placed in Category 1. Stream segments without sufficient data to determine use support or impairment may be placed in either Category 2 or 3. Category 2 houses waters with some uses determined to be supported but lacking sufficient information to assess other uses. Waters are placed in Category 3 if insufficient or no information exists to determine if any of the uses are being met. An "insufficient data" designation may result where some water quality data are available, but not enough to conclude that the use is supported or impaired, or when water quality data for mandatory (requisite) parameters is absent.

A new subcategory, Water Contact Recreation: Fish Consumption, has been added to ATTAINS to accommodate the design of USEPA's "How's My Waterway" tool. This subcategory has been assigned

to all assessment units, even when the waterbody may not support fish populations because of size, stream flow, topography, etc. In most waterbodies, no fish tissue data are available for assessment, so fish consumption is "unassessed"; thus, any waterbody that is otherwise fully supporting other uses is placed in Category 2. For future Integrated Reports, WVDEP will determine an appropriate methodology to assign the subcategory for fish consumption to waterbodies. For example, fish consumption may not apply to intermittent streams in future reports.

Overall Integrated Report Category 4 or 5

In order for a stream to be placed in Categories 1, 2, or 3, there can be no impairments. When any parameter is not meeting criteria, then the waterbody is not supporting a designated use. The entire assessment unit is considered impaired and placed in Integrated Report Category 5 (needs a TMDL) or Category 4 (does not need a TMDL). Prior to TMDL development, waters impaired by a pollutant are placed on the Section 303(d) List and in Category 5. After TMDLs are developed and approved, those waters are placed in Category 4a. Other impaired streams for which TMDLs need not be developed are placed in Categories 4b or 4c. Category 4b includes waters impaired by a pollutant for which other control mechanisms are in place that will reasonably result in the water meeting designated uses. Waters impaired by something other than a pollutant, for which no TMDL can be developed, are categorized as 4c (ex. low flow alterations).

5.2 Data for Assessment

When assessing, WVDEP generally considers water quality data with sample dates a maximum of five years prior to the cycle end date. For instance, for the 2018 cycle, data from July 2012 through the end date of June 2017 were considered for assessment. This intentionally limits the use of data more than five years old. However, in the absence of newer information, previous assessments are carried forward even if the data becomes older than five years. Additionally, if a water quality criteria change is approved which affects an older assessment, the new assessment is based upon the current criteria. A recent change to the duration of human health criteria resulted in reassessment of older total iron data for the drinking water designated use (See Section 5.3).

December 2020 was the 2022 cycle end date. Data collected after December 2020 will be assessed in the next reporting cycle. However, in specific instances, more recent data were considered to validate an assessment call. As described earlier, a 2018, 2020, or 2022 cycle year designation for newly identified impairment assessment units was accomplished by examining the monitoring sample date range for each assessment unit.

Waters are not deemed impaired based upon water quality data collected when stream flow conditions were less than 7Q10 flow (the seven-consecutive-day average low flow that recurs at a 10-year interval) or within regulatory mixing zones. Further, waters are not deemed impaired based upon "not-detected" analytical results from methodologies with detection limits that are not sensitive enough to confirm criteria compliance. For example, a dissolved aluminum result of "not detected" using a method with a detection

limit of 0.1 mg/l would not prompt a dissolved aluminum listing for trout waters with a criterion of 0.087 mg/l.

Additionally, WVDEP does not interpret the impacts of a single pollution event (such as a spill) as representative of current conditions if it is believed that the problem has been addressed. Similarly, WVDEP does not intend to interpret the results of clustered monitoring of a single event as being representative of water quality conditions for longer time periods. Datasets are screened for excessive clustering of monitoring, in space or time, to avoid misinterpretation. No data were excluded based on a single pollution event or clustered monitoring of a single event for this Combined Integrated Report assessment cycle.

The decision criteria do not provide for 303(d) listing of waters with severely limited data sets and exceedance (e.g., one sample in a five-year period exceeding water quality standards). Such waters would be classified as having insufficient data available for use assessment. WVDEP will target these "one-hit" waters for additional monitoring by incorporating them into the pre-TMDL monitoring plans at the next opportunity for TMDL development in their watershed. Where the intensified pre-TMDL monitoring (monthly sampling for one year) indicates impairment, TMDL development will be initiated even though the water may not be included in Category 5 of the current Integrated Report.

With the creation of relatively static assessment units, water quality data collected from individual monitoring stations in the assessment unit were assessed separately to determine attainment. If water quality at any monitoring station within the assessment unit was considered impaired, the entire assessment unit was considered impaired. The only exception to this general rule was relative to data collected by ORSANCO along the Ohio and Kanawha Rivers at the dams. Data collected at the dam was applied to assessment units both upstream and downstream of the monitoring location.

5.3 Numeric Water Quality Criteria

The assessment methodology for numeric water quality criteria used in preparation of the combined 2018/2020/2022 Integrated Report is consistent with those used in previous reporting cycles with one exception, the application of a duration for human health criteria. Previously, 47CSR2 listed criteria to be protective of human health. The criteria frequency was stated "not to be exceeded", but no duration was provided. The WV State Legislature and the USEPA have since approved a clarification to the human health criteria to include the duration of an annual geometric mean. See Total Iron Numeric Criteria for Drinking Water below for more information.

One additional and significant change made to the WV Water Quality Standard during the assessment period was the water quality criteria for selenium. The WV State Legislature and USEPA approved a change to add measurements of selenium concentrations in fish tissue (i.e., whole body, muscle, egg/ovary), in addition to the previously established water column concentration criteria. Water column concentrations were the only data considered for this Integrated Report cycle. In the future, once an assessment protocol is developed and data are available, concentration of selenium in fish tissue may result in listings or delistings of selenium impairment.

Chronic Criteria Protective of Aquatic Life

Typically, in cases where exceedances of chronic aquatic life protection criteria occur more than 10 percent of the time, the water is impaired. If the rate of exceedance demonstrated is less than or equal to 10 percent, then the water is supporting the designated use under evaluation.

Table 5-2 presents guidelines for sample counts to determine whether a parameter is meeting criteria or causing impairment for chronic criteria protective of aquatic life. Importantly, in order to assess parameters and capture the critical conditions for designated uses, a dataset should represent variations expected in water quality due to seasons, weather conditions, and flow regimes. Regardless of the sample count, if results do not represent critical conditions, data will not be used to delist known impaired waterbodies.

If the data being evaluated is generated as part of a comprehensive network monitored for a specific purpose, the data may be assigned a higher level of assessment quality, and the "10-percent rule" may be applied with confidence to smaller data sets. The primary example of an intensified monitoring program that generates higher assessment quality data is the pre-TMDL monitoring program. The pre-TMDL monitoring format includes flow measurement and monthly water quality monitoring for one year at multiple locations throughout a watershed. Information is generated over a range of stream flow conditions and in all seasons. Habitat assessment and biological monitoring are performed in conjunction with water quality monitoring. The information generated under this format is among the most comprehensive available to assess water quality. Upon conclusion of monitoring, agency personnel make a definitive judgment relative to impairment. In most instances, application of the "10-percent rule" to the pre-TMDL monitoring data sets result in the classification of waters as impaired if two or more exceedances of a criterion are demonstrated.

Table 5-2: Guidance to determine status when assessing parameters for chronic criteria protective of aquatic life

Sample Count	Exceedance Count	Parameter Status	Additional Consideration
≥20	>10%	Causing impairment	Assess data collected within 3 years. If longer than 3 years, determine frequency of exceedances/year.
<20	2 or more	Causing impairment	Assess data collected within 3 years. If longer than 3 years, determine frequency of exceedances/year.
>20	≤10%	Meeting Criteria	Do not list new impairment. To delist a known impairment, samples must be evaluated to determine if monitoring captured low and/or high flow critical condition in waterbody. Ideally, delisting decisions would be based on at least 20 samples. Data from multiple years may be assessed to consider at least 20 samples.
5-19	One or less	Meeting Criteria	To delist a known impairment, samples must be evaluated to determine if monitoring captured low and/or high flow critical condition in waterbody. Frequency and quality of

Sample Count	Exceedance Count	Parameter Status	Additional Consideration
			samples will also be considered when making delisting decisions. Ideally, delisting decisions would be based on at least 20 samples. Data from multiple years may be assessed to consider as many samples as possible. In instances where fewer than 20 samples are available, best professional judgement will be applied to determine if enough information is available to change a listing status.
<5	One or less	Insufficient Information	No listing decision will be made.
<5	2 or more	Causing Impairment	Assessed data collected within 3 years. If longer than 3 years, determine frequency of exceedances/year

Acute Criteria Protective of Aquatic Life

Under West Virginia Water Quality Standards, acute aquatic life protection criteria have associated exposure durations of one hour and may be exceeded once every three years. The normal practice of "grab-sampling" ambient waters is generally consistent with the one-hour exposure duration specified in the standards. Therefore, a direct application of the allowable exceedance frequency provided in the standards is made when assessing impairment relative to acute aquatic life protection criteria. If two or more exceedances of acute criteria are observed in any three-year period, the water is considered impaired. This rule is applied to acute criteria and to excursions of the water quality criteria for pH and dissolved oxygen.

Nutrient Criteria for Lakes to Protect Aquatic Life and Contact Recreation

Following 47CSR2 Section 8.3, WVDEP's lake assessment of chlorophyll-a and total phosphorus results were based on the average of a minimum of four samples collected within the May 1 through October 31 sampling season. Lake assessments are based on data collected within a meter of the surface.

Total Iron Numeric Criteria for Drinking Water

Following the approval of the duration of an annual geometric mean for human health, WVDEP decided to reassess the iron impairments assigned to the drinking water designated use. Unlike most assessment efforts, this reassessment considered data obtained from monitoring or modeling as far as was feasible to ascertain. Annual geometric means were calculated for datasets with counts of five or greater per year. When it was determined that the annual geometric mean did not exceed 1.5 mg/L at any time, an assessment unit was delisted for the drinking water use. In order to reassess modeling impairments identified through TMDL modeling projects, all baseline output files were analyzed using an R-code routine to calculate discrete annual geometric means. Those assessment units that had no exceedances of 1.5 mg/L in any annual geometric mean were delisted for the drinking water use. This effort was completed in order to accurately report impairment to the public relative to metals in their drinking water.

Fecal Coliform Numeric Criteria for Contact Recreation and Drinking Water

Fecal coliform assessments were based on the previously described decision criteria for numeric water quality criteria. Numeric fecal coliform water quality criteria are applicable to the Water Contact Recreation and Public Water Supply designated uses. Section 8.13 of Appendix E of the West Virginia Water Quality Standards states:

> *8.13 Maximum allowable level of fecal coliform content for Water Contact Recreation (either MPN or MF) shall not exceed 200/100ml as a monthly geometric mean based on not less than five samples per month; nor to exceed 400/100ml in more than 10 percent of all samples taken during the month.*
>
> *8.13.1 Ohio River mainstem (zone I) - During the non- recreational season (November through April only) the maximum allowable level of fecal coliform for the Ohio River (either MPN or MF) shall not exceed 2000/100 ml as a monthly geometric mean based on not less than 5 samples per month.*

Given the complexity of fecal coliform criteria, most assessments are performed by comparing observations to the "maximum daily" criterion value of 400 counts/100ml. Evaluation of the monthly geometric mean fecal coliform criterion (200 counts/100ml) occurs only where five or more individual sample results are available within a calendar month.

In general, the most frequent and regular fecal coliform water quality monitoring conducted by the Watershed Assessment Section is once per month. That monitoring frequency precludes assessment of the monthly geometric mean criterion and hinders accurate assessment of the maximum daily criterion per month. In some instances, more frequent fecal coliform monitoring can be accomplished on limited numbers of streams and/or stations where water quality assessments are performed.

WVDEP uses the following protocols when making assessments relative to fecal coliform numeric criteria:

1. No assessments are based upon the monthly geometric mean criterion (200 counts/100ml) unless an available data set includes monitoring at five per month or greater frequency. When data sets are available, the listing decision criteria for numeric water quality criteria are applied, considering each monthly geometric mean as an available monitoring result.

2. The listing decision criteria are applied to the maximum daily criterion (400 counts/100ml) and available individual monitoring results, but without the monthly prejudice. For example, if twice per month monitoring is conducted for a year and two results in two separate months are greater than 400, the stream would be assessed as fully supporting (2/24 – 8.3 percent rate of exceedance) rather than basing assessments on two months out of 12 in noncompliance (2/12 – 16.7 percent rate of exceedance). If five samples per month monitoring is conducted for one year and four daily results greater than 400 are measured in four different months, the stream would be assessed as fully supporting (4/60 – 6.7 percent rate of exceedance) rather than

noncompliance (4/12 – 33.3 percent rate of exceedance), provided the monthly geometric means were below the 200 counts/100 ml criteria.

Continuous Monitoring Data

The WVDEP uses deployable sondes to collect data on a continuous basis on selected streams. These submerged datalogging sondes collect data continuously (most often hourly or twice hourly) for a deployment period ranging from several days to several months, being especially effective for evaluating the specific requirements of water quality criteria such as pH and dissolved oxygen. For example, the pH criterion states that water quality values should remain between 6.0 and 9.0 standard units at all times (exception for waters with high photosynthetic activity). The use of continuous monitors allows WVDEP to better assess if streams are meeting water quality criteria. WVDEP is currently developing a method to assure quality of the data and to assess the vast amount of data collected by continuous monitoring instruments. The methodology must address both the magnitude and frequency of violation stipulated in current water quality criteria.

While maintaining deployable sondes, WVDEP collects discrete water quality data for pH, dissolved oxygen, specific conductance, and temperature. These data are used to correct the data collected directly by the deployable sondes. The discrete data were evaluated and assessed for this cycle period. Even though more than one reading was collected during the maintenance activities at each site, only one reading was chosen to represent the waterbody condition for each visit so that conditions during one site visit are weighted similarly to other discrete sampling events during assessments.

Ohio River – Total Iron Aquatic Life Standards

Prior to 2012, ORSANCO assessed water quality data along sections of the Ohio River bordering West Virginia based on the state's total iron numeric water quality standard. In 2012, ORSANCO's governing commission began using a weight of evidence approach when assessing all aquatic life standards for its biennial 305(b) report. However, the EPA's Region III office has stated for 303(d) listing purposes, it will only accept assessments based on a philosophy of independent applicability. Therefore, West Virginia's 303(d) assessments for aquatic life will recognize violations based on either water quality or biological survey data. A review of the ORSANCO total iron water quality data revealed violation rates greater than 10 percent for several segments of the Ohio River and, as such, the segments have been listed as impaired on West Virginia's 303(d) list.

5.4 Narrative Water Quality Criteria – Biological Impairment Data

The narrative water quality criterion of 47 CSR 2 §3.2.i prohibits the presence of wastes in State waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the West Virginia Stream Condition Index (WVSCI). The WVSCI is a benthic macroinvertebrate multi-metric index for use in wadeable streams, composed of six metrics selected to maximize discrimination between streams with known

impairments and reference streams. Streams were listed if the data was comparable (e.g., collected utilizing the same methods used to develop the WVSCI, adequate flow in riffle/run habitat, and within the index period).

WVSCI-based "biological impairments" were included on West Virginia's Section 303(d) lists from 2002 through 2010. In 2012, legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

In the preparation of the Draft West Virginia 2012 Section 303(d) list, the WVDEP did not add new biological impairments. Previously listed biological impairments were proposed to be retained. In finalizing the 2012 list, the EPA added biological listings to those proposed by the WVDEP. The EPA considered available benthic macroinvertebrate data and added impairments to the list for biological scores less than 68 under the WVSCI methodology. The EPA determined that the uncertainty zone historically used by the WVDEP was not scientifically supported and therefore used an impairment threshold equal to the 5th percentile of reference scores as originally calculated.

For 2014, the WVDEP included biological impairment listings based upon the methodology used by the EPA in their 2012 oversight actions. The EPA partially disapproved the WVDEP's 2014 submission, eventually finalizing the list by adding 28 streams based on a genus level index known as GLIMPSS which had never been used by the WVDEP for 303(d) listing purposes.

For the 2016 listing cycle, the WVDEP determined biological impairments based on WVSCI. The WVDEP maintained that, considering the legislative mandate of SB 562, it would be inappropriate to utilize the GLIMPSS while a new assessment methodology is being developed. That said, the WVDEP updated the WVSCI scoring thresholds, based on a much larger set of reference site samples available. The WVSCI thresholds were recalculated and are still based on the 5th percentile of reference site index scores. The recalculated impairment threshold used for the 2016 303(d) list is 72. The USEPA approved the 2016 303(d) list based on WVSCI in light of concerns from WVDEP about the robustness of the GLIMPSS reference dataset.

WVDEP prepared a procedural rule to address the requirements of §22-11-7b but did not finalize the rule. Rather, the process described in the procedural rule was utilized as WVDEP's assessment methodology in the preparation of this combined 2018/2020/2022 list. The methodology generally requires two benthic macroinvertebrate samples to be analyzed to make an assessment decision. However, a single sample can be used to designate assessment units as impaired if the WVSCI score is below 50, and as attaining if the WVSCI score is greater than 72. Sites with initial WVSCI scores between 50 and 72 may require a second sample to be collected and assessed. The process for determining impairment of biological integrity is described in more detail in Appendix A.

If not already accomplished for listing purposes, each assessment unit will be assessed during TMDL development to determine the causative stressor(s) of impairment and the contributing sources of pollution will be identified.

Biological impairments identified in the previous 303(d) List are proposed to be delisted under the following scenarios:

- Where previous listings were determined to have been made in error.
- Where more recent biological monitoring results demonstrated WVSCI scores greater than 72.
- Where approved TMDLs have been developed pursuant to numeric water quality criteria and the Stressor Identification performed in the TMDL process demonstrated that their implementation would resolve the stress to the benthic macroinvertebrate community that caused the original listing.

5.5 Narrative Water Quality Criteria - Fish Tissue and Consumption Advisories

The narrative water quality criterion of 47CSR2–3.2.e prohibits the presence of materials in concentrations that are harmful, hazardous or toxic to man, animal or aquatic life in State waters. Fish consumption advisories are used to inform the public about potential health risks associated with eating fish from West Virginia's streams. WVDEP, the Division of Natural Resources, and the Bureau for Public Health have worked together on fish contamination issues since the 1980s. An executive order from the governor and subsequent Interagency Agreement signed in 2000 formalized the collaborative process for developing and issuing fish consumption advisories.

Risk-based principles are used to determine whether fish consumption advisories are necessary. These advisories are used as a public education tool to help citizens make informed decisions about eating fish caught in State waterbodies. The risk-based approach estimates the probability of adverse health effects and provides a statement on the health risk facing the angler and high-risk groups including women of childbearing age and children. West Virginia's fish consumption advisories include guidelines on the number of meals to eat and information on proper fish preparation to further minimize risk.

Waterbody-specific fish consumption advisories exist for six major rivers (including backwaters in tributaries) and four lakes for a variety of fish species and contaminants. Additionally, there is a general statewide advisory that recommends limiting consumption of certain fish from all West Virginia waters due to low-level mercury and/or polychlorinated biphenyl (PCB) contamination. The statewide advisory provides species-specific recommendations ranging from one meal per week to one meal per month. The following webpage contains the most recently issued West Virginia fish consumption advisories:

http://www.wvdhhr.org/fish/

The presence of contaminants in fish tissue from commonly consumed species in amounts leading to a two meal per month or more stringent advisory is considered sufficient evidence of impairment. In addition, methylmercury has a specific body-burden water quality criterion for protection of public water supply and water contact recreation designated uses. The criterion states "The total organism body burden of any aquatic species shall not exceed 0.5 µg/g as methylmercury." Therefore, the WVDEP applies the criterion to all aquatic species rather than just the commonly consumed fish species.

For the mainstem Ohio River, the applicable ORSANCO body-burden criterion is 0.3 µg/g. As with previous 303(d) lists, WVDEP has deferred to ORSANCO's assessment results for mercury listing purposes. ORSANCO's assessment methodology is included in their Biennial Assessment of Ohio River Water Quality Conditions. ORSANCO's assessment methodology can be found at

http://www.orsanco.org/publications/biennial-assessment-305b-report/

5.6 Narrative Water Quality Criteria – Filamentous Algae

The narrative water quality criterion of 47CSR2 – 3.2.g prohibits algae blooms which may impair or interfere with the designated uses of the affected waters. WVDEP lists streams for filamentous algae impairment because the algae blooms impair or interfere with the Water Contact Recreation use and/or the Public Water Supply use of a stream. The methodology (303(d) Listing Methodology for Algae Blooms) was finalized by DEP in June 2013 and is available at

http://www.dep.wv.gov/WWE/Programs/wqs/Documents/Greenbrier%20Algae/AlgaeListingMethodology2014.pdf

To develop the listing methodology for impairment of the Water Contact Recreation designated use, WVDEP utilized the results of a scientific survey of people who use West Virginia rivers to determine how much filamentous algae cover would adversely impact various recreational activities. The report *West Virginia Residents' Opinions on And Tolerance Levels of Algae In West Virginia Waters* is available at

http://www.dep.wv.gov/WWE/Programs/wqs/Documents/WVAlgaeSurveReport_ResMgmt_WVDEP_2012.pdf .

In general, WVDEP considers the Water Contact Recreation use of a stream segment to be impaired if filamentous algae cover is greater than 20% and extends for a longitudinal distance greater than three times the average stream width OR if filamentous algae cover of greater than 40% is measured, regardless of the longitudinal extent of the bloom.

WVDEP considers the Public Water Supply use to be impaired if algae blooms cause taste or odor in the drinking water that requires a level of treatment beyond "conventional treatment". Additionally, WVDEP considers available taste or odor complaints about finished drinking water when assessing the Public Water Supply designated use and may classify the use as impaired even though additional treatment is not implemented.

The listing methodology did not describe conditions that would qualify a stream for delisting. WVDEP will revise the listing methodology for filamentous algae impacted streams to include criteria for removing a stream when the impairment no longer exists. A stream may be delisted if any of the following apply:

- WVDEP has evaluated the stream for impairments of Water Contact Recreation for a period of five consecutive years and found no blooms which would have caused the stream to be listed as impaired for recreational use.

- Specific measures to control algae growth have been implemented, and WVDEP has evaluated the stream for a period of three consecutive years finding no algae blooms causing use impairment.

- For algae impairments related to the Public Water Supply use, when taste and odor complaints associated with algae blooms are alleviated and no treatment beyond "conventional treatment" is required at the drinking water treatment facility for three consecutive years.

6.0 ASSESSMENT RESULTS

The following section describes the results of the assessments completed for stream and lake assessment units. The results of assessments have been loaded to ATTAINS. The counts of water bodies, figures, and tables are those reported directly from ATTAINS. Data results are organized at three levels: IR Category, Designated Use, and Parameter. Each level provides scenarios of attainment, impairment, and insufficient information. Assessment results have also been included in the Integrated Report StoryMap.

Individual assessment unit results are also provided in Google Sheets workbooks. The first is titled *Combined Cycle 303(d)List* and provides the 303(d) listings for the 2018, 2020, and 2022 assessment cycles in a combined list. An introductory tab provides a description of the data included in the workbook's individual sheets or "tabs". For example, one tab is called "303d List-Category 5". This is where the user can find the combined 2018/2020/2022 303d listed streams.

A second workbook is titled *IR Category Designated Use*. This workbook provides the overall IR Category for each assessment unit, as well as details on whether an assessment unit supports each of its designated uses.

Both workbooks can be downloaded as "Supplemental Tables" from the following website: https://dep.wv.gov/wwe/watershed/ir/pages/303d_305b.aspx.

6.1 IR Category Results

Streams

Table 6-1 shows a summary of the classification of West Virginia streams by the five IR Categories (see Table 5-1). Table 6-1 also includes the percentage of counts and miles for each IR Category. As described earlier, because assessment units have been created using a 1:24,000 scale NHD streamline product, 85.2% of stream assessment units are unassessed and placed in IR Category 3, based on the count of assessment units. In contrast, only 58.9% of stream miles are unassessed. The streams with limited or no data are typically small unnamed tributaries, which usually contribute to larger waterbodies which have been assessed. All major rivers in the state have been assessed and placed into categories. Figure 6-1 provides a pie chart to visualize the assignment of IR Categories for streams.

Table 6-1: 2018/2020/2022 Category Summary for West Virginia Stream Assessment Units (AUs)

Overall Category	# of Stream AUs	% Stream AUs	Miles	% Miles
1	0		0	
2	1,710	3.6	5,132	9.5
3	40,116	85.2	31,671	58.9
4A	3,766	8.0	11,758	21.9
4C	92	0.2	81	0.2
5	1,384	2.9	5,105	9.5
TOTALS	47,068		53,747	

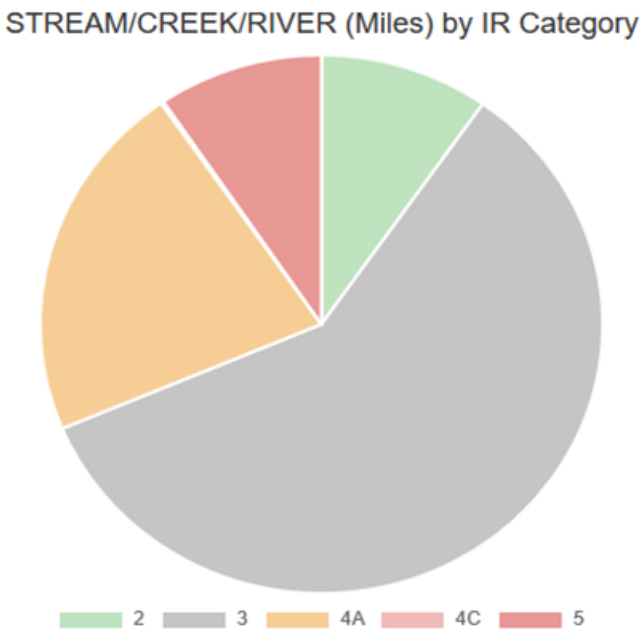


Figure 6-1: Stream miles broken out into overall IR Categories

Category 5 includes 1,382 impaired stream assessment units, covering approximately 5,106 stream miles that are impaired and need TMDLs developed. The number and length of impaired streams varies from one list year to the next due, in part, to the TMDL development timeline. TMDLs are always in various stages of development and, with the additional sampling data generated, streams and stream segments may move from Categories 1, 2 or 3 to Category 5. Additionally, TMDLs that have not yet been approved by the EPA remain listed in Category 5. Once these TMDLs are approved for all impaired parameters, those assessment units will move to Category 4A. Section 8.0 TMDL Development Process provides more information.

Lakes

As with streams, many lake assessment units have not been monitored or assessed based on the newly delineated assessment units. When delineating the assessment units, lakes that had not been previously assessed were identified and added for possible assessment in the future. When considering the count of lakes, 77.7% of lake assessment units have not been assessed. Like streams, the State's largest lakes have been assessed, resulting in only 25.1% of the total lake acreage categorized as unassessed. Lakes with more than one major tributary forming "arms" of the lake were separated into smaller assessment units. If an entire lake was listed previously in the 303d list as impaired, that impairment status was applied to all delineated assessment units of the lake. See Table 6-2 for details on the counts and acreage placed in each IR Category. Figure 6-2 provides a pie chart to visualize the assignment of IR Categories for lakes.

Table 6-2: 2018/2020/2022 Category Summary for West Virginia Lake Assessment Units (AUs)

Overall Category	# of Lakes AUs	% Lakes AUs	Acres	% Acres
1	0	0	0	0
2	53	12.2	6920	27.8
3	337	77.7	6227	25.1
4A	5	1.2	95	0.4
5	39	8.9	11,621	46.7
TOTALS	434	100	24863	100

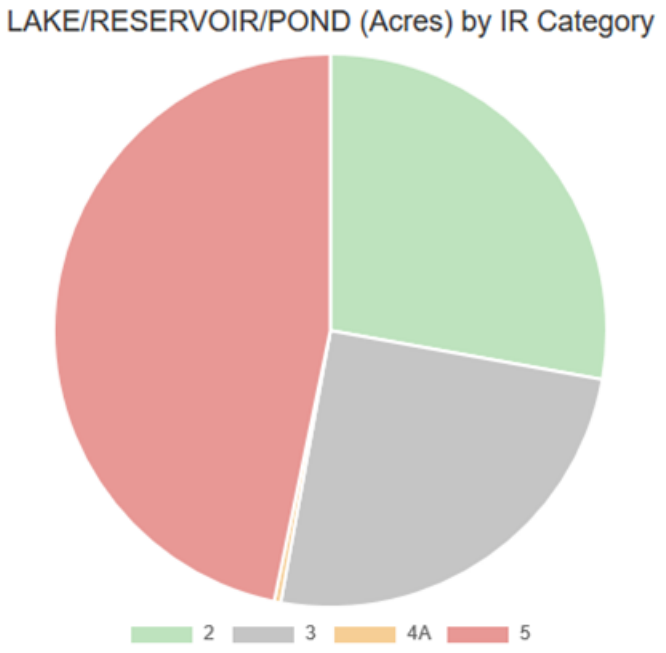


Figure 6-2: Lake areas broken out into overall IR Categories

6.2 Use Support Results

The IR Category placement provides an overall status of attainment or impairment of a waterbody. The overall status is derived from the collective attainment statuses for each designated use. If any use is not supported, the entire waterbody will be placed in IR Category 4 or IR Category 5. Table 6-3 summarizes the counts of assessment units (both lakes and streams) that are not supporting each designated use, fully supporting each designated use, or have insufficient data or no data to assess. Tables 6-4 and 6-5 summarize the stream miles and lake acreage by use. WVDEP has prepared a Google Sheets workbook called *IR Category Designated Use* to provide the overall IR category for every assessment unit, as well as use attainment status for every designated use. The workbook can be assessed at the following site and found under the 2018/2020/2022 Cycle Year tab:

https://dep.wv.gov/wwe/watershed/ir/pages/303d_305b.aspx

Table 6-3: Designated use support summary for all West Virginia assessment units by count

Uses	Not Supporting	Insufficient Information	Not Assessed	Fully Supporting	Total
Public Water Supply	3,556	2,260	39,909	1,776	47,501
Warm Water Fishery	4,106	1,509	39,641	1,163	46,419
Trout Waters	332	201	199	352	1,084
Water Contact Recreation: Recreation	3,482	1,397	40,607	2,017	47,503
Water Contact Recreation: Fish Consumption	84	9	47,410	0	47,503
Agriculture and Wildlife	652	859	40,677	5,315	47,503
Water Supply Industrial, Water Transport, Cooling and Power	652	859	40,677	5,315	47,503

Table 6-4: Designated use support summary for West Virginia streams

Designated Use	Not Supporting	Insufficient Information	Not Assessed	Fully Supporting	Total
	miles	miles	miles	miles	miles
A-Public Water Supply	12,678	4,520	30,918	5,628	53,744
B1- Warm Water Fishery	12,325	3,033	30,279	3,909	49,546
B2- Trout Waters	1,537	682	462	1,518	4,199
C-Water Contact Recreation: Recreation	12,565	2,595	32,228	6,357	53,745
C-Water Contact Recreation: Fish Consumption	530	79	53,136	0	53,745
D-Agriculture and Wildlife	1,885	1,570	32,412	17,878	53,745
E- Water Supply Industrial, Water Transport, Cooling and Power	1,885	1,570	32,412	17,878	53,745

Table 6-5: Designated use support summary for West Virginia lakes

Designated Use	Not Supporting	Insufficient Information	Not Assessed	Fully Supporting	Total
	acres	acres	acres	acres	acres
A-Public Water Supply	9,555	2,077	6,288	6,943	24,864
B1- Warm Water Fishery	2,511	8,841	8,152	0	19,504
B2- Trout Waters	31	2,548	2,781	0	5,360
C-Water Contact Recreation: Recreation	2,542	2,985	10,932	8,404	24,864
C-Water Contact Recreation: Fish Consumption	9,936	0	14,927	0	24,864
D-Agriculture and Wildlife	2	820	5,408	18,634	24,864
E- Water Supply Industrial, Water Transport, Cooling and Power	2	820	5,408	18,634	24,864

6.3 Causes for Impairment

The information in Tables 6-6 and 6-7 provides an overview of the impairment status of West Virginia waters, with some impaired for multiple water quality criteria.

ATTAINS provides an opportunity to report on both impairment and attainment of water quality criteria for specific parameters. However, the Tables below underreport the miles and acreages meeting criteria for specific parameters, a result of established data capture and reporting methods primarily focused on impairments. In the future, WVDEP will alter the data capture methods to also include parameter attainment. See Section 7 Probabilistic Data Summary for a more appropriate representation of the overall water quality of State waterbodies.

Figures 6-3 and 6-4 provide the distribution of stream miles and lake acreage impaired or attaining water quality standards for the listed parameters. Impairment is identified in the graph as "cause", meaning the parameter is a cause for impairment.

Table 6-6: Summary of impairment causes for West Virginia streams shown in miles

Parameter	Impairment Cause (miles)	Meeting Criteria (miles)	Insufficient Information (miles)	Total (miles)
Iron	11,962	443	271	12,676
Fecal Coliform	11,318	942	132	12,392
Benthic Macroinvertebrate Bioassessments	6,982	4,347	350	11,679
pH	1,297	1,631	317	3,245
Aluminum, Dissolved	1,166	491	167	1,825
Dissolved Oxygen	165	821	413	1,399
Selenium	515	609	53	1,178
Filamentous Algae	75	418	0	493
PCBs in Fish Tissue	441	0	0	441
2,3,7,8-tetrachlorodibenzo-P-Dioxin	360	70	0	430
Manganese	37	175	0	212
Lead	0	161	0	161
Zinc	0	139	0	139
Dioxin In Fish Tissue	66	61	0	127
Chloride	56	34	2	92
Methylmercury in Fish Tissue	84	0	0	84
Aluminum, Total	64	0	0	64
Flow Regime Modification-Low Flow	62	0	0	62
Buried Stream	54	0	0	54
Beryllium	23	7	0	30
Ammonia	0	9	0	9
Temperature	7	0	0	7
Nitrate	0	6	0	6

Table 6-7: Summary of impairment causes for West Virginia lakes shown in acres

Parameter	Impairment Cause (acres)	Meeting Criteria (acres)	Insufficient Information (acres)	Total (acres)
Methylmercury in Fish Tissue	9,393.25	0		9,393.25
Chlorophyll-a	692.1	5,826.4		6518.5
Phosphorus	1,883.02	3,970.46		5,853.48
Polychlorinated Biphenyls (PCBs)	543.17	0		543.17
Sedimentation/Siltation	162.12	0		162.12
Trophic State Index (TSI)	81.45	0		81.45
Iron	60.37	0		60.37
Dissolved Oxygen	2.38	0		2.38

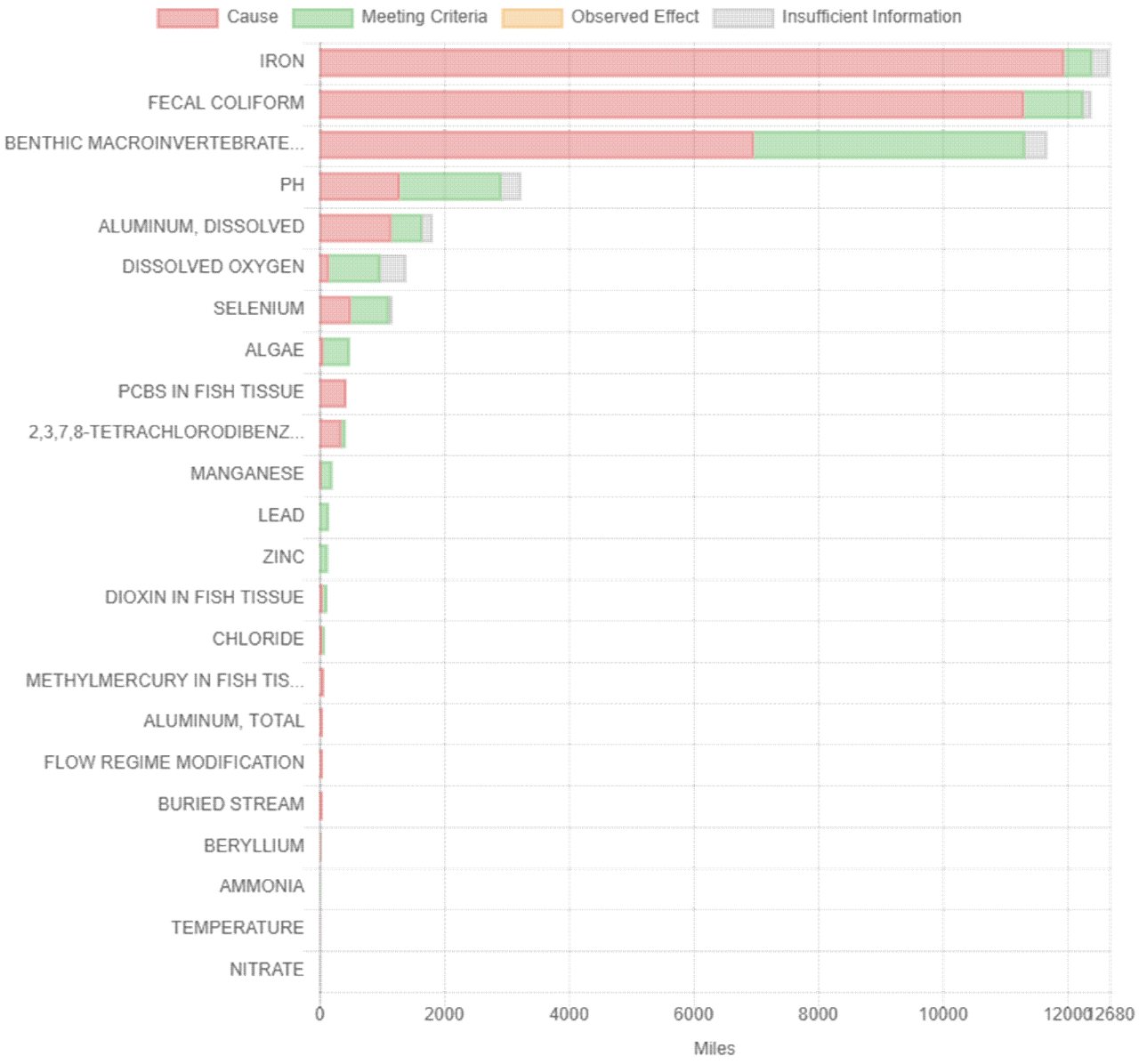


Figure 6-3: Chart showing a breakdown of stream miles with parameter attainment or impairment

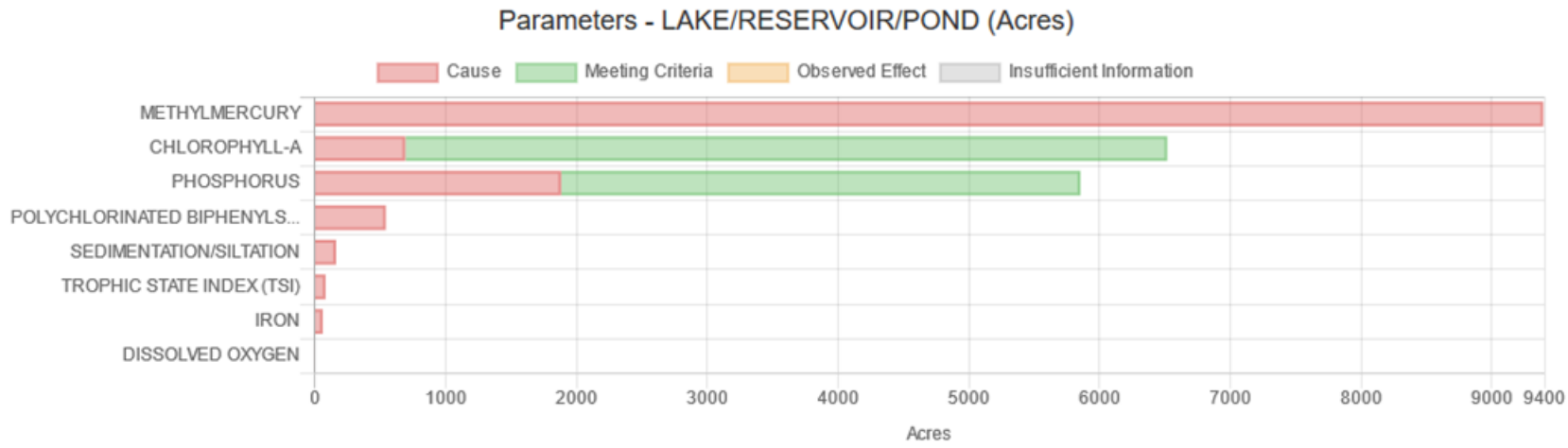


Figure 6-4: Chart showing a breakdown of lake acres with parameter attainment or impairment

6.4 Filamentous Algae Resulting in Delisting

Advanced nutrient removal technology was installed on several wastewater treatment plants (WWTPs) discharging to the South Branch of the Potomac River and the Greenbrier River after these streams were first listed for filamentous algae impairment in 2010. WVDEP has monitored instream water quality and levels of filamentous algae growth since the installation of the nutrient removal units. Following the upgrades, reductions in filamentous algae biomass occurred quickly, due to reductions in phosphorous loading from the treatment plants.

The following graph (Figure 6-5) compares the percent of the Greenbrier River covered by filamentous algae, before and after the treatment plant upgrades, during peak growing season in years with a similar flow rate in the river. Treatment plant effluent phosphorous loadings were reduced by more than 80%, and this resulted in an 85% reduction in the surface acres of the river covered by filamentous algae.

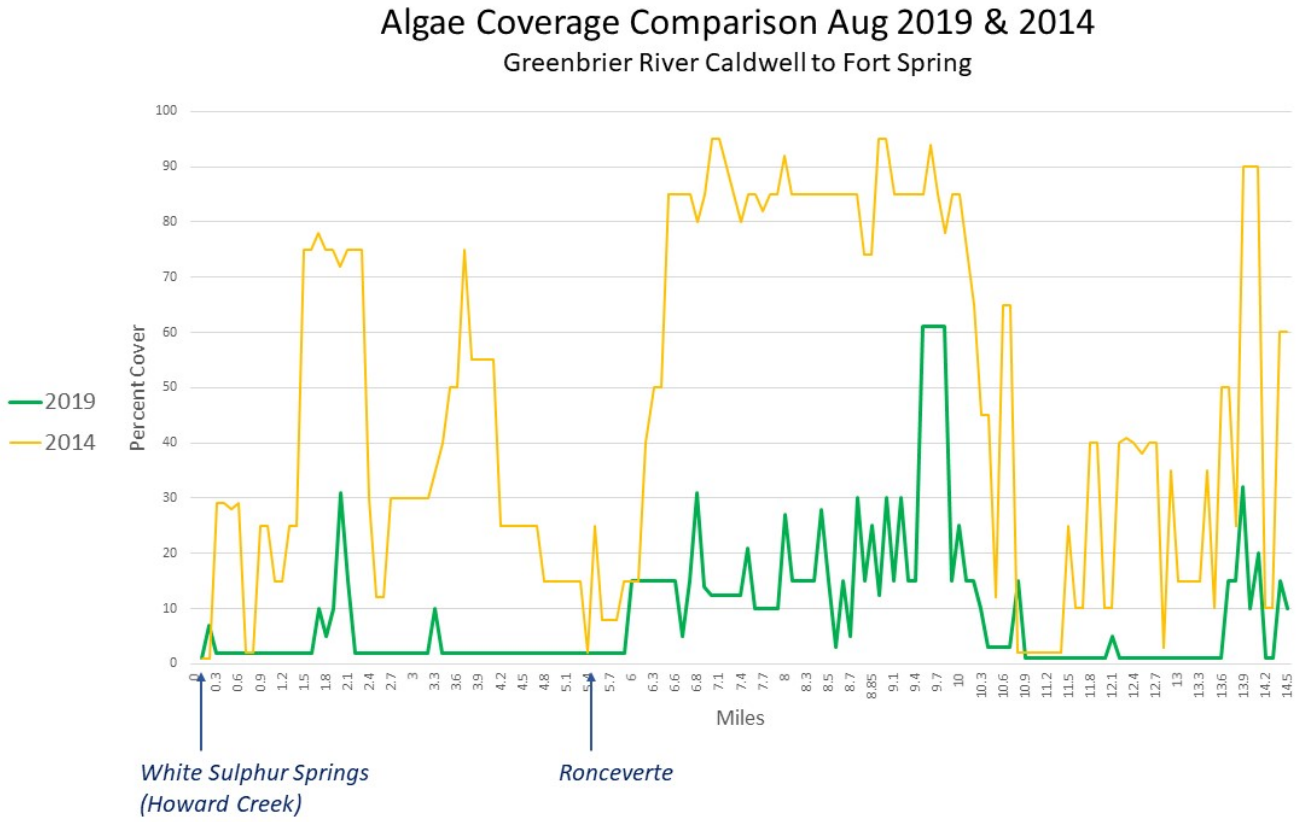
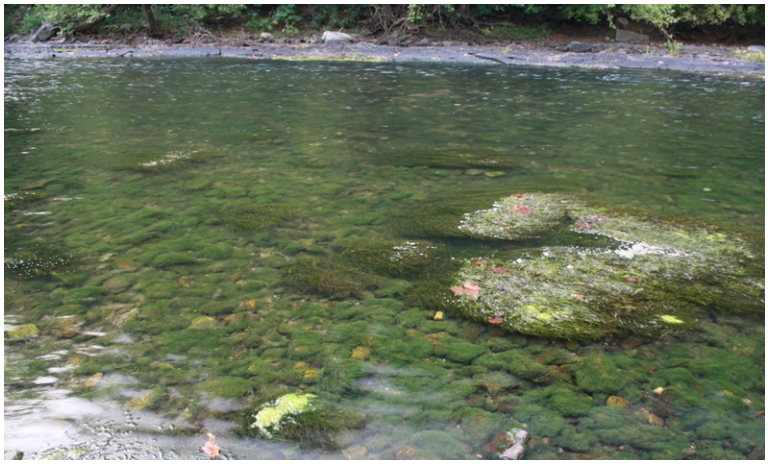


Figure 6-5: Observed filamentous algae coverage in the Greenbrier River

WVDEP's observation and measurement of filamentous algae growth, and its monitoring of taste and odor complaints in drinking water, have resulted in the removal of the South Branch of the Potomac River and portions of the Greenbrier River from the 303(d) list. The photos (below) contrast the filamentous algae coverage in the South Branch and Greenbrier Rivers.



South Branch of Potomac at public access for the famed “Trough” section (2009)

South Branch of Potomac at the “Trough” public access after the Moorefield Regional WWTP installation (2019)

Greenbrier River at Fort Spring (2008)

Greenbrier River at Fort Spring following WWTP upgrades at White Sulphur Springs and Ronceverte (2019)

All previously impacted portions of the Greenbrier River have improved significantly since the WWTP upgrades, but a three-mile section of river below one of the wastewater treatment plants exhibited algal growth above the listing threshold during the summer of 2021. Because this three-mile segment of river overlaps portions of two larger Assessment Units, the Greenbrier River remains listed from RM 35.6 to RM 49.7. WVDEP will continue monitoring this WWTP and the river below it to determine if the 2021 bloom was the result of an operational problem, aging equipment, or the extremely low river flow in the summer of 2021.

Application of the assessment methodology to observations from the 2017-2021 growing seasons resulted in the following impairments on the 2018-2022 Draft West Virginia 303(d) List:

- Greenbrier River – RM 35.6 (Davis Spring) to RM 49.7 (Howards Creek) – refinement of 2016 listing
- Cacapon River – RM 39.0 (North River) to RM 76 (Route 259 Bridge near Wardensville)
- Tygart River – RM 73.2 (Grassy Run) to RM 90.1 (Dodson Run)

7.0 PROBABILISTIC DATA SUMMARY

The goal of WVDEP's probabilistic monitoring program is to provide statistically unbiased estimates of stream condition throughout a particular region (i.e., watershed, ecoregion or state) without assessing every stream mile in that region. This approach can be used to describe various aspects of stream condition including, the proportion of stream miles with biological impairment, the proportion of stream miles with specific water quality criterion violations, and the characterization of the relative importance of stressors such as sedimentation or acid precipitation. The target population for these efforts was small to medium sized (1st - 4th order) wadeable streams. Ninety-eight percent of West Virginia's stream miles are of this size class and approximately 70% of these are wadeable. The probabilistic design used for this summary allows DEP to characterize overall water quality conditions at an ecoregion scale (Figure 7-1), basin scale

(Figure 7-2), and statewide. The 'basins' are groups of four to six 8-digit HUC watersheds that provide data sufficient to develop estimates of condition with fairly small confidence boundaries. Probabilistic assessment sites were distributed within the three major ecoregions in West Virginia: the Western Allegheny Plateau (70), Central Appalachians (69), and Ridge and Valley (67). Due to its small extent in West Virginia, the Blue Ridge Mountain Ecoregion (66) was combined with Ecoregion 67 for assessments and data analysis. The data used for these analyses are from 296 sites sampled at baseflow conditions during the late spring/early summer of 2016 – 2020.

The probabilistically selected sites are assessed using three broad categories of aquatic integrity indicators: biological community quality; water quality; and habitat quality. From these, several individual indicators were chosen to help illustrate the condition of West Virginia's rivers and streams during the period of interest in this report. They are presented for statewide, the three ecoregions and six basins shown in the figures below. In each of the graphs, the statewide results are listed first, followed by the ecoregions, and then the basins.

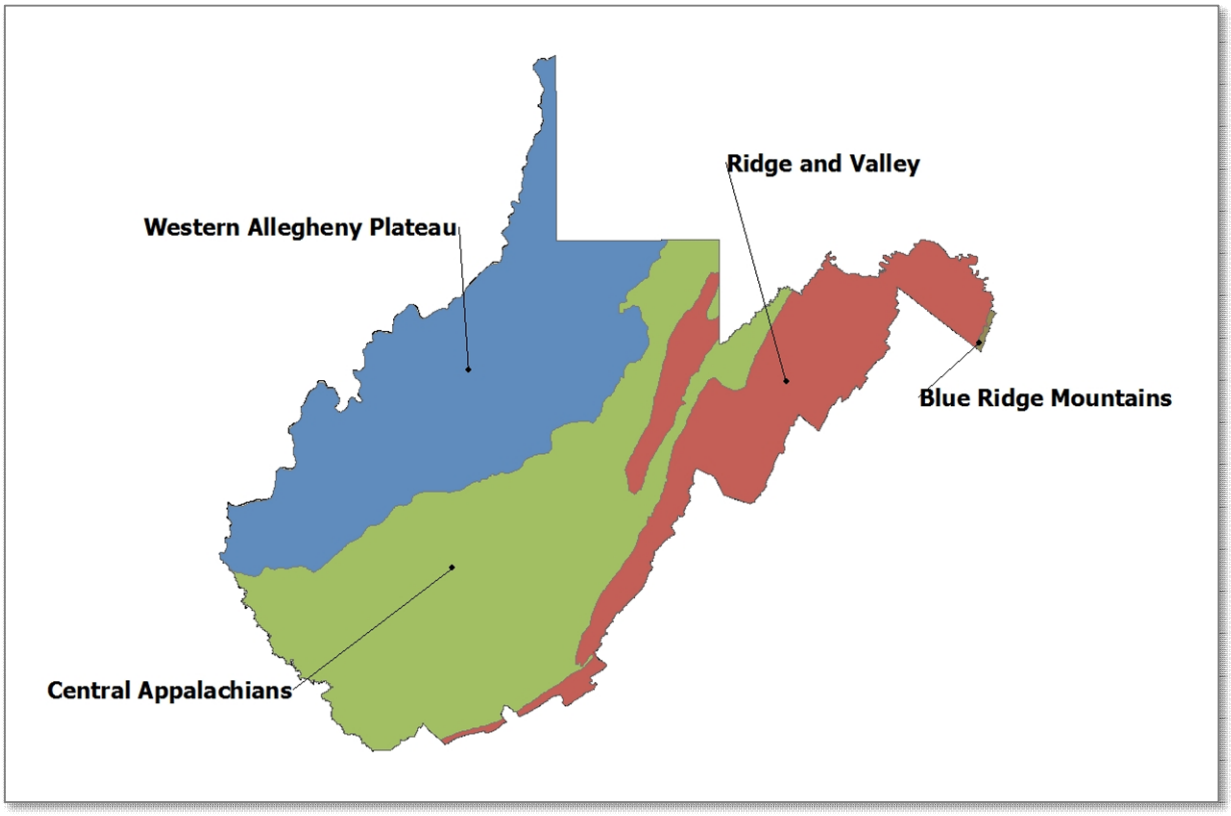


Figure 7-1: West Virginia Ecoregions

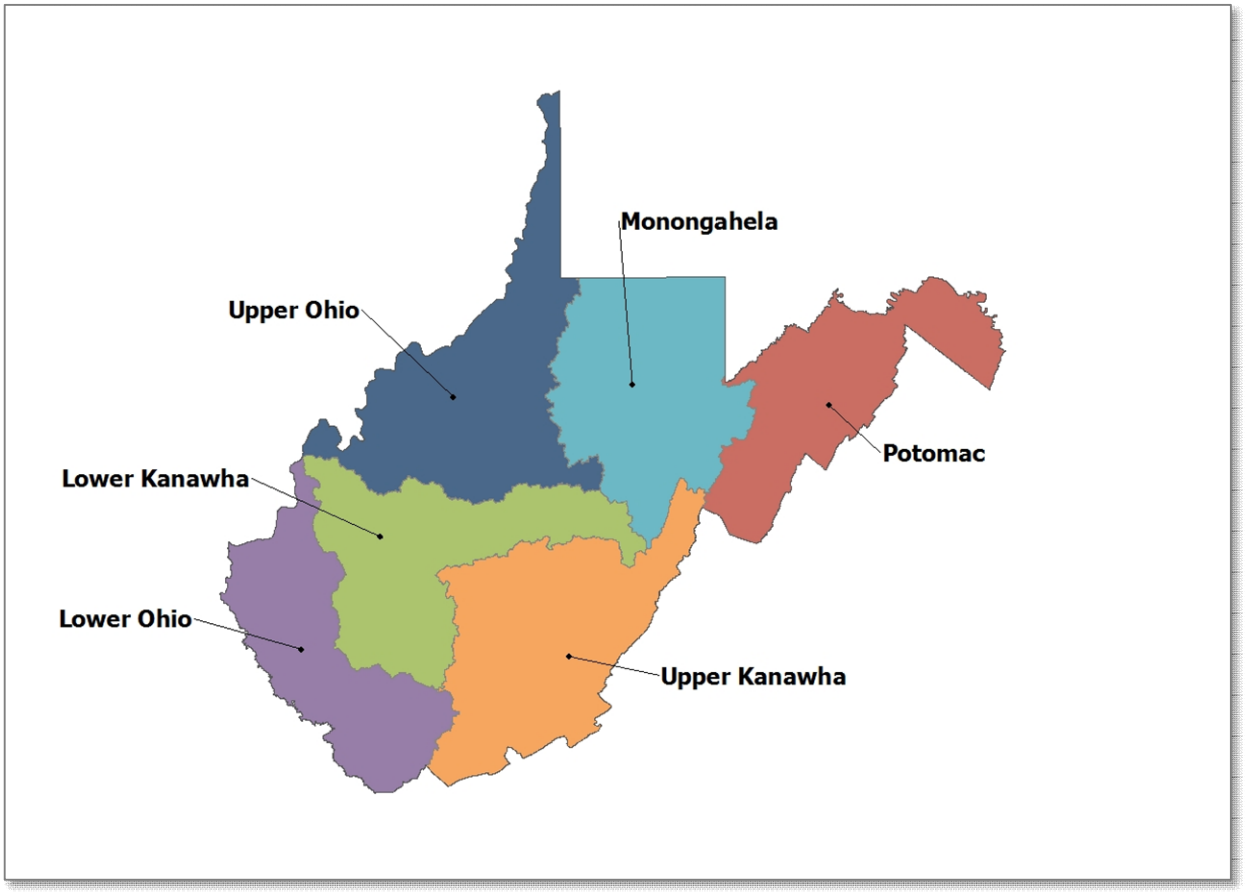


Figure 7-2: West Virginia Basins

7.1 Biological Community

The biological communities living in West Virginia streams are exposed to many stressors, including toxic contaminants, sedimentation, nutrient enrichment, and acid precipitation. The WVDEP uses benthic macroinvertebrates to assess the biological condition of streams in the state. These organisms provide reliable information on water and habitat quality in streams and have been used as indicators all over the world for nearly 100 years. They are extremely diverse and exhibit a wide range of tolerances to pollutants. Further, they serve as an excellent tool for measuring overall ecological health, especially when summarized into a single index of biological integrity.

In West Virginia prior to 2012, the health of benthic macroinvertebrate communities had been rated using a statewide family-level multi-metric index developed for use in wadeable riffle/run streams, the West Virginia Stream Condition Index (WVSCI). Beginning in 1998, the WVDEP started identifying benthic macroinvertebrates to genus level with the intention of establishing a new biotic index. Development of a genus level index was completed. The tool, known as GLIMPSS (Genus Level Index of Most Probable Stream Status), which is stratified by season and ecoregion, was peer reviewed, published, and used in this summary report. GLIMPSS, similar to WVSCI and other indices of biotic integrity, summarizes scores of various metrics into a single index value. The metrics were selected to maximize discrimination

between streams with known stressors and reference streams. Reference streams have little or no human disturbances. All identified reference streams were combined and a subsequent reference condition was established based on their benthic macroinvertebrate communities.

Based on the probabilistic data utilized in this summary and a comparison to low-end reference condition (5th percentile of all appropriate season and ecoregion reference sample GLIMPSS scores), 49.2 percent of wadeable stream miles have scores equal to or above the low-end reference condition threshold (i.e., are generally in good biological condition) statewide with the remaining 50.8 percent scoring less than this threshold (Figure 7-3). Breaking this down by ecoregion, the Ridge and Valley has the highest percentage of streams with healthy aquatic ecosystems, with 69.5 percent scoring above the 5th percentile threshold. The Western Allegheny Plateau ecoregion scores lowest with an estimated 40.0 percent of stream miles comparable to reference. The percent of stream miles in the Central Appalachians scoring above the GLIMPSS threshold is estimated to be 48.0. Among basins, the Potomac had the highest percent of streams miles (63.0) above the reference threshold, while the Lower Ohio had the fewest (40.6).

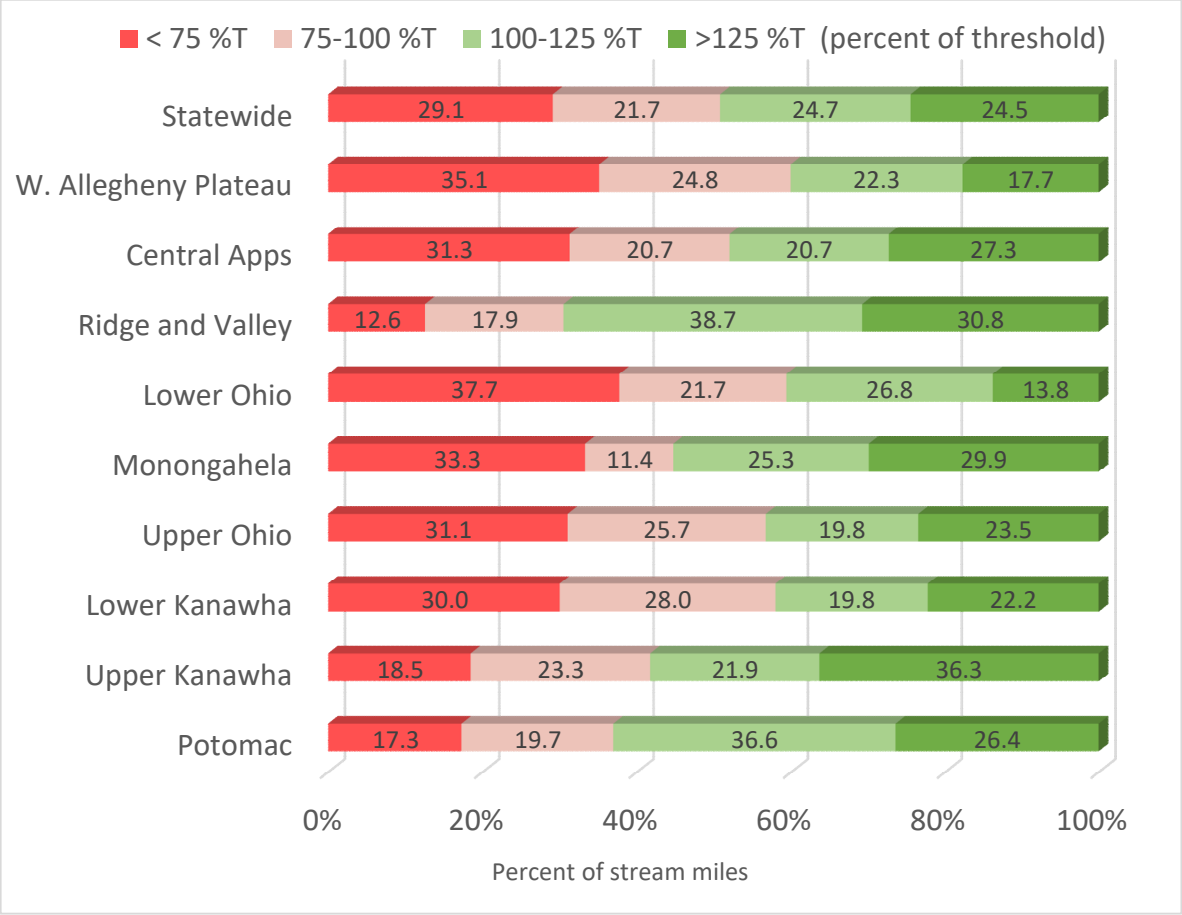


Figure 7-3: Biological Health – Benthic Macroinvertebrate Community IBI Scores for GLIMPSS at Genus Level (except Chironomidae)

7.2 Water Quality Indicators of Aquatic Integrity

The Watershed Assessment Branch analyzes over 20 different water quality parameters at each of the sites sampled as part of the probabilistic monitoring program. Below are the results of six of these parameters, including:

- Conductivity – various levels
- Sulfate > 50mg/L
- Acidity: pH < 5.0 and <6.0
- Bacterial Contamination: fecal coliform bacteria > 400 colonies/100mL
- Dissolved Organic Carbon - various concentrations
- Hardness – various concentrations

Conductivity

Conductivity, or specific conductance, is a measure of how well water conducts electricity, determined by what and how much is dissolved in the water. In certain areas, conductivity is naturally elevated by calcium and other minerals dissolved from limestone and other soluble rocks. In others, it is high because of added pollution from a variety of sources. Large scale land disturbances and the use of valleys fills, results in high conductivity caused by water percolating through fractured rock that had once been solid. High conductivity waters are often associated with degraded benthic macroinvertebrate communities.

In general, West Virginia streams have relatively low conductivity, with 82.4% of wadeable stream miles statewide having late spring /early summer levels below 300 µS/cm (levels tend to rise as the streamflow drops during summer and fall) and many regions having the majority of their stream miles less than 100 µS/cm (Figures 7-4 and 7-5). The Upper Ohio Basin and the closely aligned Western Allegheny Plateau ecoregion have fewer low conductivity (<100 µS/cm) streams, including some areas (northern panhandle) with high conductance streams associated with coal mining. The Monongahela Basin includes some of the lowest conductivity streams (headwaters of Tygart and Cheat River watersheds) as well as some of the highest conductivity streams that are impacted by mining, as well as industrial and residential development. Figure 7-4 (below) shows average specific conductivity by 12-digit HUC watersheds using all available data (not limited to probabilistic data). Higher conductivity values in the eastern panhandle are attributed to the limestone geology of the area.

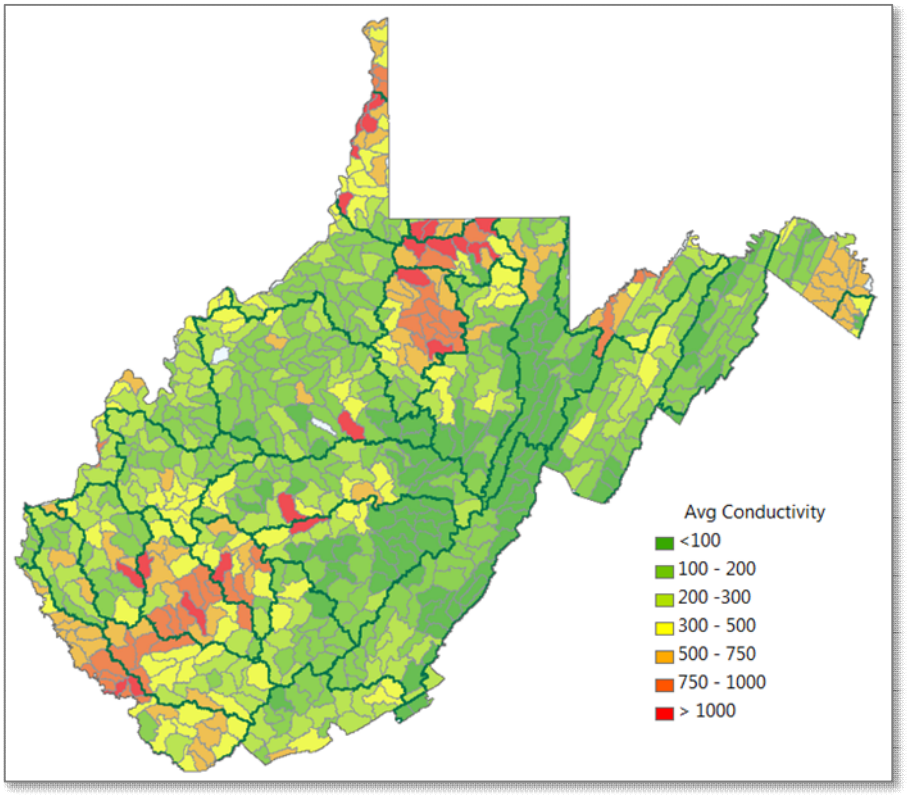


Figure 7-4: Average Specific Conductance at 12-digit-HUC Scale Watersheds in West Virginia

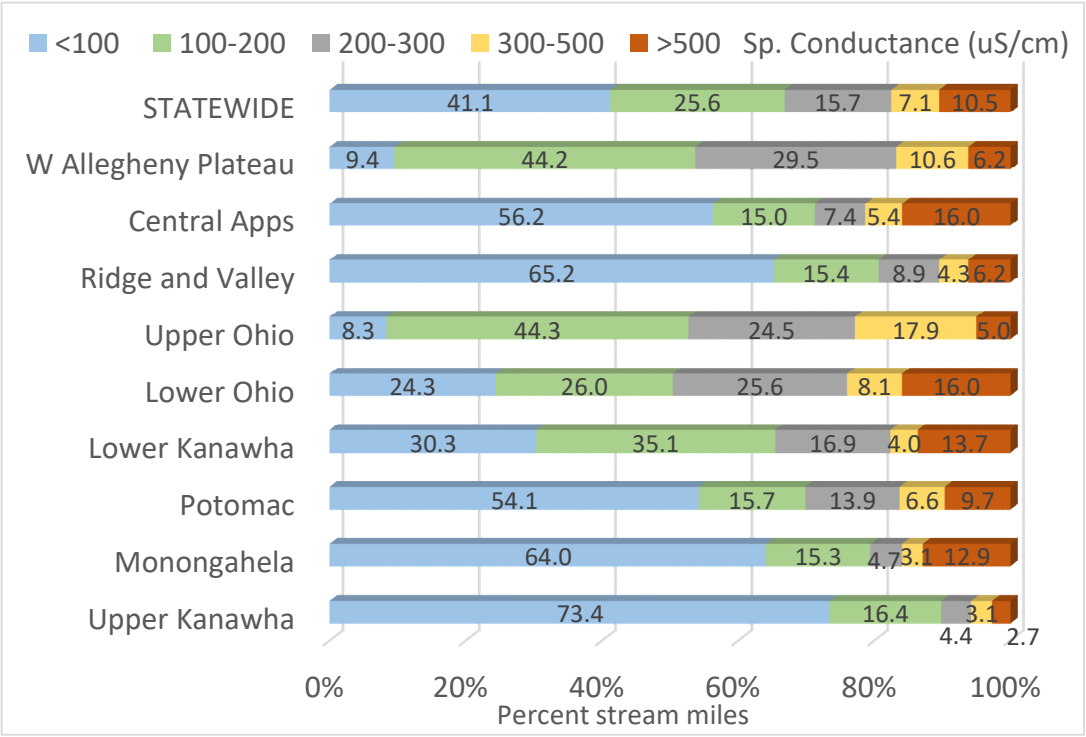


Figure 7-5: Specific Conductance in West Virginia Streams

Sulfate

Streams receiving mine drainage may be impaired by low pH and/or elevated concentrations of metals, including iron, aluminum, and manganese. Other dissolved ions, such as sulfate, may also be present in concentrations above background levels. A sulfate concentration greater than 50 mg/L was used to identify probabilistic sites influenced by mine drainage. Following this guideline, approximately 14 % of the stream miles statewide are influenced by mine drainage (Figure 7-6). Observed on an ecoregional basis, mine drainage influences a greater proportion of stream miles in the coal rich Central Appalachians (24.4%) than in the Ridge and Valley (2.2%) or Western Allegheny Plateau (8.0%). Among basins, the Lower Ohio (26.3%) and Lower Kanawha (16.9%) had the highest percent of stream miles exceeding the 50 mg/L threshold of sulfate.

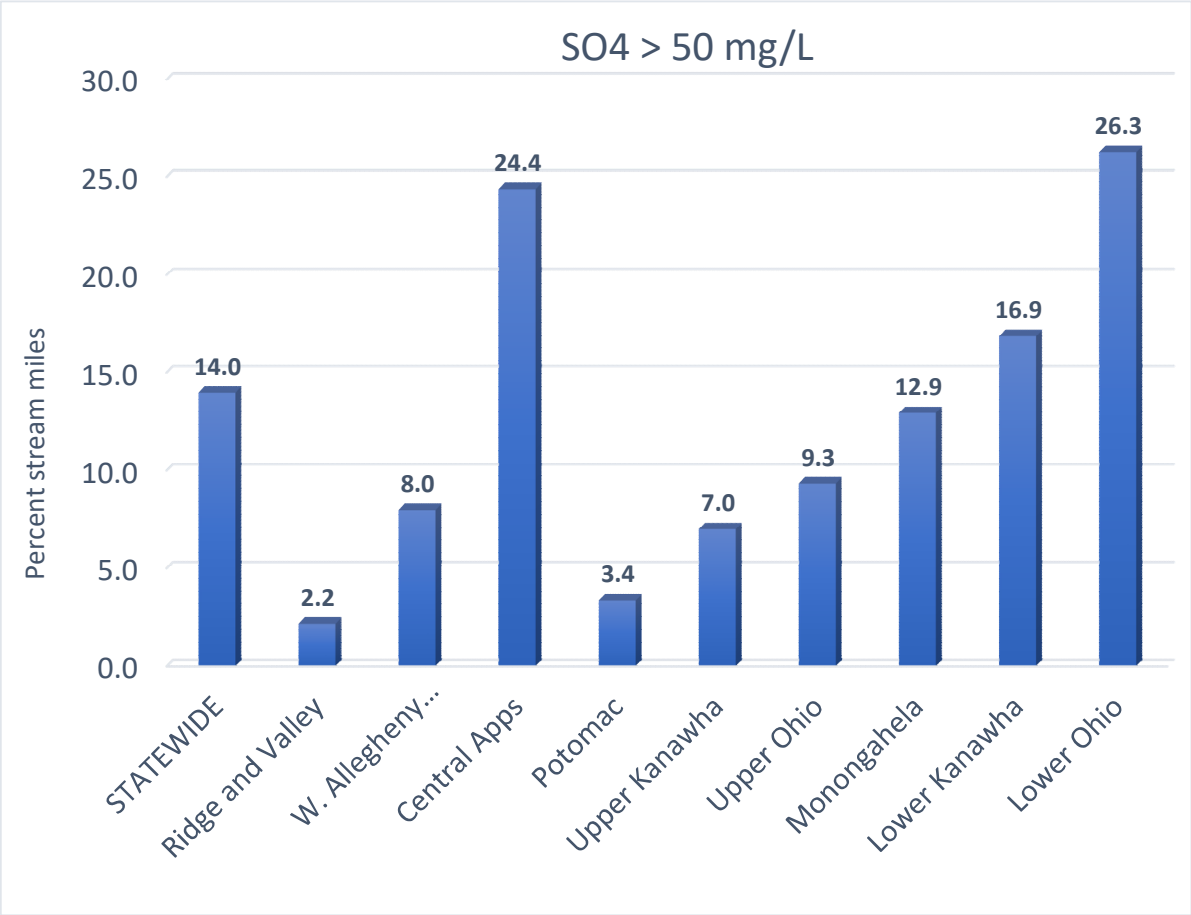


Figure 7-6: Sulfate in West Virginia Streams

Bacterial Contamination

Many West Virginia streams contain elevated levels of fecal coliform bacteria. Contributors to the problem include leaking or overflowing sewage collection systems, illegal homeowner sewage discharges by straight pipes or failing septic systems, and runoff from urban or residential areas and agricultural

lands. Based on probabilistic data, 20.0% of stream miles in the state have fecal coliform bacteria levels that exceed the criterion of 400 colonies/100mL (Figure 7-7). In general, watersheds in the more developed regions of the state had a greater proportion of stream miles exceeding the criterion. Among ecoregions, the proportion of stream miles violating the criterion was highest in the Western Allegheny Plateau with 36.0 % of stream miles exceeding the criterion. The proportions of stream miles exceeding the criterion were considerably lower in the Central Appalachians at 13.5% and Ridge and Valley Ecoregions at 4.8%. WVDEP's probabilistic monitoring is performed at baseflow conditions and, because samples are not collected during storm runoff events, bacteria levels that may increase under these higher flow conditions are not represented in the results. The Upper Ohio and Lower Ohio basins had the highest percent of stream miles exceeding the bacteria criterion with 42.1% and 26.1%, respectively.

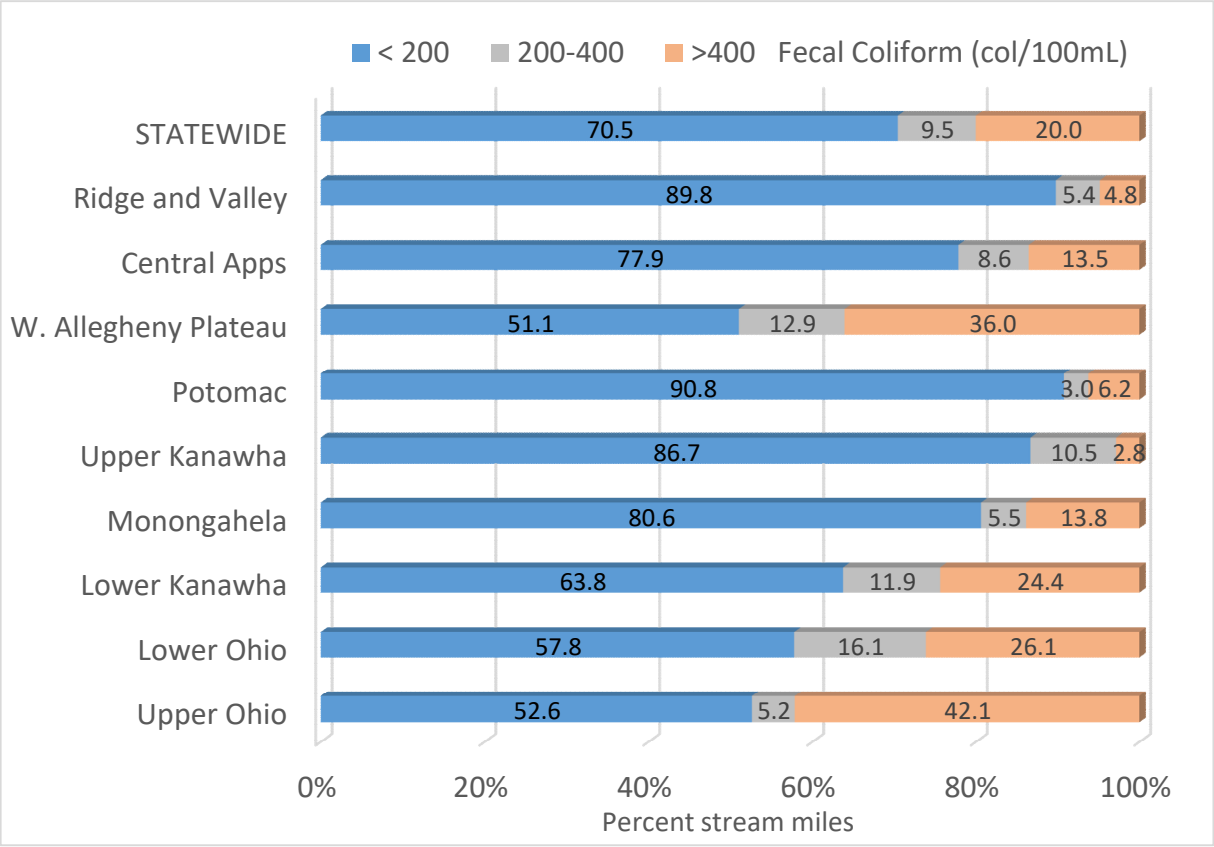


Figure 7-7: Fecal Coliform Bacteria in West Virginia Streams

Acidity

Aquatic life communities in the headwater sections of many West Virginia streams continue to be impacted by low pH (acidic) water. The impairment is most prevalent in watersheds with soils of low buffering capacity and most often caused by acid precipitation and less often (but potentially more severely) by acid mine drainage. An evaluation of probabilistic data indicates that approximately 5.7% of the stream miles in the state have pH values below 6.0 (Figure 7-8). Most of the stream miles identified as impacted by acidic waters are in the Central Appalachians Ecoregion, representing 10.2% of the stream

miles within this area. Specifically, the Forested Hills and Mountains section of this ecoregion are largely susceptible to acid precipitation impacts due to infertile soils and resistant sandstones of the Pottsville group. The Ridge and Valley Ecoregion is less susceptible to the impacts of acid deposition with geologic materials such as limestone and shale providing more buffering capacity to neutralize acid precipitation. Nonetheless, probabilistic data indicates that approximately 3.7% of the stream miles in the Ridge and Valley Ecoregion are impacted by acidic conditions. Although present, the extent of stream miles impacted by acidic waters within the Western Allegheny Plateau Ecoregion is very low, just 1.3%. Again, this ecoregion has well buffered soils that limit the impacts of acid precipitation. Furthermore, where they do exist in the western Allegheny Plateau ecoregion, acidic waters are more likely the result of acid mine drainage than acid precipitation. The Monongahela Basin had the highest level of low pH waters among basins with nearly 11.5% of stream miles estimated to be acidic. The Monongahela Basin likely has significant contributions from both acid deposition and acid-mine drainage.

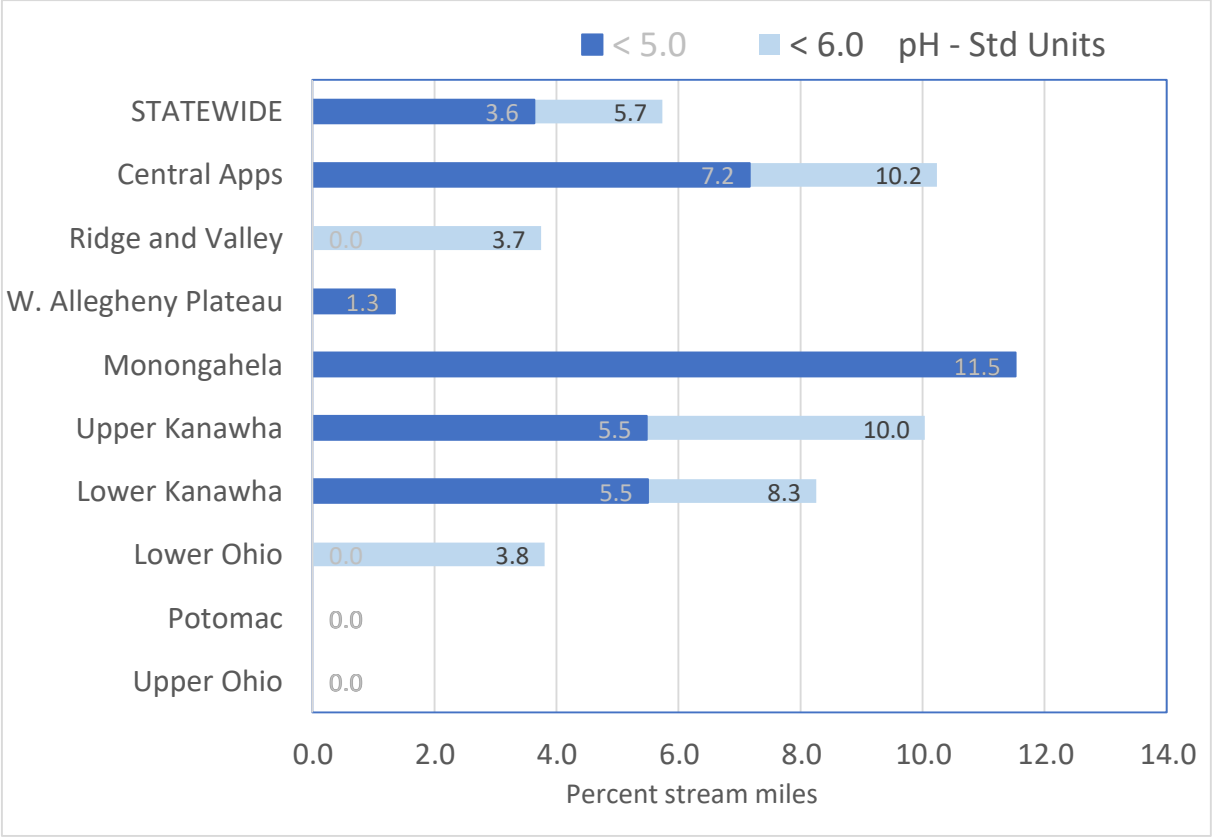


Figure 7-8: Acidic Streams in West Virginia as Indicated by pH

Dissolved Organic Carbon (DOC)

WVDEP added DOC to the list of parameters analyzed at probabilistic sites in 2019. USEPA put out new aluminum criteria in 2018 that is dependent on the conditions of the water, specifically pH, hardness, and DOC. Hardness analyses have been included since the beginning of the probabilistic monitoring program in 1997. To better understand the potential implications of EPA's aluminum

criteria, estimates of DOC (Figure 7-9) and hardness levels (Figure 7-10) have been added to this summary of the program's results.

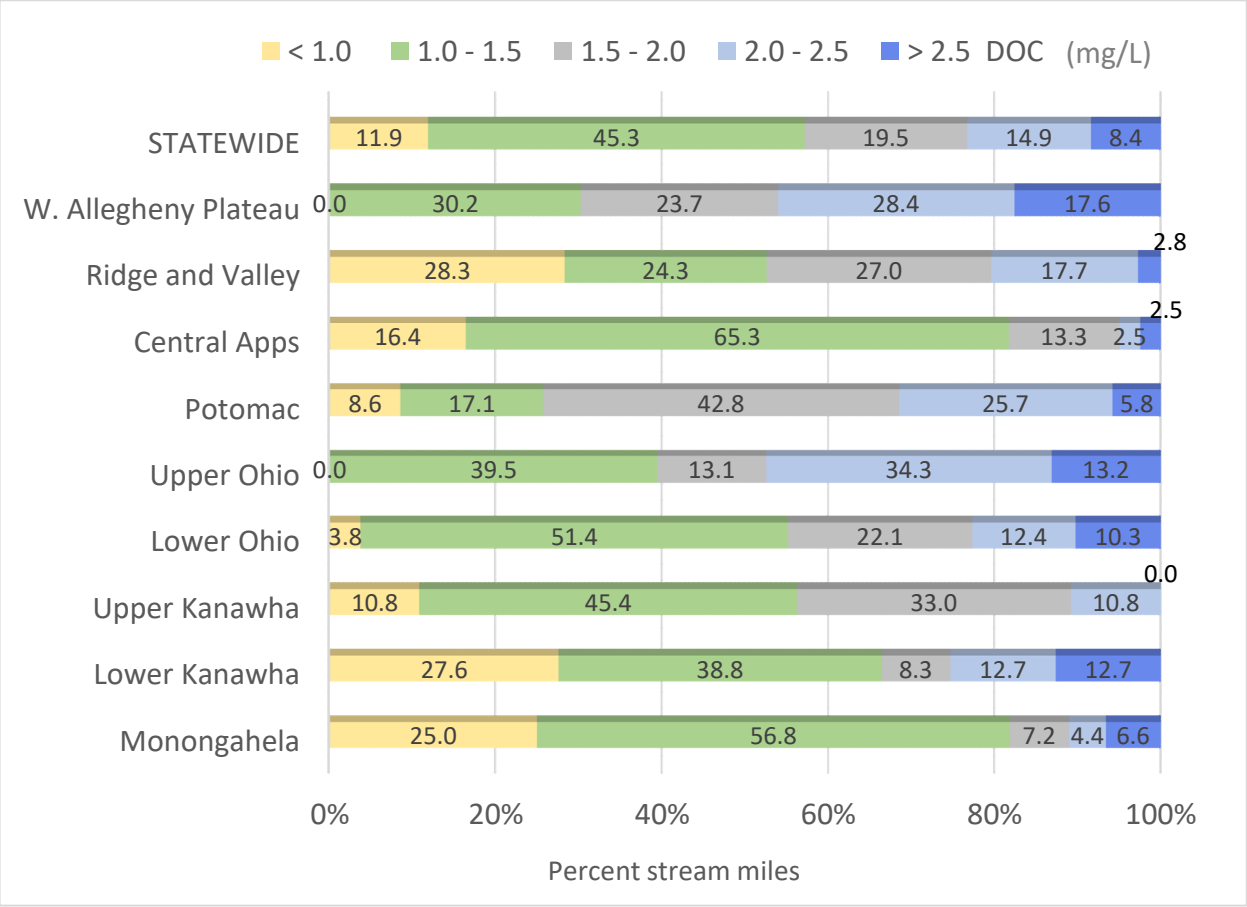


Figure 7-9: Dissolved Organic Carbon (mg/L) in West Virginia Streams

Hardness

Hardness in West Virginia varies from very low in some mountain streams to very high in certain streams impacted by mining and other industry. Statewide, 25.8 percent of stream miles had hardness of 25 mg/L or less; and 10.9 percent of stream miles had hardness > 200 mg/L. Figure 7-10 shows the probabilistic results and Figure 7-11 provides a better representation of how variable hardness is across the state versus the ecoregion and basin summaries. For example, the Monongahela Basin includes streams with some of the lowest and some of the highest values.

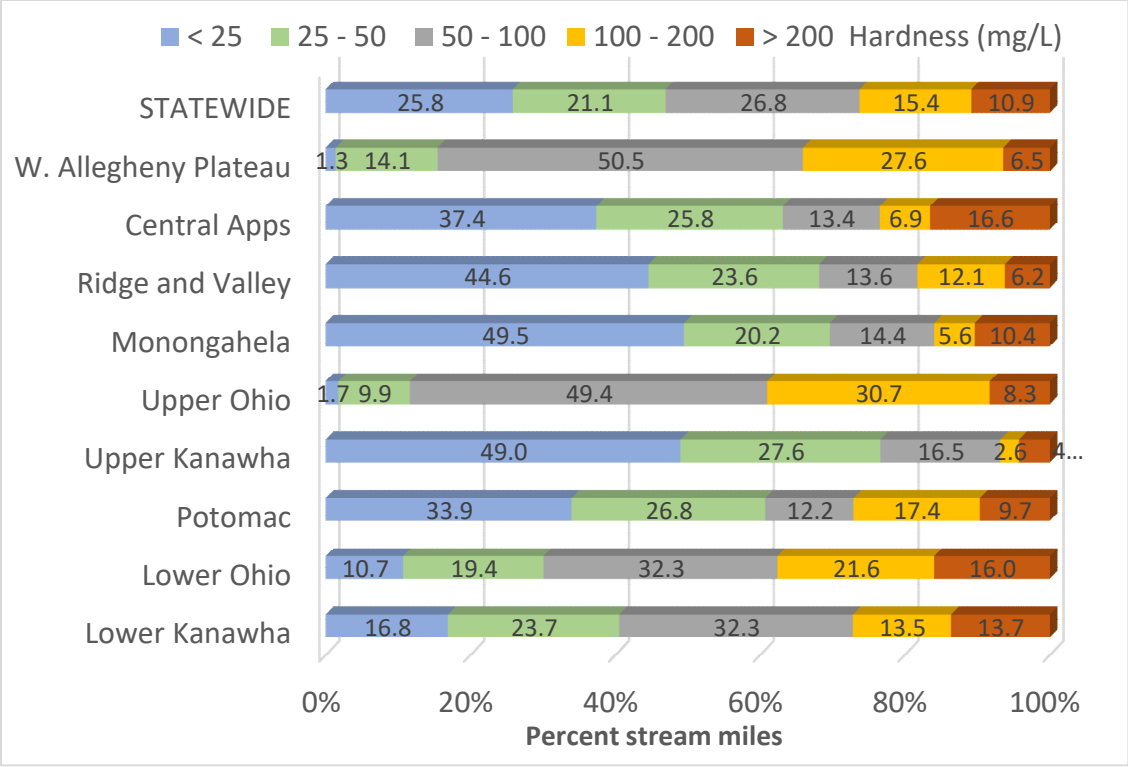


Figure 7-10: Hardness (mg/L) in West Virginia Streams

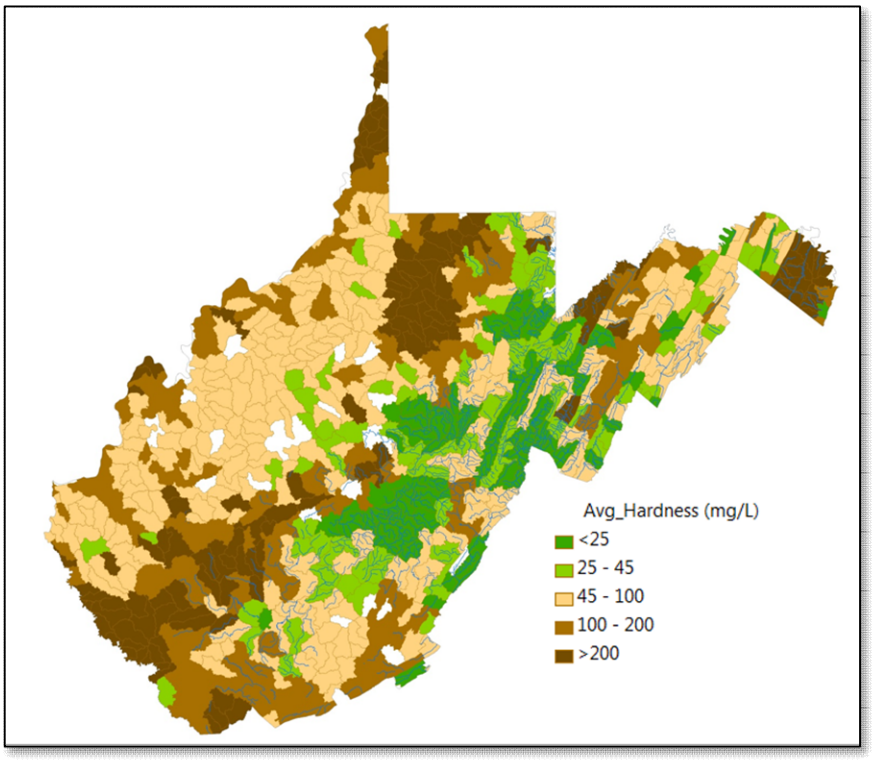


Figure 7-11: Hardness (mg/L) in West Virginia HUC 12 Watersheds

7.3 Habitat Indicators of Aquatic Integrity

Overall Stream Habitat Condition

During the course of probabilistic sampling, WVDEP personnel collect data on many features of both riparian and instream habitat known to be important to the biological communities of streams. Habitat parameters from EPA's Rapid Bioassessment Protocol (RBP) were measured. These include measures of the amount of sediment and embeddedness in the stream channel as well as measures of the vegetation along the bank and riparian zone in the stream corridor. Specifically, ten parameters are scored (0-20) based on their quality and then combined to assess the overall physical habitat condition of the site. The overall scores (Total RBP Habitat – max score 200 pts.) were categorized as good, moderate, or poor (Figure 7-12). Based on probabilistic data, just 14.0% of stream miles statewide have good habitat quality (total RBP score of 160 or greater), 71.5% of stream miles have moderate habitat quality (110–159), and 14.5% of stream miles have poor habitat quality (< 110). While these categorical thresholds are somewhat arbitrary, they do provide a good comparison of habitat conditions between geographic areas.

On an ecoregional basis, the Ridge and Valley had the highest proportion of stream miles rated in the good category for overall habitat quality at 24.6%. Additionally, this ecoregion had the least number of stream miles rated as poor for overall habitat quality at only 8.0%.

Total habitat quality scores are lower in the Western Allegheny Plateau. The presence of more widespread development and factors such as higher rates of soil erosion in this ecoregion are potential causes for zero percent of its stream miles being rated as good in overall habitat quality. Additionally, the percentage of stream miles with poor habitat quality (25.4%) is substantially higher in this ecoregion.

The Upper Kanawha basin stands out as having the highest percentage of stream miles (29.3%) with good overall habitat. This basin includes large portions of the Monongahela National Forest and several undisturbed wilderness areas. The Upper Ohio basin had almost no miles in good condition and almost a quarter of their stream miles in poor condition.

It is important to consider that approximately 90% of stream miles in the state are in the moderate or poor habitat categories. This indicates that most of the state's stream miles have at least some degree of habitat degradation. Although the DEP may gain insight into overall habitat conditions by combining the individual measures, it is useful to examine specific habitat characteristics.

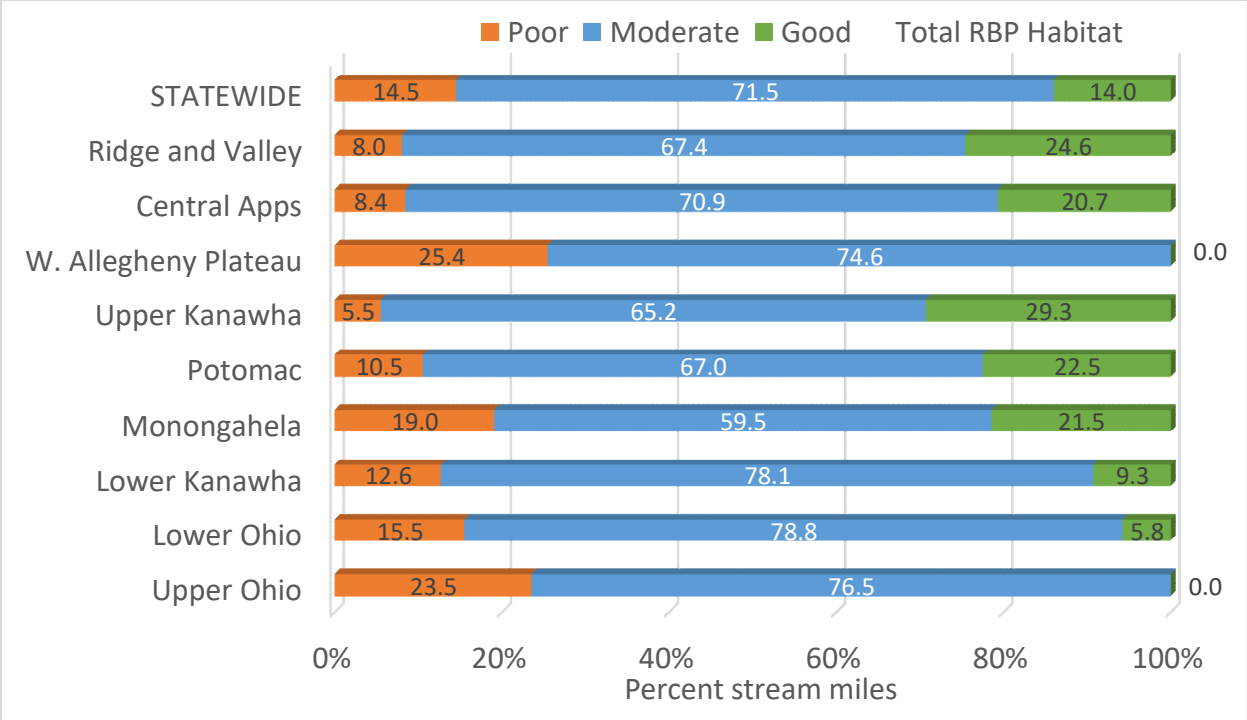


Figure 7-12: Overall Stream Habitat (RBP Total Score) in West Virginia Streams

Relative Presence of Embeddedness

Sedimentation, and the resulting embeddedness, is one of the most important problems facing West Virginia streams. Figure 7-13 shows the extent to which rocks (gravel, cobble, and boulders) are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish for shelter, spawning, and egg incubation is decreased. The Western Allegheny Plateau had the highest percentage of streams with poor or very poor ratings (34.2%) for embeddedness. This is likely because this region has slower, low-gradient streams, has more erodible soils, and more land-disturbing activities than in other areas. The Central Appalachians and Ridge and Valley streams fared better with 25.0% and 12.2% combined poor and very poor ratings, respectively. The Lower Ohio and Monongahela basins had the highest percent of stream miles in the poor or very poor category with 40.6% and 29.0%, respectively.

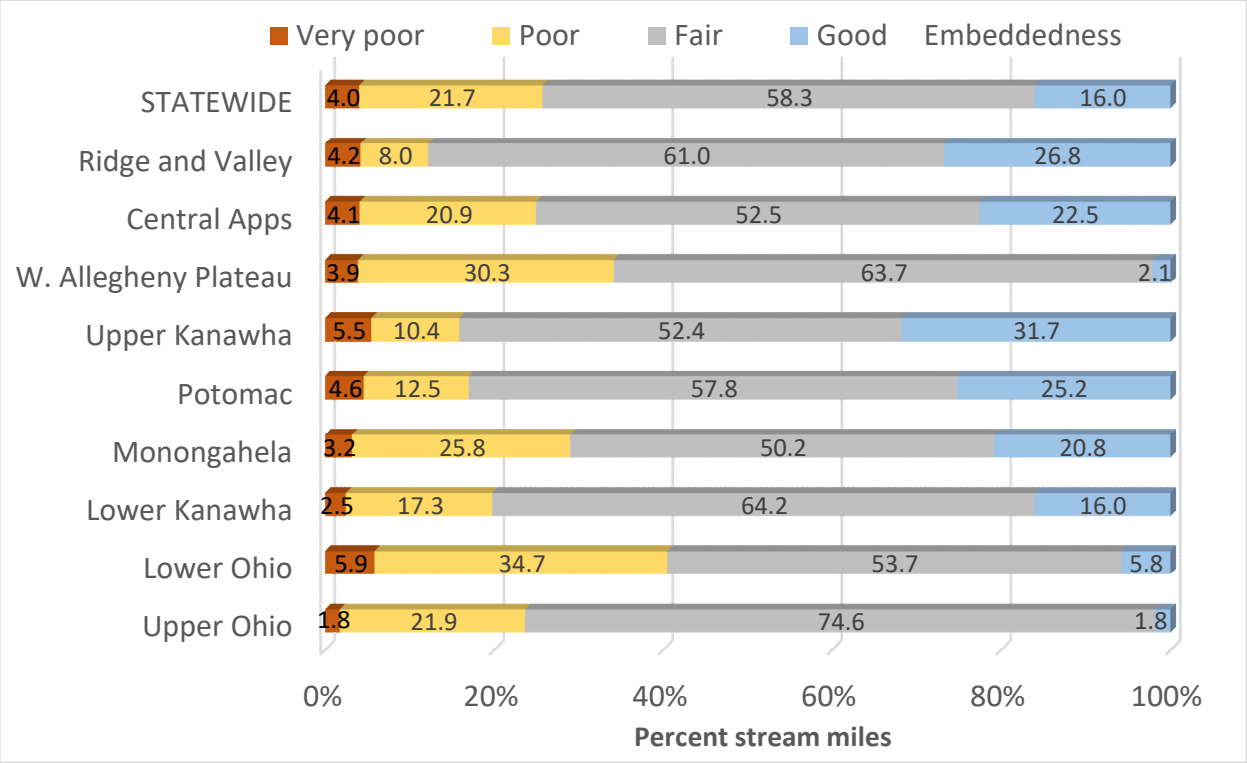


Figure 7-13: Embeddedness Scores in West Virginia Streams

Condition of Riparian Vegetation Zones

The Western Allegheny Plateau ecoregion had the lowest percentage of wide, undisturbed riparian zones at just 8.2 % (Figure 7-14). The Central Appalachians and Ridge and Valley ecoregions were much better, with 51.9% and 51.3%, respectively, of stream miles in good condition for this indicator. This indicator rates streamside zones on the amount of undisturbed vegetation present, which is desirable for providing shade, creating a more stable stream bank, and minimizing the amount of sediment, excess nutrients, and other pollutants entering the stream. Among basins, the Potomac was better than the others for riparian zone intactness with an estimate of 52.9% of its stream miles in the good category.

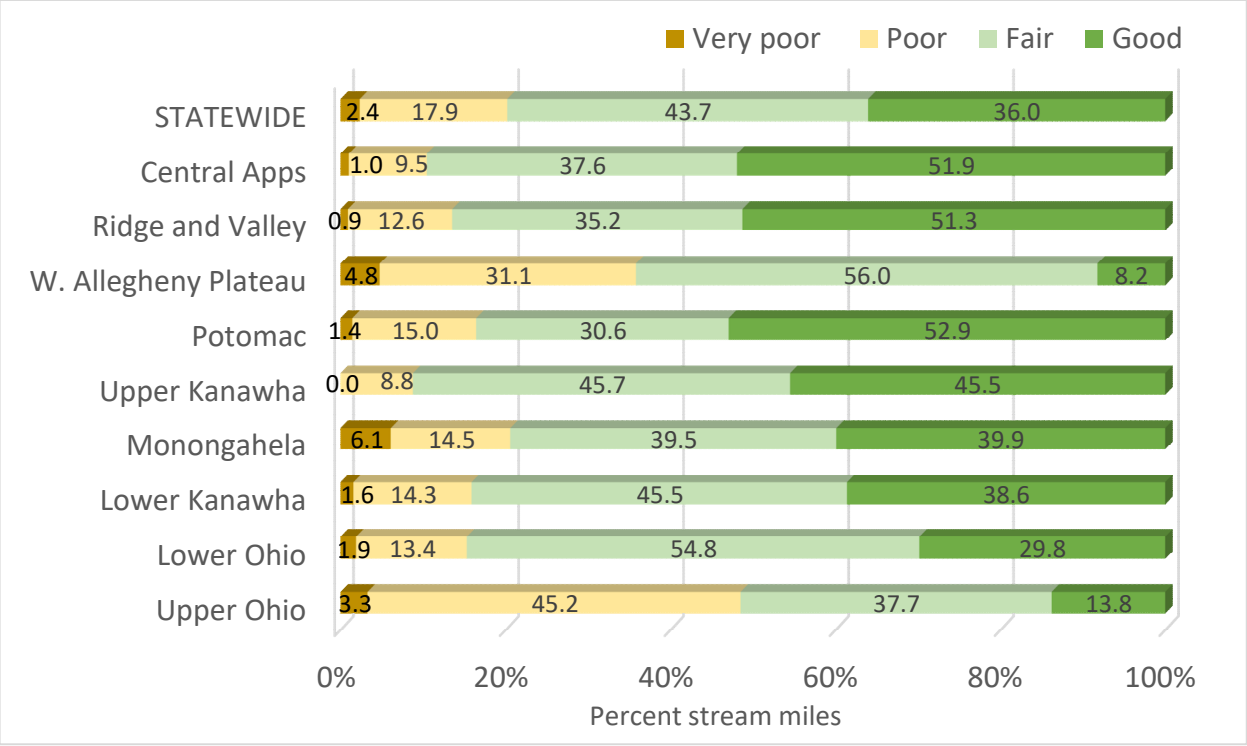


Figure 7-14: Riparian Zone Vegetation Scores in West Virginia Streams

Range of Human-Refuse Intensity Values - Trash/Aesthetic Index

The "Trash/Aesthetic Index" is a measure of the amount of human refuse that is in and around the stream (including that which could be washed into the stream at high flows) (Figure 7-15). The Central Appalachian and the Ridge and Valley ecoregions had the highest percentage of "clean" stream miles with over 60 percent of stream miles in that category.

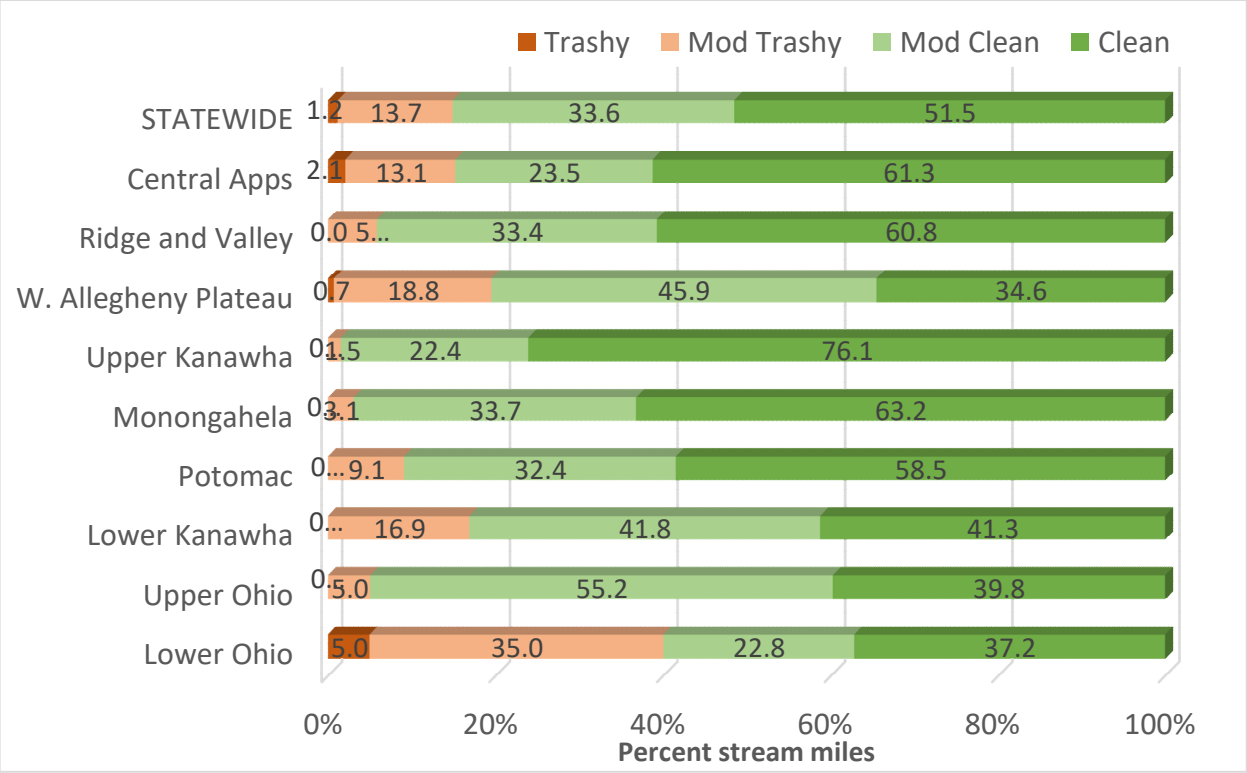


Figure 7-15: Trash/Aesthetic Scores in West Virginia Streams

8.0 TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT PROCESS

From 1997 until 2003, EPA Region III developed West Virginia TMDLs under the settlement of a 1995 lawsuit, Ohio Valley Environmental Coalition, Inc., West Virginia Highlands Conservancy, et. al. v. Browner, et. al. The lawsuit resulted in a consent decree between the plaintiffs and the EPA that specified TMDL development requirements and compliance dates. While the EPA was working on developing TMDLs, WVDEP concentrated on building its own TMDL program. With the help of the TMDL stakeholder committee, the agency secured funding from the state legislature and created the TMDL section of the Watershed Assessment Branch within the Division of Water and Waste Management.

The TMDL Section is committed to implementing a TMDL process that reflects the requirements of TMDL regulations, provides for the achievement of water quality standards, and ensures that ample stakeholder participation is achieved in development and implementation of TMDLs. The DWWM's approach to TMDL development allows 48 months to develop a TMDL from start to finish. This approach enables the agency to carry out an extensive data generation and gathering effort to produce scientifically defensible TMDLs; and allows sufficient time for modeling, report drafting, and frequent public participation opportunities.

WVDEP's TMDLs are generally developed according to the Watershed Management Framework cycle. The framework divides the state into 32 major watersheds and operates on a five year, five-step process.

The TMDL process begins in the first year of the cycle with pre-TMDL sampling and public meetings in the affected watersheds. The data is compiled and TMDL development begins in year two of the cycle. In the third year, TMDL development continues and the TMDL is drafted. The TMDL is finalized in the fourth year. In the fifth year of the cycle, TMDL implementation is initiated through the NPDES permitting process and efforts toward limiting nonpoint source loading. Throughout the TMDL development process, there are numerous opportunities for public participation and input.

For ongoing TMDL projects, the 303(d) list identifies and prioritizes the waters and impairments for which future TMDLs will be developed by specifying the year in the "Projected TMDL Year" column. For other waters and impairments, where the timing of TMDL development is less certain, a high priority has been placed on TMDL development in this Combined Integrated Report. In future efforts, WVDEP will develop a methodology for prioritizing TMDLs to refine the priority listings. Pre-TMDL sampling has traditionally followed the framework cycle, i.e., impaired streams from watersheds in Hydrologic Group A were sampled in the same year as the targeted sampling. More recently, in order to address impairments that have been listed for several years, some watersheds are being selected for TMDL development outside of the framework cycle schedule.

WVDEP personnel are typically working on some aspect of TMDL development in each of the five Hydrologic Groups (A-E). Each set of TMDLs moves through several stages of development prior to finalization and the EPA's approval. Table 8-1 shows the state's TMDL development progress. The number after the Hydrologic Group letter indicates the number of TMDL cycles that have occurred in each group. For examples, Cacapon River represents the fifth TMDL cycle in Hydrologic Group E; while Tug Fork River represents the fifth TMDL cycle for Hydrologic Group C. Tug Fork River was prioritized because WVDEP's programmatic goal to revisit watersheds where TMDLs were developed under the consent decree.

Table 8-1: DEP TMDL Development Progress and Planning Since the 2016 Integrated Report (updated through May 2023)

Hydrologic Group	Watersheds	Progress
A4	Shenandoah Jefferson	Pre-TMDL monitoring ongoing 2022-2023
B3	Tygart Valley	EPA Approved 2016
B4	Elk River (above Sutton Lake) North Branch Potomac (Stony River)	Pre-TMDL monitoring ongoing 2022-2023
C3	Gauley (Meadow River) Potomac Direct Drains (Rockymarsh Run and Warm Springs Run)	EPA Approved 2016
C4	Lower Guyandotte	EPA Approved 2022
C5	Tug Fork River	TMDL approved 2023
C6	Potomac Direct Drains (including Back Creek and other tributaries)	Pre-TMDL monitoring ongoing 2021-2023

Hydrologic Group	Watersheds	Progress
	Gauley River	Pre-TMDL monitoring and TMDL effectiveness site selection complete. Monitoring to begin July 2023.
D3	Monongahela mainstem Little Kanawha (Hughes River)	EPA Approved 2018
D4	Little Kanawha (other than Hughes River)	TMDL development ongoing
E3	Upper Guyandotte	EPA Approved 2021
E4	Big Sandy Lower Ohio Twelvepole Creek	EPA Approved 2021
E5	Cacapon River	Pre-TMDL monitoring completed in 2022. (Monitoring delayed due to COVID-19 pandemic travel restrictions)

WVDEP believes the TMDL development process, which links extensive water quality monitoring and source tracking efforts with pollutant sources through computer modeling, provides the best assessment of criterion attainment and the most accurate identification of the watershed sources for which pollutant reductions are necessary. TMDL modeling predicts water quality over a wide range of climatic and stream flow conditions, incorporates the specific exposure duration and exceedance frequency terms of water quality criteria and prescribes pollutant/s allocations that will result in attainment of criteria in all stream segments.

WVDEP's website contains all approved TMDL documents and the draft TMDL documents currently out for public comment. These documents can be found at:

http://www.dep.wv.gov/WWE/watershed/TMDL/Pages/default.aspx

9.0 INTERSTATE WATER COORDINATION

9.1 Virginia DEQ on Bluestone River PCB monitoring and TMDL development

WVDEP has been working with the Virginia Department of Environmental Quality (VADEQ) to assess Polychlorinated Biphenyls (PCBs) impairment along the Virginia section of the Bluestone River. The product of this cooperative effort will be a TMDL for the Bluestone River and tributaries with loadings and allocated reductions for sources in both Virginia and West Virginia. The West Virginia DEP, Virginia DEQ, and EPA Region III have been cooperating to locate and reduce sources of PCBs to the Bluestone River. As part of this effort, remediation of former industrial sites has been completed. Efforts included leveling and removal of the electric motor remanufacturing buildings on the site. Also, contaminated water

and debris were removed from the site and clean material used to backfill the open basement areas of the property. Within the watershed, additional monitoring and source evaluation is on-going to determine what steps may be necessary in the future.

Continued monitoring has determined in part that groundwater rising into the Bluestone River watershed is contaminated by PCBs and contributes to the impairment of the river. Virginia DEQ is leading an effort to develop a TMDL in the watershed that will likely address the contaminant sources in both states.

9.2 Virginia DEQ on New River PCB TMDL development

Virginia DEQ developed a PCB TMDL for the mainstem New River and selected tributaries and impoundments. WVDEP contributed to the TMDL via the Technical Advisory Committee to ensure the final TMDL meets both state's water quality standards. The New River PCB TMDL developed for the Virginia portion of the watershed was approved in March 2019.

9.3 Ohio River Valley Water Sanitation Commission – ORSANCO

As with previous reports, WVDEP Combined Integrated Report includes assessments based on data provided by ORSANCO. Throughout the development of ORSANCO's Biennial Assessments, WVDEP has been involved with ORSANCO's efforts to standardize assessments among the compact states. WVDEP's personnel continue to participate in several standing committees, along with representatives from other compact states, charged with helping direct ORSANCO's water quality and biological monitoring efforts.

9.4 Chesapeake Bay

The Chesapeake Bay is impaired by nutrients and sediment from multiple sources originating locally and in upstream states. This biologically diverse waterbody is an important economic and recreational resource. The need to restore this waterbody is a high priority for many agencies, organizations and the public in general. Approximately ten percent of West Virginia's stream miles drain into the Potomac River and on into the Bay. In addition, portions of the James River Watershed in West Virginia contribute flow to the Bay.

In June 2002, Governor Bob Wise signed the Chesapeake Bay Program Water Quality Initiative Memorandum of Understanding, committing West Virginia to nutrient and sediment load reductions. In November 2005, West Virginia proposed pollutant reduction plans in the West Virginia Potomac Tributary Strategy. In December 2010, EPA finalized TMDLs for the Chesapeake Bay and other impaired tidal waters in Virginia and Maryland. In response to the TMDLs, West Virginia and the other Bay jurisdictions developed Watershed Implementation Plans (WIPs). The West Virginia WIP identifies actions and controls the State will pursue to implement the TMDLs, and West Virginia will accomplish its TMDL responsibilities if the WIP is successfully executed. Progress in meeting the TMDL responsibilities is measured and reported regularly. The WIP has been revised to ensure TMDL 2025

implementation goals are met. Many DEP programs are actively participating in this effort. The West Virginia WIP and supporting documents may be viewed at:

http://www.wvchesapeakebay.us/WIP/WIP3.cfm

9.5 Interstate Commission on Potomac River Basin

The Commission is a non-regulatory agency of basin states (Maryland, Pennsylvania, Virginia and West Virginia), Washington, D.C. and the federal government, promoting watershed-wide solutions to the pollution and water resources challenges facing the basin and its more than 6.11 million residents. Examples of current commission efforts include the Chesapeake Bay Program involvement, stream biological assessments, support of selected stream gages, the Potomac Groundwater Assessment, Potomac Basin Drinking Water Source Protection Partnership coordination, and Potomac Watershed Toxic Spill Model support. In addition, the Commission's public outreach program supports and helps coordinate an annual watershed-wide cleanup effort and produces and distributes the newsletter *Potomac Basin Reporter* to 20,000 subscribers. The commissioners are appointed by their respective jurisdictions and provide policy guidance and oversight for a skilled staff of scientists and educators.

10.0 WATER POLLUTION CONTROL PROGRAMS

10.1 Division of Water and Waste Management

The Division of Water and Waste Management's mission is to preserve, protect, and enhance West Virginia's watersheds for the benefit and safety of all its citizens through implementation of programs controlling hazardous waste, solid waste, and surface and groundwater pollution from any source.

The DWWM strives to meet its mission through implementation of programs controlling surface and groundwater pollution caused by industrial and municipal discharges, and through the oversight of construction, operation, and closure of hazardous waste, solid waste, and underground storage tank sites. In addition, the DWWM works to protect, restore, and enhance the state's watersheds through comprehensive watershed assessments, groundwater monitoring, wetlands preservation, inspection and enforcement of hazardous and solid waste disposal, and proper operation of underground storage tanks.

Environmental Enforcement (EE), a branch of the Division of Water and Waste Management, is charged with assuring compliance with many state pollution control regulations, including the Solid Waste Management Act, Water Pollution Control Act, Groundwater Protection Act, Hazardous Waste Management Act, Underground Storage Tank Act, and Dam Safety Act by providing assistance, inspecting regulated sites, and enforcing conditions required by these acts.

10.2 National Pollution Discharge Elimination System (NPDES) Program

The DWWM's primary mechanism for controlling point sources is the West Virginia NPDES permitting program. This program, administered by the Permitting Branch, regulates activities and facilities involved in the installation, construction, modification, and operation and maintenance of industrial and wastewater treatment systems, as well as their discharges. Individual and general permits are issued to implement the program and typically include effluent limits, requirements for facility operation and maintenance, discharge monitoring, and reporting. Other permits require installation and implementation of best management practices in lieu of effluent limitations and discharge monitoring requirements. In addition to the NPDES program, the Permitting Branch administers a pretreatment program, which outlines procedures for regulating proposed industrial wastewater connections to publicly owned treatment works (POTW). The program imposes discharge limitations for these indirect discharges and requires the installation of pretreatment facilities where necessary to ensure that the pollutants contributed by industrial users do not pass through the POTW and violate water quality standards, and to prevent interference with POTW operations and sludge disposal practices. The National Combined Sewer Overflow (CSO) Policy is implemented as a component of the NPDES Permits for POTWs with CSOs. WVDEP has issued three Concentrated Animal Feeding Operation (CAFO) permits with no further permits currently under consideration. Activities administered by the Permitting Branch include regulation of industrial solid waste landfills, land application of sewage sludge, and developing wasteload allocations for new or expanding sewage treatment facilities. Table 10-1 (below) contains a list of permit applications processed from July 2015 through December 2020.

Table 10-1: WVDEP-DWWM-Permit Branch NPDES Permit Action Summary

	New Permits	Permit Modifications	Permit Reissues	Permit Transfers
Industrial	539	377	1335	126
Sewage Treatment	1322	1407	2530	324
Construction Stormwater	3079	814	427	69
Total	4940	2598	4292	519

In addition to permitting, compliance assessment and enforcement activities are coordinated between Permitting and Environmental Enforcement. Noncompliance, initially addressed by administrative actions to compel compliance, may include warning letters and, if necessary, progresses to notices to comply, enforcement orders, and/or referrals for civil action.

10.3 Nonpoint Source Control Program

The Nonpoint Source Program in WVDEP's Watershed Improvement Branch focuses on restoration and protection of streams from nonpoint source pollution. The program assesses nonpoint source impacts, then develops and implements watershed-based plans and projects designed to reduce pollutant loads from agricultural, silviculture, resource extraction, urban runoff, construction activities, and failing septic systems. Program initiatives are based upon education, technical assistance, financial incentives, demonstration projects, and enforcement, as necessary. The Nonpoint Source Program supports overall

administration and coordination of the nonpoint source activities through these participating state agencies: the West Virginia Conservation Agency, the Office of Oil and Gas, and the Division of Health and Human Resources. Specific activities are funded annually under the Nonpoint Source Program.

Many of the streams included on the state's list of impaired waters are affected by nonpoint sources. The majority of the Total Maximum Daily Loads being developed involve nonpoint source water quality impacts. To more effectively respond to TMDL implementation needs, the Nonpoint Source Management Plan was updated in 2000 to incorporate watershed management principles, including integration of TMDL and Watershed Management Framework scheduling. In addition to several plans currently under development, the Nonpoint Source Program has a total of 44 watershed-based plans, 32 of which have recently had, or currently have, active projects. These watershed-based plans, addressing a variety of nonpoint pollution sources, are in various stages of implementation. They are developed in cooperation with the stakeholders, including federal, state, and local government agencies within the watershed. As a result of these plans, numerous nonpoint source remediation projects for acid mine drainage, agriculture, streambank erosion, and dirt roads have been undertaken. The goal of the watershed-based plans is restoring the impaired streams to meet water quality standards. The successes to date emphasize the need to focus more resources on voluntary installation of best management practices in identified priority watersheds where local stakeholders are interested in making a difference.

10.4 Groundwater Program

Under the Groundwater Protection Act, West Virginia Code Chapter 22, Article 12, Section 6.a.3, DEP's Groundwater Program is responsible for compiling and editing information for a biennial report to the Legislature on the status of the state's groundwater and groundwater management program. WVDEP, the West Virginia Department of Agriculture, and the West Virginia Department of Health and Human Resources all have groundwater regulatory responsibility and contribute to the report. Along with these three state agencies, six standing committees currently share the responsibility of developing and implementing rules, policies, and procedures for the Ground Water Protection Act (1991): the Environmental Quality Board, the Groundwater Coordinating Committee, the Groundwater Protection Act Committee, the Groundwater Monitoring Well Drillers Advisory Board, the Well Head Protection Committee, and the Nonpoint Source Coordinating Committee. The biennial report provides a concise, thorough overview of those programs charged with the responsibility of protecting and ensuring the continued viability of groundwater resources in West Virginia. The current biennial report to the Legislature covers the period from July 1, 2015 through June 30, 2017. Copies of the report "Groundwater Programs and Activities: Biennial Report to the West Virginia 2018 Legislature" may be obtained by contacting the Groundwater Program at the Division of Water and Waste Management, 601 57th St., S.E., Charleston, WV 25304 or by calling (304) 926-0495. The report also may be reviewed at:

https://dep.wv.gov/WWE/Programs/gw/Documents/2018-04-09.%20Groundwater%20Biennial%20Report%20(002).pdf

The Ambient Groundwater Quality Monitoring Network was established in 1992 by the DWWM in cooperation with the USGS. The network provides critical data needed for proper management of West Virginia's groundwater resources. The major objective of this USGS study is to assess the ambient

groundwater quality of major systems (geologic units) within West Virginia and to characterize those individual systems. Characterization of water quality from the major systems helps to:

- determine which water quality constituents are problems within the state;
- determine which systems have potential water quality problems;
- assess the severity of water quality problems in respective systems; and
- prioritize these concerns.

The USGS and WVDEP have worked jointly on several groundwater monitoring efforts including monitoring sentinel wells and a wide variety of topical studies. All associated groundwater quality data for each well sampled and summaries of groundwater quality from the topical studies are published in the USGS Water Resources Data for West Virginia annual report.

10.5 Division of Mining and Reclamation

The mission of the Division of Mining and Reclamation (DMR) is to regulate the mining industry in accordance with federal and state law. Activities include issuing both NPDES and Surface Mining Control and Reclamation Act (SMCRA) permits for mineral extraction sites and related facilities, inspecting facilities for compliance, monitoring water quality, tracking ownership and control, and issuing and assessing violations. The DMR is responsible for the computer databases that track their regulatory activities - Environmental Resources Information System (ERIS) and Applicant Violator System (AVS, the federal OSM database). The Permitting unit is responsible for review permit applications for surface and underground coal mines, preparation plants, coal loading facilities, haulage ways, and coal-related dams. This unit also reviews permit applications for non-coal quarry operations (sand, gravel, limestone, etc.). Permit review teams staffed with geologists, hydrologists, engineers, and others are located in each regional office throughout the state and in the headquarters office.

The DMR's Inspection and Enforcement unit is responsible for inspecting all coal mining and quarry operations in the state. It enforces compliance through regular inspections and Notices of Violation; and it ensures site reclamation through final release of the operation. This unit is also responsible for civil penalty assessments, show cause proceedings, bond forfeiture and collection. The DMR's Program Development unit is responsible for implementing a proactive approach to policy issues, legislation, and training. This unit is designed to keep the DMR staff current with technological advances and to provide clear direction through development of cogent policy and guidance to meet legal and regulatory requirements. This unit provides regulatory interpretation and support to field offices, develops and updates handbooks and forms, drafts legislation, and initiates regulation changes. Other responsibilities of this unit include the Small Operators Assistance Program, public relations, special projects, employee training, and research of laws, regulations, and policy.

11.0 COST BENEFIT ANALYSIS

A true cost/benefit analysis on the economic and social costs and the benefits of water pollution control is a difficult and time-consuming task. Particularly, the evaluation of industrial facilities would be a monumental task considering the various types of industry (mining, chemical, power generation, etc.), each having a very different process of pollution control. However, the information contained in the following paragraphs provides an idea of the amount of money currently expended to construct and upgrade both the municipal facilities within the state, as well as programs available to homeowners wanting to correct failing onsite sewage systems.

WVDEP is responsible for administering a combination of state and federal funds expended for projects to improve water quality in State streams. The following narrative provides an overview of the programs within WVDEP's Division of Water and Waste Management that provide funding for water quality improvements and a summary of the funds dispersed between July 2015 and December 2020 to improve water quality.

11.1 Clean Water State Revolving Fund Program

The Clean Water State Revolving Fund (CWSRF) program is a funding program administered by the State Revolving Fund Section to address water quality problems through wastewater facility construction, upgrades, or expansions. The CWSRF Section is charged with general oversight, fiscal management, and technical and administrative compliance review of local governmental entities that receive funds and provides information and guidance on administrative actions needed to process a loan through the program. When a community has been recommended by the West Virginia Infrastructure and Jobs Development Council to seek CWSRF program funding for financial assistance, the community is contacted by a financial manager and project engineer. A meeting may be scheduled to advise the community leaders about the overall program requirements and specifically what they should do next to obtain a CWSRF loan. There are federal, state, and program requirements that must be met prior to scheduling a loan closing. The CWSRF currently has three financial assistance programs available. These three programs are described below.

Low Interest Loan Program

A low interest loan program for construction of municipal wastewater treatment works is available for municipalities and public service districts to build, upgrade, or expand treatment facilities and collection systems. Conventional loans with a repayment period of 20 years are available with an interest rate and annual administrative fee not exceeding 3.0% for certain communities. Loans with repayment periods from 21 to 40 years are available for disadvantaged communities where financial affordability is an issue. The interest rate and annual administration fee on these loans range from 2.0% to 0.5%. Based on meeting a variety of factors, communities can potentially receive forgivable loans for some of or possibly all of the project, in which there is no interest, administration fee or principal to be repaid. From July 2015 through June 2020, 166 wastewater treatment facility loans totaling approximately $285,300,000.00 were funded.

Agriculture Water Quality Loan Program

The Agriculture Water Quality Loan Program is a partnership with the West Virginia Conservation Agency developed to address pollution from nonpoint sources using Best Management Practices approved by the U.S. Environmental Protection Agency. CWSRF money is loaned to participating banks so they can offer below market rate low interest loans to qualifying applicants. Additional information is available from local Conservation District offices, http://www.wvca.us/map.cfm. From July 2015 through June 2020, no nonpoint source agriculture BMP loans were funded. Efforts are being made by CWSRF staff to increase participation in this program; however, it is difficult to compete with other non-loan / grant sources, unless this is used to leverage a match requirement.

Onsite Systems Loan Program

In cooperation with the West Virginia Housing Development Fund and Safe Housing and Economic Development office (Welch, WV), a low interest loan program has been established to address onsite sewage disposal problems. The "Onsite Systems Loan Program" provides loans to replace malfunctioning septic systems and to install new onsite sewage systems for homes that have direct sewage discharges to ditches and streams. Centralized treatment for these homes will not be available in the next five years. For the current reporting period of July 2015 through June 2020, a total of $1,278,141.00 in pass through funding was provided to the two agencies.

11.2 Cost Benefit Analysis Conclusion

Although it may be difficult, or even impossible, to fully quantify costs and benefits of water pollution control measures, WVDEP recognizes that multiple millions of dollars are expended annually by businesses, municipalities, and private and public entities (including state and federal agencies) to improve and maintain water quality in West Virginia. These expenditures address pollutants from various media, including solid and hazardous waste, air, and water.

12.0 PUBLIC PARTICIPATION AND RESPONSIVENESS SUMMARY

The draft Section 303(d) List was advertised for public comment on April 14, 2022. A press release announced the availability of the draft document and request for public comments. The draft document was also promoted via e-mail and the Internet. The public comment period extended from April 14, 2022 to June 1, 2022. The WVDEP considered all comments and modified the Integrated Report and 303(d) list as appropriate to make corrections and add clarification. Comments have been compiled and responded to in this summary.

Public comments were received from West Virginia Rivers Coalition (co-signed representatives of Appalachian Mountain Advocates, New River Conservancy, Upper Potomac Riverkeeper, West Virginia Council of Trout Unlimited, West Virginia Environmental Council, and West Virginia Highlands Conservancy), West Virginia Coal Association (WVCA), John Maxey, representing the Blue Ridge

Watershed Coalition, Randy Kelsing (Clarksburg, WV), Amy Piedrahita (Harpers Ferry, WV), Aileen Curfman, and Margaret Didden (Shepherdstown, WV). In addition, public comments were received from 104 individuals (Table 12-1) through a West Virginia Rivers Coalition campaign. The campaign provided commenters with a sample letter. The contents of the individual letters were reviewed, and substantially different comments were addressed, separately. The WVDEP appreciates the efforts commenters have put forth to improve West Virginia's listing process. Comments and comment summaries are bold and italicized. Agency responses appear in plain text.

Table 12-1. Participants in WV River Action Network Campaign

Name	City	State
Adam Johnson	Morgantown	WV
Amy Cimarolli	Davis	WV
Andrew Wagner	Fayetteville	WV
Art Glick	Renick	WV
Ashly Bargman	Renick	WV
Barb Johnson	Harpers Ferry	WV
Barbara Brown	Morgantown	WV
Barbara Howe	Morgantown	WV
Becky Romine	Lewisburg	WV
Bill Quigley	Morgantown	WV
Bradley Riffee	Alum Bridge	WV
Carole Williams	Morgantown	WV
Carrie Kline	Elkins	WV
Carroll Bassett	Frankford	WV
Charles Brabec	Canvas	WV
Charles Walburn	Hedgesville	WV
Cheyenne Carter	Thomas	WV
Chris Asmann	Fort Spring	WV
Chris Benison	Morgantown	WV
Chrissy Zeitner	Bruceton Mills	WV
Christina Melocik	Charles Town	WV
Chuck Wyrostok	Spencer	WV
Clara and Robert Halfin	Parsons	WV
Connie Dale	Waverly	WV
Constance Dowrick	Berkeley Springs	WV
Danielle Stewart	Beckley	WV
David Bott	Morgantown	WV
David Brisell	Bruceton Mills	WV
Debbie Naeter	Frankford	WV
Diana Green	Charleston	WV
Diana Greenhalgh	New Milton	WV
Diana Mullis	Hedgesville	WV
Don Sauter	Bruceton Mills	WV

Name	City	State
Doug Krause	Charleston	WV
Duane Nichols	Morgantown	WV
Eddie Fletcher	Williamsburg	WV
Edward Lynch	Wellsburg	WV
Elizabeth Hastings	Harpers Ferry	WV
Emily Dragon	Shenandoah Junction	WV
Eric Hopkins	Morgantown	WV
Erin Graber	Westover	WV
Franklin Anderson	Nitro	WV
Franklin Crabtree	Union	WV
Fred Reiniger	Oak Hill	WV
Jake Bolen	Huntington	WV
James Webb	Shenandoah Junction	WV
Jamie Shinn	Morgantown	WV
Jennifer Baker	Lewisburg	WV
Jerry Bowles	Lewisburg	WV
Jerry Carson	Cross Lanes	WV
Jim Hatfield	Saint Albans	WV
Jodi McMillian	Charleston	WV
Joe McMurray	Rock Cave	WV
John Doyle	Charleston	WV
John Elliot	Buckhannon	WV
John Rossbach	Elkins	WV
Judith Clark	Dunmore	WV
Judith Clister	Bruceton Mills	WV
Judith Smallwood	Lewisburg	WV
Kara Cox	Scarbro	WV
Kelley Sills	Greenville	WV
Kimberly Dilts	Cass	WV
Kirk Bottner	Shepherdstown	WV
L.Leon Okes	Parkersburg	WV
Leslie Devine-Milbourne	Berkeley Springs	WV
Lisa Payne	Harpers Ferry	WV
Margaret Davis	Rock Cave	WV
Margaret Stange	Fayetteville	WV
Maya Nye	Morgantown	WV
Melissa Shafer	Bruceton Mills	WV
Michael Klausing	Nitro	WV
Michael Meadows	Hillsboro	WV
Nancy Abrams	Morgantown	WV
Naomi Cohen	Gap Mills	WV
Neil Randolph	New Cumberland	WV

Name	City	State
Nicole Forrester	Davis	WV
Pamela Cubberly	Morgantown	WV
Pamela Ruediger	Parsons	WV
Patricia Huffman	Point Pleasant	WV
Patti Miller	Berkeley Springs	WV
Paula Hunt	Morgantown	WV
Phil White	Charleston	WV
Richard Williams	Fairmont	WV
Robert A. Mertz	Spencer	WV
Robert Skeen	Charleston	WV
Robert Stanley	Saint Marys	WV
Ronda Lehman	Harpers Ferry	WV
Sally Roberts Wilson	Morgantown	WV
Sarah Cross	Elkins	WV
Sarah Phillips	Inwood	WV
Shawn Romano	Charleston	WV
Stephanie Goettge	Morgantown	WV
Steven Runfola	Morgantown	WV
Steven Bodnar	Williamstown	WV
Sue Covello	Middleway	WV
Susan Sailer	Morgantown	WV
Suzanne Vance	Weston	WV
Teresa Sopher	Beckley	WV
Timothy Simmons MD	Charleston	WV
Toby Garlitz	Lewisburg	WV
Tom Degen	Chloe	WV
Tom France	Ronceverte	WV
Vivian Stockman	Spencer	WV
William Turner	Lewisburg	WV

Commenters expressed concern that the last approved 303d list was 2016, stating that the lists serve as a resource for WV agencies, consultants, and organizations working in conservation. Commenters accurately cited 40 C.F.R. 130.7(d) requiring the Integrated Report submission on even numbered years. However, commenters inaccurately interpreted the delay in the 2018 and 2020 303(d) lists and Integrated Reports as creating a backlog of streams in need of restoration that are not receiving attention.

WVDEP acknowledges the delay of the 2018 and 2020 cycle Integrated Report represents a temporary inability to meet the expectation of submitting a 303(d) list and report on a two-year cycle. It is a considerable challenge for the WVDEP to accomplish biennial 303(d) listing requirements. Often, USEPA approval is received with limited time prior to the next list being due. Since the EPA approval validates the listing methodology it informs the protocols that will be deemed acceptable in the subsequent list. The

USEPA did not approve of the 2016 303(d) List until February 4, 2019. Assessment efforts for the 2018 and 2020 lists began in earnest after that letter was received. In addition, delays in releasing a draft integrated reports for the 2018 and 2020 cycles, largely were the result of converting the WV assessment unit schema to one that could remain static from year to year, making reporting in the USEPA ATTAINS possible. The previous strategy for segmenting streams resulted in changes to delineations, reach descriptions, and assessment unit identifiers each year.

To further complicate this process the USGS through the WVGES released a revised National Hydrography Dataset (NHD) streamline layer in 2018. Months-long efforts to convert the assessment unit schema to the NHD streamline layer had to be repeated with the new release. WVDEP anticipates this one-time conversion to the new assessment unit delineations will provide an opportunity to assess data more efficiently for future rounds. (See the following comment/response for more details.)

The choice to provide a combined 2018/2020/2022 list was a solution to release information as efficiently as possible by assessing and reporting on three cycles of data in one effort. During this effort, WVDEP's commitment to monitoring, assessing, and preparing restoration plans (i.e., TMDLs) remained and the delays in the release of an Integrated Report did not result in a delay in TMDL development.

Most new 303(d) listings in any assessment cycle are the result of extensive pre-TMDL monitoring efforts prior to the development of a TMDL. These data are assessed and TMDLs are prepared for impaired streams, independently of the 303(d) list. The TMDL public engagement process allows stakeholders an opportunity to comment on the status of the streams. After a TMDL is approved, some streams identified as impaired based on pre-TMDL monitoring remain in Category 5 (i.e., in need of a TMDL). Those streams remain when no TMDL was presented to resolve impairment in the TMDL project. Most often those are for conditions not allowable – biological where current pollutant TMDLs do not resolve the stressor to aquatic life. To illustrate this point, there are 590 assessment units/pollutant combinations first listed on the 2018/2020/2022 303(d) lists that do not have approved TMDLs. The majority of these will be addressed in TMDLs currently in development for the Tug Fork River and Little Kanawha River watersheds. There are 1,724 assessment unit/pollutant combinations that were identified as impaired after the completion of the 2016 303(d) list for which pollutant TMDLs have been approved and added to Category 4a. In conclusion, a delay in the release of an Integrated Report or 303(d) List did not delay ongoing efforts to develop TMDLs for impairments.

Commenters expressed concerns that the new strategy for delineating assessment units and format of the 303(d) List and Integrated Report make it difficult to compare lists from 2016 to the combined 2018/2020/2022 list and asked that WVDEP provide a way to compare the lists.

Commenters are correct that comparing the two lists is difficult because of the change in the assessment unit delineations and coding systems. This drawback was weighed against the need to establish an assessment strategy that would allow WVDEP to report data in the USEPA ATTAINS. Delineating static assessment units provides an opportunity to consistently report on water quality in the future. WVDEP utilized the NHD 1:24,000 streamline layer to delineate the assessment units, providing a coding system at a finer resolution than the previous systems that was originally based on a 1:100,000 resolution. WVDEP, as well as USGS, relies on the NHD streamlines for presenting data such as flow. Using a finer scale GIS to provide a consistent stream code has been a goal for several years. The transition has been a

difficult endeavor and WVDEP is committed to presenting data in such a way that stakeholders can stay abreast of the State's water quality.

A crosswalk table, "WV 2016_2022_AUID_Crosswalk_Final" was prepared to help compare the 2016 assessments to the combined 2018/2020/2022 assessment unit identifiers. This crosswalk table was provided in the Draft Supplemental Tables on the WVDEP website:

https://dep.wv.gov/wwe/watershed/ir/pages/303d_305b.aspx

In response to comments, to aid reviewers and the public in determining if the status of a stream segment has changed, the "Overall IR Category" has been added to the crosswalk table for both listing cycles. To learn more about the overall IR category see Section 5.0 of the Integrated Report. In addition, the Integrated Report provides summaries of impairments in tables referred to as "Designated Use Support Summary for West Virginia Streams". These can be compared to similar tables in the 2016 Integrated Report. The mileage and acreage of streams and lakes are presented in the summary tables, so one can compare those to understand the status of the water quality in the state.

Lastly, when considering specific parameter categories, in the absence of new data providing evidence to the contrary, stream reaches that were impaired in the 2016 303(d) list remained impaired in the Combined 2018/2020/2022 Integrated Report. New impairment listings, for each of the combined years can be viewed in the Supplemental Table- "Combined Cycle 303(d)_List", by filtering on "First Listed" column on any tab.

Commenters inaccurately asserted that the new format introduced "5 different categories" for impaired streams.

Since the 2004 Integrated Report, assessed streams have been assigned into one of five Integrated Report categories as they are in the Combined 2018/2020/2022 Integrated Report. The definitions and criteria for categorizing have remained the same.

Commenters expressed concern that 85% of the stream segments do not have the data necessary to assess the health of those streams and called for WVDEP to allocate more resources toward assessments.

WVDEP described the changes in the assessment unit delineation and specifically the decision to adopt a finer scale streamline layer in the new assessment schema in Section 1.0 of the Integrated Report. A depiction of the difference in streamline layer is provided in Figure 1-1. The finer resolution streamline layer results in many more streamlines to code. In reality, the number of streams and amount of water has not changed in the State of West Virginia since the 2016 Integrated Report. The only change is that in the new assessment unit schema, WVDEP will be accounting for tens of thousands of more stream miles that were not mentioned previously.

While the depiction of the State's unassessed waters has changed, the commenters' assertion that WVDEP lacks the data to determine the health of WV waters is inaccurate. Since the creation of the Watershed Assessment Branch in 1996, WVDEP has collected more than 98,000 samples from more than 10,000 monitoring locations throughout the state. Also, thousands more data are available from monitoring efforts prior to 1996, with monitoring data dating as far back as 1946. The data collected through

monitoring programs gives WVDEP the ability to evaluate the water quality of the state, even when samples are not collected directly from every assessment unit. For instance, as described in the Section 3.0 of the IR, all major rivers and many large streams have ongoing monitoring that can be used to monitor the overall health of their watersheds through the Ambient and Long Term (LTMS) monitoring programs (Figure 12-1).

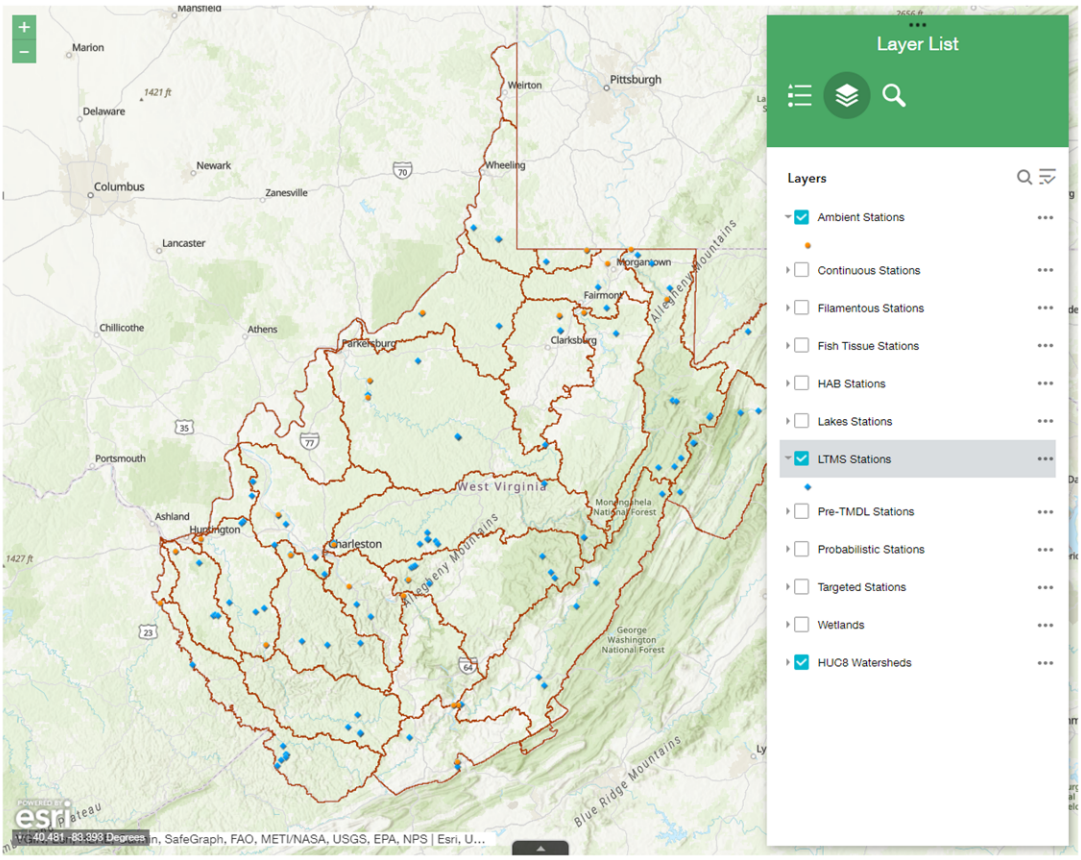


Figure 12-1: Screenshot from the Integrated Report StoryMap showing the Ambient and Long Term (LTMS) monitoring locations.

In addition, while it is infeasible to assess every small tributary, the probabilistic program is designed specifically to make scientific determinations about the water quality throughout the state (Figure 12-2). Section 7.0 of the Integrated Report provides a summary of the probabilistic data. Lastly, even if not directly monitored, the water quality of tributaries is considered when downstream impairments are studied for TMDL development. Comprehensive TMDLs for major watersheds include pollutant sources (e.g., landuses, permits, etc.) that contribute pollutants to any tributary in the watershed. Watersheds are split into smaller "subwatersheds", the finest unit of the TMDL modeling effort. Figure 12-3 illustrates the resolution of the subwatershed divisions in the TMDL watersheds and specifically in the Lower Guyandotte River watershed. There are 543 subwatersheds represented in the Lower Guyandotte TMDL model. The subwatershed is characterized in the modeling, including upland and instream parameters that influence the water quality. Reductions of pollutant sources are prescribed throughout a watershed to the extent necessary to attain the water quality standards at each subwatershed pour point (i.e., furthest downstream point), as well as to provide assimilative capacity for downstream impairment. Reductions

are prescribed for both permitted and non-point sources of pollution. TMDL watershed modeling has represented the permitted and non-point sources in approximately 80% of the State. As a result, even if monitoring has not occurred directly on all tributaries, load reductions have been prescribed in a "top-down" process that when implemented will ensure protection and attainment of water quality standards throughout the watershed.

Many of the assessment units for which monitoring, assessments and TMDLs have not been completed are largely in areas where there are few anthropogenic impacts, such as the national forest lands. Figure 12-4 provides a screenshot of the pre-TMDL monitoring stations from the Integrated Report StoryMap.

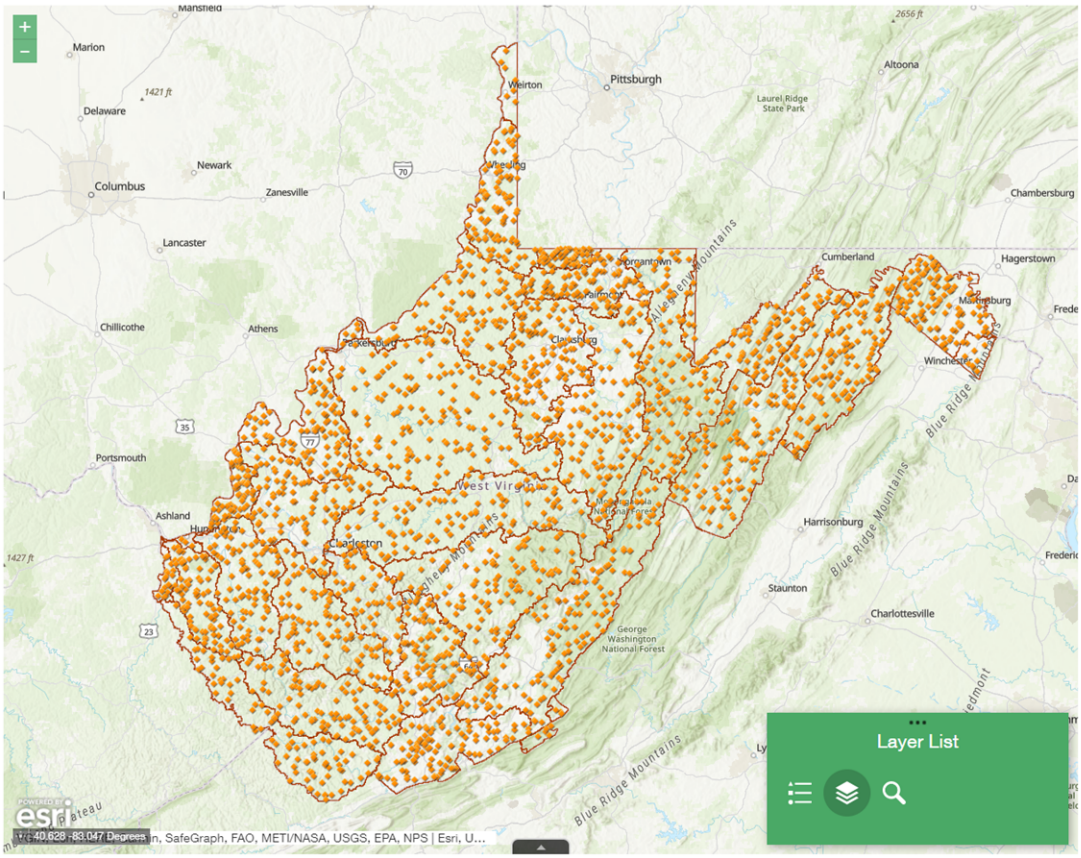


Figure 12-2: Screenshot from the Integrated Report StoryMap showing the Probabilistic monitoring locations.

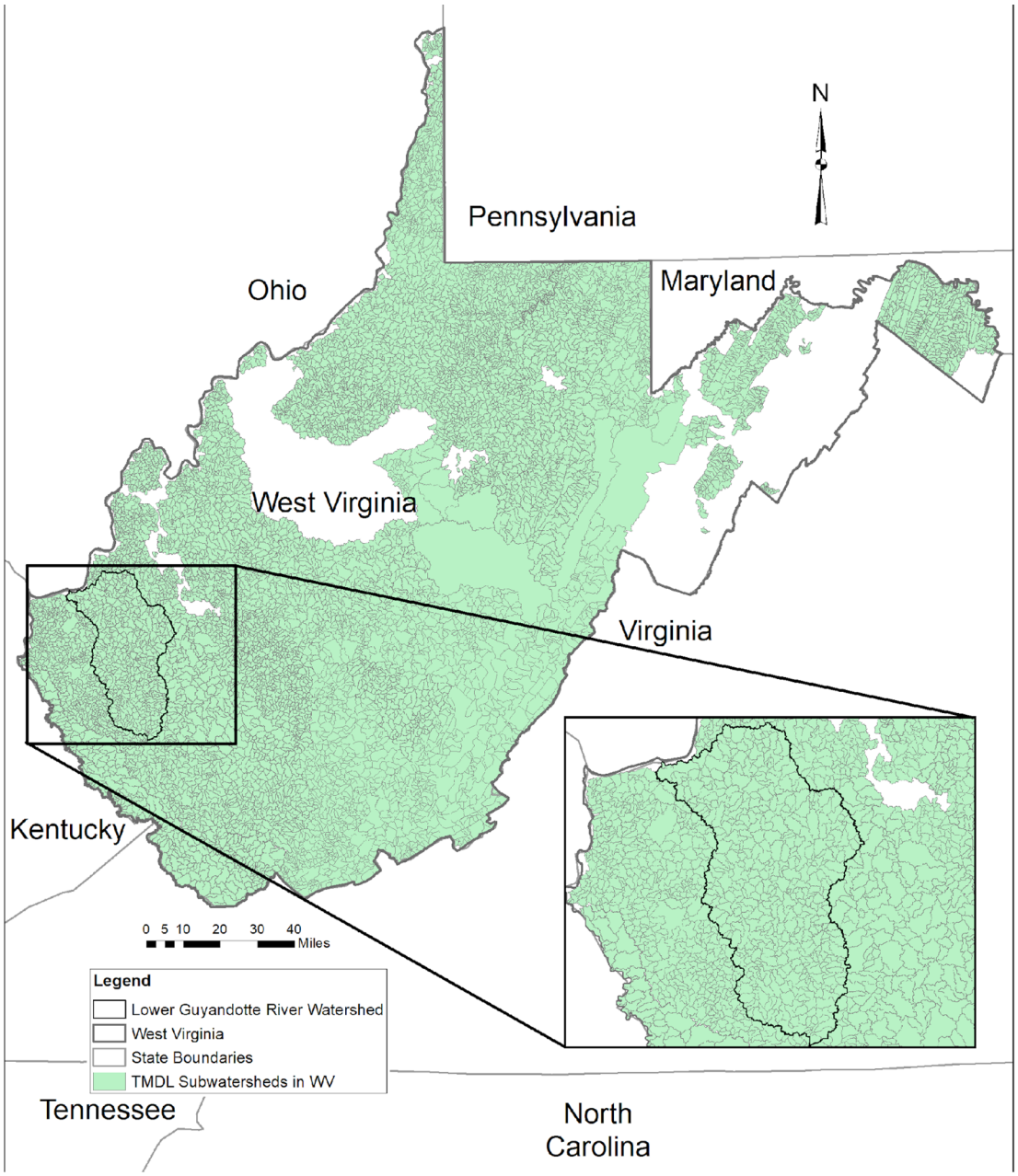


Figure 12-3: Illustration of the subwatershed delineations of comprehensive TMDLs, highlighting Lower Guyandotte watershed.

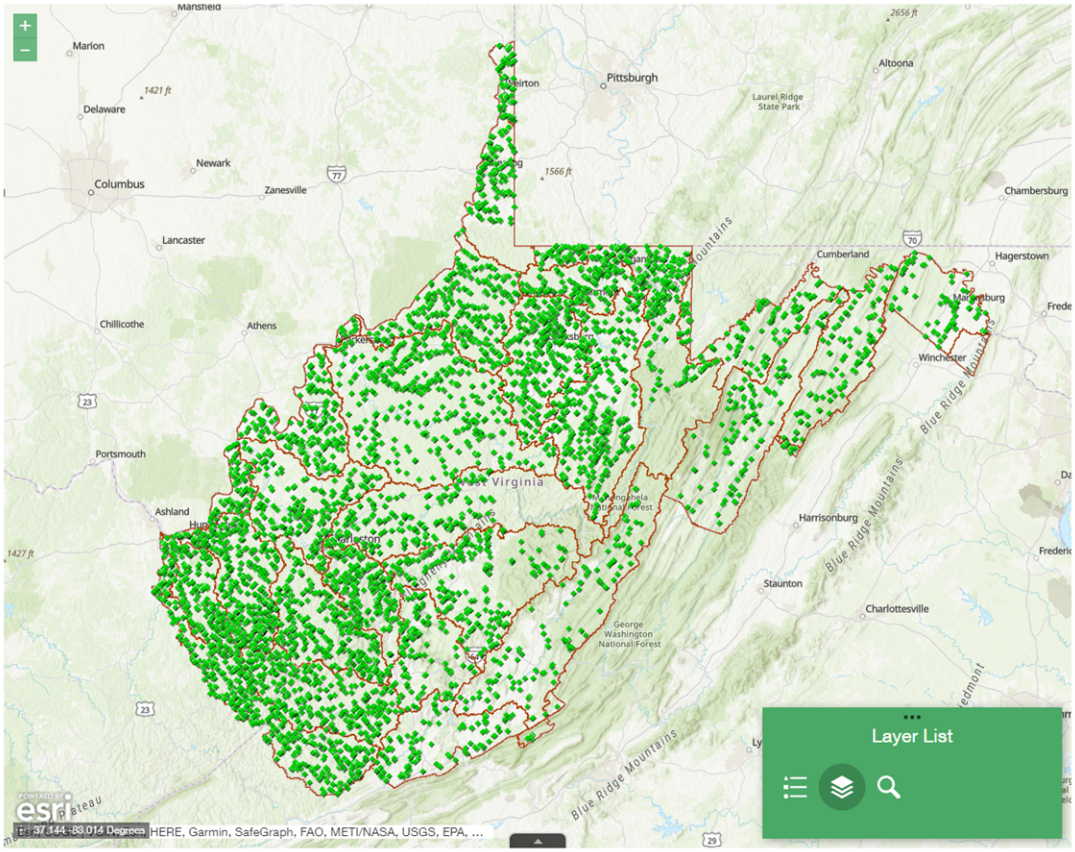


Figure 12-4: Screenshot from the Integrated Report StoryMap showing the pre-TMDL monitoring locations.

Commenters inaccurately characterized a data cutoff date in the assessment procedure as a failure of the WVDEP to use all existing and readily available data, stating "By ignoring at least a year's worth of available data, the agency is in direct conflict with the plain language of 40 C.F.R. 130.7(d) which requires it to use "all existing and readily available data."

It is not practicable to assess and report on data in real time for the purposes of the Integrated Report; thus, a data cutoff must be established. Historically, WVDEP has used a cutoff date based on the pre-TMDL monitoring period ending on June 30 on the odd numbered year prior to the Integrated Report submissions. For instance, the cut-off date for the 2016 303(d) list was June 30, 2015. The months between the cut-off date and submission of a final Integrated Report are needed to conduct a quality assurance check of 100% of the data, assess data, publish the 303(d) list for public comment, to respond to comments, and load data to the USEPA ATTAINS database.

USEPA establishes guidance each cycle for the Integrated Report through a memorandum. In the "*Information Concerning 2022 Clean Water Act Section 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions, signed March 31, 2021*", USEPA explain that State can establish a reasonable "cut-off" date (e.g., a deadline for submittal of the data and information or public comment opportunity) as a useful approach for timely completion of an integrated report. The guidance goes on to state that if a "cut-off" date

is established, a state should clearly explain that data and information submitted after that date would be considered during the next listing cycle.

To be clear, data collected after December 2020 will be assessed for the 2024 cycle Integrated Report. The 2024 cycle "cut-off" date will likely be June 30, 2023, the end of the pre-TMDL monitoring period.

Commenters quantified the number of streams segments added to the combined 2018/2020/2022 303(d) list, as well as the number of impaired stream miles with and without TMDLs, as evidence that the WVDEP must dedicate more resources toward TMDL implementation to make sure pollution reductions are being met.

TMDLs are implemented through permitting and non-point source programs at the WVDEP. Implementation of TMDL WLAs in reissued permits is required through federal law (40 CFR §122.44 (d)(1)(vii)(B)). Implementation of load allocation is achieved through voluntary participation and supported through federal funding authorized by the Clean Water Act Section 319. The Division of Water and Waste Management Watershed Improvement Branch oversees the Section 319 funding program for the WVDEP. WVDEP staff regularly collaborate to support efforts of watershed associations by providing training to citizen scientists, interpretation of TMDLs, resources for writing watershed-based plans, and additional water quality monitoring.

In addition, WVDEP Watershed Assessment Branch staff are tasked with TMDL effectiveness monitoring in waters where TMDL implementation has occurred. Plans are underway to identify point and nonpoint source projects carried out by permittees, watershed associations, and partnering agencies, to focus future monitoring program efforts. The general expectation is that water quality has improved in those waters affected by the implementation.

Commenters reiterated comments provided for the Water Quality Standards triennial review process relative to trout waters. Commenters specifically ask for an updated list of trout waters to ensure they are receiving the proper protections and for a streamlined process to allow for identification and listing of future trout waters. Commenters recommend forming a workgroup comprised of representative members of the WV Wild Trout Collaborative and other scientists with specialized expertise in trout. In informal communications, commenters also asked that the Integrated Report StoryMap provide a GIS layer of trout waters and expressed concern that a known trout stream, Big Run of North Fork of South Branch Potomac (NHD: WV-PSB-105-CT) was not represented accurately in the Integrated Report.

WVDEP investigated the status of Big Run (NHD: WV-PSB-105-CT) and found that an error occurred in the NHD streamline layer for Assessment Units that resulted in it being categorized with a Warm Water Fishery use. The error was corrected and the uses for all documented trout streams were reviewed for accuracy. The Integrated Report StoryMap provides GIS layers of the uses for assessed waters. For practical reasons, unassessed stream reaches are segregated into an "unassessed" GIS layer in the StoryMap. Two resources exist to view trout status in the state. One being the "WV_IR_Category_DesignatedUse_Final" spreadsheet provided as a Supplemental Table to the Integrated Report. The spreadsheet provides the uses for all assessment units in the state and details for uses that are fully supported and not supported. Column K "Trout Waters" can be filtered for data (removing blanks) to see the assessment units considered trout in the assessment process. A second

resource for trout streams is the GIS layer provided on the WV TAGIS map application at: https://tagis.dep.wv.gov/wvdep_gis_viewer/. The trout layer provided there is described as: *This layer includes streams from WQ Standards Appendix A; streams that are known to support year-round sustaining trout populations; and streams suspected of supporting year-round trout populations. These 'suspected trout' streams are the target of future studies that aim to confirm their proper classification in regards to Water Use Category B (B1 - warm water fishery streams or B2 - Trout Waters).*

WVDEP continues to coordinate with the WVDNR and other stakeholders to determine whether streams should be categorized as trout waters. Streams under investigation may have updated uses in the 2024 Integrated Report. In response to comments pertaining to trout waters during the agency's triennial review of the water quality standards, the WVDEP has instigated a workgroup to evaluate the definition of trout water and the process for identifying this designated use.

Several commenters shared personal efforts to educate/protect themselves and other, specific instances of pollution, and pointed out the importance of the State's water resources to aquatic life, wildlife, human health, recreation, and tourism. Commenters asked WVDEP to prioritize these resources and uses when considering permits for expansion of housing developments and industry.

WVDEP appreciates receiving comments from stakeholders who personally invest in and enjoy the State's water resources. We encourage continued engagement, including participation in local watershed associations. For additional information on joining, creating, or supporting a local watershed association, contact basin coordinators of the Watershed Improvement Branch. Search for Watershed Basin Coordinators at the WVDEP main website for further information.

One commenter asked to add Second Big Run of Oil Creek of the Little Kanawha River (NHD: WV-OLK-177-H), in Lewis County WV, to the list of impaired streams, citing conditions in the stream due to disturbance during the construction of the Mountain Valley Pipeline.

WVDEP Environmental Enforcement staff have responded to the conditions shared in this comment.

At this time, no data have been directly collected from Second Big Run by the Watershed Assessment Branch monitoring section. Even so, Second Big Run is a tributary to Oil Creek where impairments are listed for total iron and fecal coliform. These impairments are included in an ongoing project to develop TMDLs for the Little Kanawha River watershed. While Second Big Run will not have a specific TMDL equation written, reductions to pollutant sources in the Second Big Run watershed will be prescribed to address the downstream impairment in Oil Creek.

A commenter expressed understanding for delays created in part by the pandemic but expressed concern that the delays with the integrated report prevents seeking federal funding to restore impairment in seven tributaries to the Shenandoah River in Jefferson County, WV. The commenter cited a target TMDL date of 2023 from the 2016 303(d) for this watershed. This commenter, along with a second commenter, referencing the Jefferson County drainage to the Shenandoah River, pointed out the importance of the tributaries and the Shenandoah River to the region.

The WVDEP has prioritized tributaries referenced in this comment for additional sampling to obtain data for use in the calibration of a TMDL model. The decision to include these streams was made while planning the pre-TMDL monitoring effort in the eastern panhandle after contemplating how best to

approach a TMDL project for these tributaries. Development of a TMDL for the streams will provide the foundation for seeking federal grants. WVDEP appreciates the efforts of all citizen scientists and particularly those who advocate for the tributaries to the Shenandoah. The commenters pointed out that they have monitored some streams for 10 years, which is a monumental accomplishment. WVDEP looks forward to supporting future efforts to seek federal funding through the CWA Section 319 program.

Aquatic Life Assessment

Numerous and opposing comments were received in response to the agency's approach to listing biological impairments pursuant to the narrative water quality criterion at 47 CSR 2-3.2.i. The remainder of this responsiveness summary applies to this broad issue. The WVCA referenced their comments for the 2010 and 2012 303(d) List, dated May 19, 2010, and June 26, 2012, respectfully; and requested that they be considered. Comments that were repeated in the previous WVCA comments were consolidated to avoid redundancy. Comments pertaining to specific listing decisions for the 2010 and 2012 303(d) were not addressed in this responsiveness summary. Those comments were summarized and addressed in previous integrated reports. Throughout this section the Aquatic Life Assessment and Biological Stressor Identification Procedure is referred to as the "assessment procedure". The full assessment procedure can be reviewed in Appendix A.

Commenters assert that the zones of uncertainty are statistically and scientifically unsupported and weakens the WVSCI. Commenters describe the assessment procedure when WVSCI scores are between 61 and 72, comparing the zone of uncertainty to a gray zone used by WVDEP up until the 2012 303(d) over-list by the USEPA. Commenters quoted the USEPA rationale for disapproving of a portion of WV 2012 303(d) relative to biological impairments and specifically rejecting the gray zone.

The zone of uncertainty between WVSCI 61 and 72 is not comparable to the gray zone used by the WVDEP in biological assessment prior to the 2012 WV 303(d) listing action from the USEPA. The difference comes in the presence of a protocol to collect additional data and the use of genus level data as an arbiter in the assessment decision. If a WVSCI score is between 61 and 72, a second benthic macroinvertebrate sample is collected and scored. If the second WVSCI score is between 61 and 72, the genus-level IBI percent threshold score of <100, if available, is used to determine impairment. This protocol was not used in the application of the original gray zone (i.e., 60.8-68 prior to 2012); thus, assessment units would remain in the gray zone perpetually.

Commenters point out that using a 5th percentile to set the attainment threshold allows for very few false positives (i.e., healthy streams that are rated as impaired).

A substantial portion of West Virginia is covered by forest both on private and public landholdings. This has afforded WVDEP the opportunity to sample and assess many high-quality streams with excellent water quality and habitat conditions. Hence, there is a high degree of confidence in the quality of statewide reference samples used to establish the statewide 5th percentile attainment threshold.

Commenters inaccurately described the assessment procedure to include averaging two scores taken within five years to obtain a score that may result in an impairment determination.

The assessment procedure does not rely on averaging WVSCI scores at any point, as is demonstrated in Figure 12-5 taken from Appendix A: Aquatic Life Use Assessment and Biological Stressor Identification Procedure shown again below.

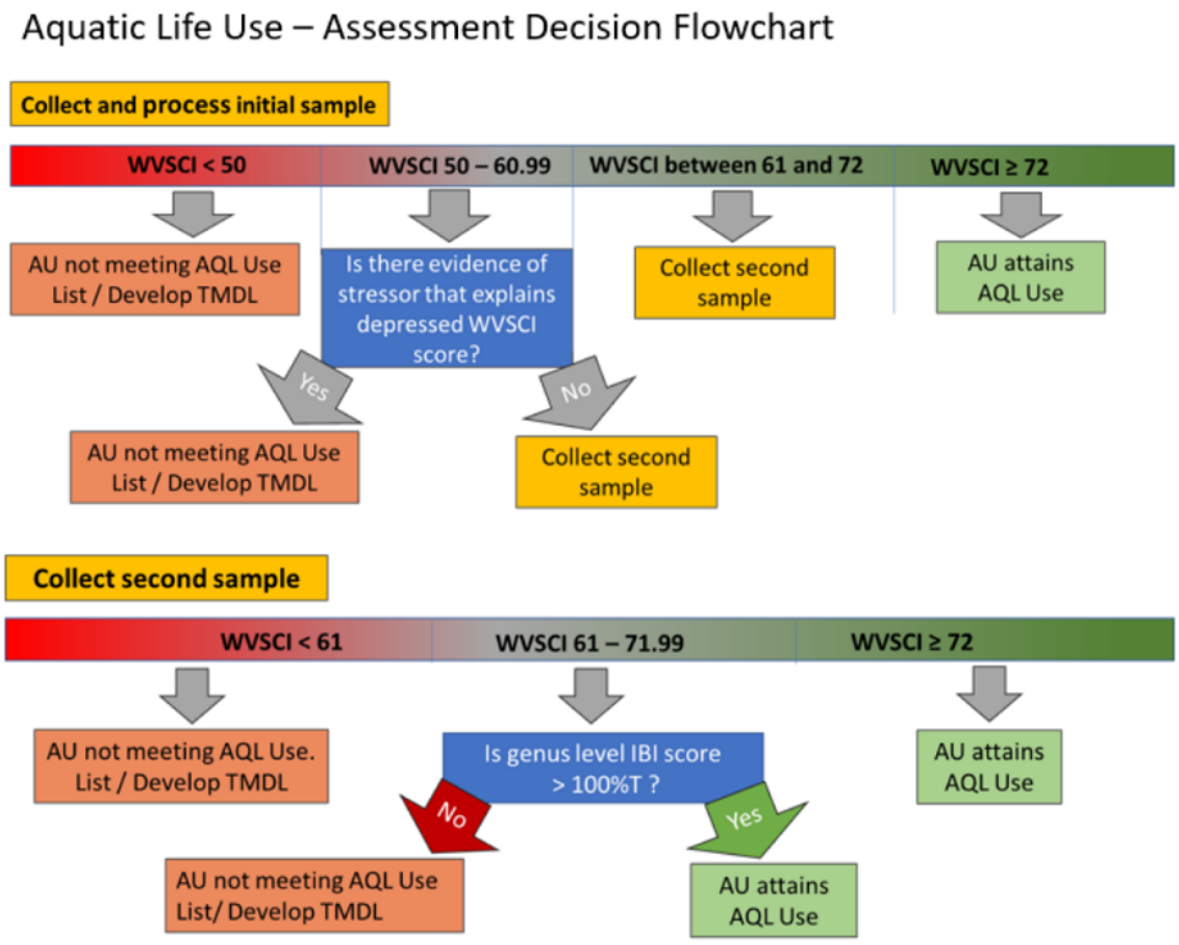


Figure 12-5: Aquatic Life Use- Assessment Decision Flowchart.

A commenter stated that the WVSCI is an inappropriate mechanism for assessing narrative criteria because it has not been promulgated as a water quality standard by the West Virginia Legislature and has not been subject to public notice and comment. The commenter contends that the same observations are true with respect to the Genus Level Index of Most Probable Stream Status (GLIMPSS).

Similarly, other commenters opposed the use of WVSCI, but did so based on their assertion that WVDEP has not articulated any reasonable basis for failing to replace the outdated WVSCI with the GLIMPSS. These commenters provided a summary of historic recommendations and actions from the USEPA, quoting letters including, the actions to the partial disapproval of the WV 2014 303(d) List and subsequent approval of the WV 2016 303(d) List, both of which WVDEP relied on WVSCI scores to carry out biological assessment. Commenters explain that the 2016 approval of a WVSCI-based

assessment was based on the rationale that GLIMPSS had too few available reference data for a specific region during one season. Commenters argue that the number of reference sites in one region for one season in GLIMPSS would be fewer than the number of reference sites for the entire state using WVSCI, because by design the reference samples are segregated. Commenters also point out that there were 729 reference samples used for GLIMPSS statewide compared to 641 samples used in the recalibrated WVSCI IBI.

The basis for biological impairment listings is the narrative water quality criterion at Title 47 Series 2 Section 3.2.i of the Code of State Rules, which prohibits significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems. This narrative criterion is a valid water quality standard that was promulgated by the West Virginia Legislature and approved by the EPA. Under the Clean Water Act and implementing regulations, the WVDEP must assess State waters with respect to attainment of water quality standards via comparison of available information to both numeric and narrative water quality criteria. The WVDEP initiated biological integrity assessments in the 1998 Section 303(d) list. An index of biological integrity (IBI, e.g., WVSCI, GLIMPSS) was first used in the 2002 Section 303(d) listing process and has remained as an integral component of all subsequent 303(d) lists. The WVDEP's position has not changed relative to its responsibility to list waters where available data indicates significant adverse impact to their biological components. Furthermore, list approval by the USEPA is expected to be contingent upon our continued implementation of either the WVSCI IBI or GLIMPSS IBI.

The WVSCI was specifically designed to accomplish assessment with respect to the 47CSR2 - 3.2.i criterion. It was developed for the USEPA and the WVDEP by national experts in the assessment of biological integrity through the evaluation of benthic macroinvertebrate communities. It is similar to the multi-metric indices used by many states and its component metrics are both validated and widely used nationally when assessing biological health of aquatic systems. As to the complaint that the use of WVSCI has not been subject to the public notice and comments, prior to the 2018/2020/2022 303(d) effort, the WVSCI has been applied in eight West Virginia Section 303(d) lists and each of those processes included public notice and comment provisions.

As to the complaint that WVDEP has failed to replace the WVSCI with the GLIMPSS, it is the position of the WVDEP that the existence of a genus level IBI does not discount the validity of the WVSCI. The agency has consistently relied on the WVSCI to assess the narrative water quality criteria since 2002. The decision was made to remain consistent with historical decisions, considering input from all stakeholders, including those who oppose using the WVSCI and GLIMPSS to measure the narrative water quality standard for aquatic life. When WVDEP was charged by legislative action to develop a new rule to interpret biological data, WVDEP was able to achieve an assessment procedure that allows the agency to focus resources on streams where impairment of the narrative water quality criterion for biological condition is clearly demonstrated through the WVSCI. The assessment procedure allows the use of genus-level data as an arbiter, when two WVSCI scores for an assessment unit are between 61 and 72 to allow a final listing determination to be made.

In a comment regarding the 2010 303(d) list, a commenter contended that the WVDEP's sole reliance on the WVSCI methodology constitutes an improper evaluation of the overall biological integrity of an

aquatic ecosystem which requires a more comprehensive assessment to include habitat and fish populations.

WVSCI is an IBI for benthic macroinvertebrates. Benthic macroinvertebrates are aquatic life and afforded Clean Water Act protection. Failing WVSCI scores indicate nonsupport of the aquatic life designated use and nonattainment of the narrative criterion at 47CSR2-3.2.i. Under WVSCI, benthic macroinvertebrates are evaluated to determine the balance of the aquatic community. Multiple metrics measure species diversity, with favorable scores indicating the community "is diverse in species composition" and "the aquatic community is not composed of only pollution tolerant species." Favorable scores also demonstrate assemblages that are sufficient to perform biological functions necessary to support fish communities. Following the passage of Senate Bill 562 in 2012, the WVDEP attempted to develop a fish IBI for West Virginia waters, but was unsuccessful, partially due to too little fish data. WVDEP continues to collect fish data throughout the State with the desire to prepare a Fish IBI at some point. Even so, while a fish IBI may be useful in non-wadeable streams or other habitats that do not support the WVSCI protocol, fish community assessment is not a prerequisite or substitute for benthic macroinvertebrate assessment in habitats that support the WVSCI protocol. WVSCI assessment indicating non-attainment provides evidence of ecosystem imbalance and adverse impact to higher trophic level organisms. The WVDEP's historic and continued use of WVSCI to assess attainment of water quality standards does not violate the Legislature's statement of public policy as contained in the West Virginia Water Pollution Control Act. §22-11-7b, as amended in 2012, states "Rules promulgated pursuant to this subsection may not establish measurements for biologic components of West Virginia's narrative water quality standards that would establish standards less protective than legislatively approved rules that existed at the time of enactment of the amendments to this subsection by the Legislature during the 2012 regular session". WVDEP interprets this to mean that the continued use of WVSCI is appropriate, because an additional standard for measurement cannot be less protective than the listing determination being made in 2012.

Further considerations of habitat condition, as well as other stressors to aquatic life, are considered in the assessment procedure when making listing decisions. As demonstrated in Figure 12-5 above, when WVSCI scores are between 50 and 61, an assessment unit will not be newly listed if there is no clear stressor. In this situation, additional benthic data is required to make a listing decision.

In a comment regarding the 2010 303(d) list, one commenter provided references to the Programmatic Environmental Impact Statement for Mountaintop Mining and Valley Fills in Appalachia (MTM/VF EIS), a supplemental study supplied by a member of the coal industry, and an academic study published after the MTM/VF EIS. The commenter contended that the referenced documents show that mountain top mining and valley fills do not cause biological impairment and therefore, the WVDEP's assessment of biological impairment through the use of the WVSCI is flawed.

Based upon the supplemental studies, the commenter characterized the WVSCI as a "measure of change, not impairment" and opined that "a mere shift" in the biological community should not be equated to impairment because the designated use of the stream remains viable. The following reference to the MTM/VF EIS was provided: Further, the EIS studies did not conclude that impacts documented below MTM/VF {mountaintop mining / valley fill} operations cause or contribute to significant degradation of waters of the U.S. (Programmatic Environmental Impact Statement. Corps, EPA et.al. Pg. II. D-9).

The referenced statement, extracted from thousands of pages of documentation, does not wholly reflect the findings of the MTM/ VF EIS. The MTM/VF EIS clearly recognizes biological impairment in certain waters downstream from evaluated mining activities, as evidenced by the following language that is contained within the same paragraph as the referenced statement: "Biological conditions in the streams with only valley fills represented a gradient of conditions from poor to very good; streams with valley fills and residences were most impacted. Impacts could include several stressors, such as valley fills, residences, and/or roads."

The recognition of biological impairment is also evidenced in the Responses to Comments section of the MTM/VF EIS: "Studies do indicate that aquatic communities downstream of surface coal mining operations and valley fills are impaired in some cases. Certain chemical parameters (sulfates, specific conductance, selenium) are sometimes elevated downstream of mining or valley fills. Stream reaches below mining and valley fills may have changes in substrate particle size distribution from increased fine material due to sedimentation. Some macroinvertebrate communities change in terms of diversity, population size, and pollution tolerance. However, the sample size and monitoring periods conducted for the PEIS were not considered sufficient to establish firm cause-and-effect relationships between individual pollutants and the decline in particular macroinvertebrate populations. Impairment could not be correlated with the number of fills, their size, age, or construction method. See Section II.C. Action 5 in the PEIS recognizes the value of continued evaluation of the effects of mountaintop mining operations on stream chemistry and biology."

Regarding the supplemental studies, the MTM/VF EIS clearly indicates that the opinions and views expressed by the individual authors of referenced studies do not necessarily reflect the position or view of the agencies preparing the EIS. The WVDEP does not interpret the cited studies as demonstrations of universal biological integrity in streams below evaluated activities and disagrees with the commenter's characterization of the WVSCI. A "shift" in the benthic macroinvertebrate community of a stream can constitute biological impairment pursuant to 47CSR2 – 3.2.i, and the WVSCI (recognized as a "best science method" in the MTM/VF EIS) provides a sound scientific basis for assessment.

In a comment regarding the 2010 303(d) list, the commenter also requests that consideration be given to all potential sources of impairment to these biological communities, and inaccurately asserted that WVDEP has ignored other sources in an effort to inflate the list of impaired waters in West Virginia and needlessly target the mining industry.

The overwhelming majority of biological impairment listings do not have associated sources identified and, in no instances, are the specific mining activities such as MTM/VF identified as sources of biological impairment. Sources are often omitted from the WVDEP 303(d) List, awaiting results of pollutant source tracking and stressor identification during TMDL development. At no time during TMDL development are mining sources singled out without a full investigation into pollutant sources for a specific assessment unit. TMDLs prescribe load reductions for both permitted source and non-point sources. Operable wasteload allocations are prescribed specifically for permitted sources including mining permits following an allocation strategy, in which all pollutant sources are considered and reduced.

Using the Aquatic Life Use Assessment and Biological Stressor Identification Procedure for listing purposes affords WVDEP the opportunity to identify sources of stress to the biological community during

listing decisions. WVDEP will take the commenters' concerns into account to identify all sources of stress in the 303(d) list in the future.

In a comment regarding the 2010 303(d) list, a commenter expressed the concern that "in many cases, the specific data relied upon by DWWM is inadequate and/or deficient" stating that "during metric development for the WVSCI, consideration of individual metrics did not include an evaluation of metric variability." The commenter also contends that biological impairment determinations should not be made based upon a single assessment because "no long term data was used to determine the variability and reproducibility of the use of WVSCI to determine stream impairment." The commenter states "**While benthic macroinvertebrate sampling does represent conditions that the community has been exposed to over time, biological communities are also subject to substantial variability. A single sampling event may reflect a recent drought, scouring floods, localized impacts or system-wide impairment." Because of this, the commenter inaccurately asserts that WVDEP is required to use an aquatic life assessment methodology similar to the 10% rule for water chemistry decisions.**

The benthic macroinvertebrate IBI allows the WVDEP to understand the impacts to the biological community overtime, not only on the day of the WVSCI sample. While a single sample WVSCI score is representative of the benthic community, WVDEP has, out of an abundance of caution and to address stated concerns, implemented the use of the Aquatic Life Assessment and Stressor Identification Procedures to confirm WVSCI scores before making listing determination. The assessment procedure includes performing stressor identification, collecting additional benthic macroinvertebrate samples, and using genus level benthic data. There is no comparison between the 10% rule used by WVDEP, described in Section 5.3 and the benthic macroinvertebrate data for the very reason stated by the commenter, "While benthic macroinvertebrate samples does represent conditions that the community has been exposed to over time,". The 10% rule applies to a data set for water chemistry collected through individual grab samples.

Commenters expressed opposition to the use of an indeterminate zone that can result in listing delays and an underestimation of streams in need of restoration. Commenters described the zone of uncertainty as having statistical deficiency, pointing out that the lowest reference site score in the WVSCI dataset is 64.74. The use of 61 as an impairment threshold for the zone of uncertainty is entirely outside of the reference dataset and unrelated to any statistical methodology appropriate for a biological assessment procedure. Commenters cite a response from WVDEP to a FOIA request on April 11, 2019, "The zone of uncertainty (61-72) is an arbitrary threshold to allow the agency flexibility in the determination of impairment for scores that approach the attainment threshold." In addition, commenters point out that the use of 50 as a single score that results in an automatic impairment cannot be supported statistically or scientifically, because it is 14 points below the lowest reference site score.

WVDEP's position has not changed regarding the derivation of the assessment procedure thresholds. The assessment procedure establishes a mechanism for further assessing streams that are below the full attainment threshold of a WVSCI 72 before making final determinations. Utilizing habitat data, water quality data, and/or the GLIMPSS IBI, WVDEP staff confirm biological impairment before listing.

It is WVDEP's position that establishing an assessment procedure for the aquatic life narrative water quality criterion is not unlike other assessment procedures applied to numeric water quality criteria. These assessment procedures are maintained as internal processes in order to provide flexibility for best

professional judgement when considering the quality, number, and frequency of data needed to accurately represent the stream's water quality, in addition to other factors difficult to capture in a procedural rule. For instance, as described in Section 5.0, assessment staff generally consider 20 samples as an appropriate number of data to make an assessment when submitted by a third party. However, staff must evaluate if those specific 20 samples are representative of the critical condition in the stream, considering flow and seasonal shifts. Staff would not make a delisting decision for a stream impaired for pH, if all 20 samples were collected during high flows in April. With that same concept in mind, the assessment procedure affords WVDEP the latitude and flexibility to verify how well a biological sample represents a given assessment unit. WVDEP is committed to collecting and considering additional data as soon as possible to finalize listing decisions to avoid delays in restoration planning.

Commenters hired ecologists to conduct a Threshold Indicator Taxa Analysis (TITAN) to better understand the ecological change points of macroinvertebrate taxa appearing frequently in the WVDEP dataset from 1998-2018. Commenters shared the results of the TITAN including a graph demonstrating that 80% of sensitive benthic macroinvertebrate taxa are absent at a WVSCI score of 72. Commenters state, "This analysis demonstrates that even a WVSCI impairment threshold of 72 will not be sufficient to protect most sensitive macroinvertebrates. There is no ecological justification for lowering it below that point."

DEP considers 72 a valid threshold because reference samples are established by evaluating a series of relevant abiotic factors in a consistent manner, and if a sample meets the expectations for reference, it represents the condition for which we are intending to protect. Using this concept, a reference station with several benthic samples that routinely scores in the lower range of the WVSCI reference distribution is no less a reference than one that scores in the upper range repeatedly.

Commenters assert that the proposed assessment methodology using arbitrary thresholds would be contrary to the Administrative Procedures Act, citing WV Code § 29A-5-4(g) as saying an agency decision should be set aside if it is either "[c]learly wrong in view of the reliable, probative and substantial evidence on the whole record; or "[a]rbitrary or capricious or characterized by abuse of discretion or clearly unwarranted exercise of discretion." In addition, commenters assert that the proposed assessment methodology results in a violation of the CWA Section 303(d) to use all existing and readily available data, as well as an inability to comply with state and federal law through the NPDES program.

In addition, commenters asserted that the assessment methodology WVDEP used to determine biological impairment failed to incorporate USEPA's recommendations made during a public comment period for a draft proposed rule for aquatic life use assessment. Commenters listed the recommendations as a request for technical documentation for the development of the rule, use of the Internal Equivalence Test as a statistically valid technique for the proposed method; incorporation of all available reference site data; and seasonal and regional partitioning of the proposed methodology. Commenters inaccurately conclude that the assessment methodology fails to meet applicable federal requirements.

As described in an earlier response, WVDEP contends that the preparation of an assessment procedure including thresholds that will prompt the need for additional lines of evidence when making a listing

decision is within the latitude afforded to the agency's assessment program by state codes. While the thresholds of 50 and 61 were arbitrarily derived as parameters in the assessment procedure decision flowchart, no delisting decisions are based on the assessment procedure thresholds of 50 and 61. Any assessment unit that is already categorized as impaired (IR Categories 5 and 4 for biological impairment) remains in those categories until a WVSCI is 72 or greater is attained. The assessment procedure simply considers more data when the WVSCI score is between 50 and 72, including stressor identification, additional benthic macroinvertebrate samples, and/or genus level benthic data for verification.

WVDEP does not consider recommendations from the USEPA in the development of the assessment procedure to represent federal requirements. The decisions based on the assessment procedure does not preclude the USEPA from scrutinizing attainment and impairment decisions during their review of the WV Integrated Water Quality and Monitoring Report, including the 303(d) List.

Appendix A

Aquatic Life Use Assessment and Biological Stressor Identification Procedures

August 2021

Introduction

The federal Clean Water Act contains requirements to report on the quality of a state's waters. Section 305(b) requires a comprehensive biennial report and Section 303(d) requires, from time to time, a list of waters for which effluent limitations or other controls are not sufficient to meet water quality standards (impaired waters). West Virginia code §22-11-7b also requires a biennial report of the quality of the state's waters. Water quality standards, both numeric and narrative are protective of designated uses. Thus, if water quality standards are not met in a waterbody, the waterbody cannot support its designated uses.

Legislative rules on Water Quality Standards (§47-CSR-2) describes in section 6.3, one of the designated uses, Category B – Propagation and maintenance of fish and other aquatic life, including both B1 (warmwater fishery) and B2 (Trout waters) waters. §47-CSR-2 – Section 3.2.i. prohibits the presence of wastes in state waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, and biological components of aquatic ecosystems and is commonly referred to as the narrative water quality criterion for aquatic life use.

WVDEP has modified its procedures for assessing attainment of the narrative criteria for Aquatic Life Use (AQL) in response to legislative action amending WV Code §22-11-7b, requiring WVDEP to develop new assessment methodologies. This document provides a general assessment procedure, identifies attainment thresholds, and provides the specific processes and tools used in determining attainment of the narrative criteria for the Aquatic Life Use. This document also includes the stressor identification component that is utilized to determine when additional monitoring is required.

Procedures for assessing AQL in non-wadeable streams and rivers and lakes have not yet been developed. This document will be updated when those methods are developed.

Part I. Aquatic Life Use Attainment Procedures

This assessment methodology is based on benthic macroinvertebrate community data that has been determined to be the most effective and efficient way to assess wadeable streams with riffle / run habitats – by far the most common aquatic resource across West Virginia.

> Biological assessments and criteria address the cumulative impacts of all stressors, especially habitat degradation, and chemical contamination, which result in a loss of biological diversity. Biological information can help provide an ecologically based assessment of the status of a waterbody and as such can be used to decide which waterbodies need TMDLs (USEPA 1997c) and aid in the ranking process by targeting waters for TMDL development with a more accurate link between bioassessment and ecological integrity. (Barbour 1999).

> Rapid bioassessment using the benthic macroinvertebrate assemblage has been the most popular set of protocols among the state water resource agencies since 1989 (Southerland and Stribling 1995).

Regarding efficiency, benthic macroinvertebrate data can be collected by one person with minimal equipment and in a relatively short period of time. WVDEP has collected over 10,000 samples since the Watershed Assessment Branch began collecting these samples in 1996. The Watershed Assessment Section's Standard Operating Procedures Manual provides an in-depth description of benthic data collection that must be followed to meet quality assurance and quality controls and comparability before data are considered reliable for assessment.

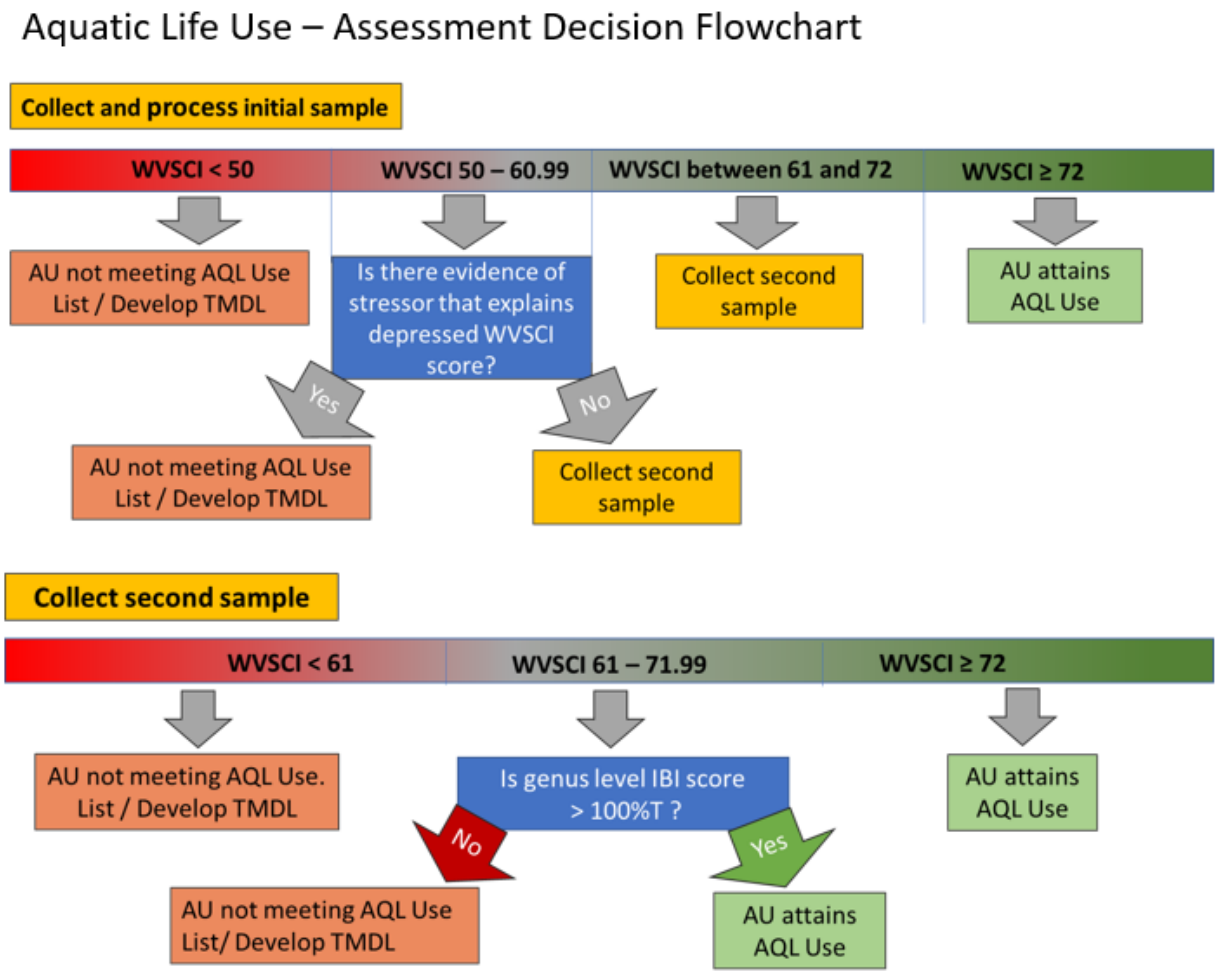
Benthic IBI:
Based on general rapid bioassessment protocols designed to efficiently determine the health of wadeable streams, WVDEP developed a state specific Benthic Index of Biotic Integrity (Benthic IBI), referred to as the West Virginia Stream Condition Index (WVSCI), using family level benthic macroinvertebrate data collected from 1996 to 1999. Information on the development of WVSCI, the use of biological data, and the metrics on which a WVSCI score is derived are available at: https://dep.wv.gov/WWE/watershed/bio_fish/Pages/Bio_Fish.aspx. This site also describes minor updates made to WVSCI scoring that were made possible by the large volume of data acquired since 1999. WVDEP has based AQL assessments for 303(d) listing on this IBI since 2002.

Assessment Specifics:
When reporting on water quality and impairment, the WVDEP applies attainment decisions to assessment units of a waterbody. Depending upon the size of the waterbody and factors such as anthropogenic influences and historic data; a stream may be assessed as one unit or divided into multiple segments. Results from one monitoring station may be applied to an entire assessment unit.

If conflicting results emerge from multiple monitoring stations within the same assessment unit, assessments decisions will be based on the preponderance of the data from recent samples. Data from the collection efforts will be re-examined to ensure sample comparability. The proximity of the stations to pollution sources will be considered. If an obvious reason for data disagreement amongst sample stations exists, the stream segment may be divided into smaller assessment units.

The attainment threshold is a WVSCI score equal to 72, which is based on the 5th percentile of reference sample scores. The remainder of this document describes the procedures WVDEP will follow in determining attainment status. This includes descriptions of when additional benthic macroinvertebrate samples are required, a Stressor Identification determination based on water chemistry and habitat (see Part II), and/or the use of genus level taxonomy.

When a single recent benthic macroinvertebrate sample from an assessment unit is available, an attainment decision can be made if the WVSCI score is < 50 or if it is $\geq$ the attainment threshold of 72. Streams with WVSCI score <50 will be considered impaired – or not attaining the narrative criteria for AQL, and streams with WVSCI score ≥ 72 will be considered attaining.



For stream segments with an initial WVSCI score ≥ 50 and < 61, an evaluation of all available water quality and habitat data will be made based on the Stressor Identification section (Part II) of this document. The stream segment will be classified as impaired for the biological integrity criterion when water quality or physical habitat conditions clearly explain the depressed WVSCI score. If no clear causative stressor is identified, an additional benthic macroinvertebrate sample must be collected before an attainment decision can be made.

For stream segments with initial WVSCI scores ≥ 61 and < 72, and for streams with WVSCI scores ≥ 50 and < 61 with no identified causative stressor, at least one additional benthic macroinvertebrate sample is required to determine compliance with the biological integrity criterion.

For cases where a second benthic macroinvertebrate sample is required, the Department will determine biological integrity criterion compliance based on the most recent sample. Stream segments for which the most recent WVSCI score is < 61 will be considered impaired – or not attaining AQL. Stream segments for which the most recent score is ≥ 72 will be considered attaining for AQL.

For streams or stream segments whose most recent sample has a WVSCI score ≥ 61 and < 72, WVDEP will base decisions on genus level IBI scores. As with WVSCI, the attainment thresholds for this genus level IBI, which has been developed for two regions (Mountains and Plateau) and two seasons (spring and summer) will be based on the 5th percentile of region and season specific reference sample scores. These scores have been adjusted so that the 5th percentile score is equal to 100. These adjusted scores are referred to as %T (percent of threshold) Genus IBI scores. When this genus level IBI was being developed, there was concern regarding the difficulty involved with processing and identifying the small larvae of the chironomidae family which often require individual specimens be mounted on microscope slides for accurate identification to genus level. For this reason, an IBI was developed and tested that used genus level identifications for most families but kept chironomids at the family level. This version performed well and will be used in this step of the assessment process. Streams or stream segments with %T Genus IBI CF (chironomidae at family level) scores ≥ 100 will be considered attaining AQL Use and those with scores below this threshold will be considered impaired. Information on the development of the genus level IBI can be found at: https://dep.wv.gov/WWE/watershed/bio_fish/Pages/Bio_Fish.aspx

Fish Community Assessments**:**
In 2012, state legislators voted to change state code: §22-11-7b. Water quality standards; implementation of antidegradation procedures; procedure to determine compliance with the biologic component of the narrative water quality standard. Subsection (f) was updated, stating: "The secretary shall propose rules measuring compliance with the aquatic life component of West Virginia's narrative water quality standard requires evaluation of the holistic health of the aquatic ecosystem and a determination that the stream: (i) Supports a balanced aquatic community that is diverse in species composition; (ii) contains appropriate trophic levels of fish, in streams that have flows sufficient to support fish populations; and (iii) the aquatic community is composed of benthic invertebrate assemblages sufficient to perform the biological functions necessary to support fish communities within the assessed reach, or, if the assessed reach has insufficient flows to support a fish community, in those downstream reaches where fish are present."

WVDEP worked with WVU faculty and graduate students to assemble all available fish community data and develop a means of assessing this data for use in determining compliance with the aquatic life component of WV's narrative criteria. A group of fish biologists and regulators worked for several years on the development of metrics capable of accurately describing fish community health. It was determined that fish community data could not be used for small headwater streams that have too few species to allow development of useful metrics. There was also insufficient data available for larger streams and rivers. Therefore, efforts were focused on wadeable streams, defined for this project as watersheds with drainage areas of between 7 and 250 km^2. It was determined that regional differences in fish communities required unique metrics be developed for 5 distinct regions of the state and also that there was insufficient data available to develop measures for coldwater streams.

After several years of working to develop regional fish IBI's for warmwater wadeable streams it was determined that there was not enough data and other problems to provide for development of useful assessment tools for regulatory purposes.

- There were too few reference and stressed sites that are needed to assess the performance of metrics in several regions.
- For regions with adequate numbers of reference and stressed sites, no IBI could be developed that could consistently distinguish between pre-determined high quality and stressed sites.
- Higher IBI scores were correlated with known stressors (e.g. lower percent forest and human development)

Fish community data continues to be collected across the state, with a focus on areas most in need of additional data. The use of fish data for assessment of AQL Use will be revisited in the future.

Southerland, M.T. and J.B. Stribling. 1995. Status of biological criteria development and implementation. Pages 81-96 *in* W.S. Davis and T.P. Simon (editors). *Biological assessment and criteria: Tools for water resource planning and decision making.* Lewis Publishers, Boca Raton, Florida.

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.

Part II.
Stressor Identification Overview

The Biological Stressor Identification (SI) process used to identify the cause of stream impairment is based on an analysis of existing quantitative and qualitative water quality, physical habitat, and biological data. This process was originally developed as part of the TMDL development for streams deemed to be biologically impaired.
Biological assessments are useful in detecting impairment, but they do not necessarily identify the cause (or causes) of impairment. USEPA developed *Stressor Identification: Technical Guidance Document* to assist water resource managers in identifying stressors or combinations of stressors that cause biological impact (Cormier et al., 2000). Elements of the SI process are used to evaluate and identify the primary stressors on the aquatic life of biologically impacted streams. SI is a formal and rigorous method that identifies stressors and provides a structure for organizing the scientific evidence supporting the conclusions.

Technical Approach

Biological communities respond to any number of environmental stressors, including physical impacts and changes in water and sediment chemistry. The primary sources of data used in the SI process are water quality, biological, habitat, and other information stored in the WVDEP Watershed Assessment Branch (WAB) database. Importantly, this database includes information on pollutant source tracking, narrative descriptions of potential stressors and their sources, and sample location photography. SI also includes the examination of pertinent Geographic Information Systems (GIS) data including, but not limited to, National Pollutant Discharge

Elimination System (NPDES) point source data, WVDEP mining permits and activities coverages, and aerial imagery.

WVDEP interprets water quality and biological information collected primarily by the agency's Watershed Assessment Section via several monitoring programs. Most of these programs are based on collecting data from the state's 32 major watersheds (HUC 8 level) on a five-year rotation. Pre-TMDL monitoring is conducted to collect sufficient data for the development and calibration of hydrology and water quality models. This monitoring is intensive, consisting of monthly sampling for parameters of concern, which captures data under a variety of weather conditions and flow regimes in one year. A comprehensive habitat assessment and biological monitoring are performed in conjunction with water quality monitoring. Sediment related habitat evaluations are performed during all monthly visits. Pre-TMDL monitoring also includes an effort to locate the specific sources of impairment, with attention paid to identifying non-point source land use stressors as well as any permitted facilities that may not be meeting their permit requirements

Development of the Conceptual Model

The first step in the SI process is to develop a list of candidate causes, or stressors. Potential causes are evaluated based on an assessment of watershed characteristics and the likely causes and sources of biological impairment. The relationship between candidate causes of impairment and potential biological effects are based on initial data analyses, knowledge of these watersheds, and experience in defining impairment causes in similar watersheds. Sources, impairment causes, and the resulting effects on the biological community depend on the stream or watershed in question. In some cases, biological impairment can be linked to a single stressor; in other situations, multiple stressors might be responsible for the impact.

Data Analysis

The second step in the SI process is to evaluate the information related to each of the candidate causes. Water quality parameters, habitat data, source tracking data, and all other quantitative and qualitative data are grouped under each respective candidate cause for analysis. In some cases, a variety of information is used to evaluate a candidate cause (e.g., sedimentation). The evidence presented is used to determine support or non-support of the listed candidate cause. At the conclusion of this process, one or more stressors (pollutants) may be identified.

SI analysis involves comparing the water quality data, habitat information, and other non-biological data from an impaired station to established water quality standards and threshold values that have been developed on the basis of a statistical analysis of stressor-response patterns using reference stream data (Table 1.). Two sets of threshold values: elimination and strength of evidence are designated for most parameters. Elimination threshold values represent "not to exceed" levels for water quality and habitat variables. Sample station data are first compared with the elimination thresholds to determine whether additional analyses is necessary to evaluate a particular candidate cause (stressor). Each potential stressor is further evaluated using a strength-of-evidence approach if the elimination threshold is exceeded, related parameters or other information showed conflicting results, or there are limited data available. At least one parameter should exceed the candidate stressor threshold before a stressor can be identified.

Biological data are also used in the SI process and include diagnostic tools with statistically derived thresholds that evaluate a biological community's response to specific stressors. Currently, diagnostic tools based on an Observed/Expected (O/E) concept are used in SI process. O/E is a taxonomic completeness model that assesses biological condition using the ratio of observed taxonomic richness (O) to expected taxonomic richness (E) in the absence of disturbance. Expected (E) taxonomic richness is established using reference site populations. This basic concept was followed to develop three models capable of providing stressor specific evidence of biological impacts in WV streams. These models are the O/E Sensitive (taxa that are sensitive to a given stressor are included in the Expected group), O/E Opportunistic (taxa that are opportunistic to a given stressor are included in the Expected group), and Percent Model Affinity (similarity of a biological sample to the average taxonomic composition of each stressor population) approaches. The stressors for which models are developed include organic enrichment, sediment, ionic strength, acid deposition, and dissolved metals. The SI process includes calculating O/E model scores for each stressor using biological sample data and then comparing them to derived thresholds. These thresholds are considered with a weight of evidence approach along with water chemistry, habitat, and other pertinent sources of information.

Biological community metric and individual taxa are also reviewed for each sample station to confirm decisions resulting from other lines of evidence. Many pollutants have a direct and negative impact on macroinvertebrate presence/abundance; however, some stressors act by more complex means on the biota. For example, an increased abundance of the midge group *Cricotopus_Orthocladius* (Diptera - true flies) is typical in waters heavily enriched by nutrients; consequently, both the population's abundance and corresponding information regarding the potential stressor are closely considered. A useful benthic community metric for identifying metals toxicity is Ephemeroptera Taxa Richness (mayflies). This metric is often substantially reduced compared to reference site values in streams with elevated dissolved metals and low pH. As with other data, biological reviews of specific taxa and community metrics are used in a weight of evidence approach along with water chemistry, habitat, and other pertinent sources of information.

Table 1.

Candidate Cause	Parameter	Elimination Threshold (Rule out stressors at these thresholds)	Strength of Evidence (Evidence for each Candidate Cause as stressor) Candidate Stressor Thresholds
1. Metals Toxicity (Primarily Acid Mine Drainage)	Al (dissolved)	<0.09 mg/L	>0.20 mg/L – Evidence of Stressor[1,4]
	Fe (total)	Fe toxicity to benthic invertebrates is not well established.	
	Mn (total)	Mn toxicity to benthic invertebrates is not well established.	
	O/E Opportunistic Model (AMD)	na	> 2.0 – Evidence of Stressor[2]
	O/E Sensitive Model (AMD)	na	< 0.5 – Evidence of Stressor[2]
	O/E PMA Model (AMD)	na	> 0.3 – Evidence of Stressor[2]
	Benthic Taxa review	Professional judgment applied to benthic macroinvertebrate taxa and community metrics from sample station.	
	Qualitative Metals Toxicity Evaluation:	Professional judgment applied to combination of station observations including hot acidity, alkalinity, dissolved metals, specific conductance, TDS, sulfate, and other signature ions. Qualitative ratings of metals flocculation and field rating of AMD stress. Station photography, GIS imagery evaluation, and field notes and source tracking observations.	
2. Acidity (Acid Deposition)	pH	>6.3	< 6.0[3]
	O/E Opportunistic Model (Acid Precip)	na	> 2.0 – Evidence of Stressor[2]
	O/E Sensitive Model (Acid Precip)	na	< 0.5 – Evidence of Stressor[2]
	O/E PMA Model (Acid Precip)	na	> 0.3 – Evidence of Stressor[2]
	Benthic Taxa review	Professional judgment applied to benthic macroinvertebrate taxa and community metrics from sample station.	
	Qualitative Acid Deposition Evaluation:	Professional judgment applied to combination of station observations including hot acidity, alkalinity, dissolved metals, specific conductance, TDS, sulfate, and other signature ions. Station photography, GIS imagery evaluation, and field notes and source tracking observations.	
3. High pH	pH	<8.39	>9[3]
4. Ionic Strength	Specific Conductance	Consider as independent stressor in non-acidic, non-AMD streams. Maximun value at monitoring station.	
		< 300 µmhos	> 500 – Evidence of Stressor[1]
	O/E Opportunistic Model (Ionic strength)	na	> 2.0 – Evidence of Stressor[2]
	O/E Sensitive Model (Ionic strength)	na	< 0.5 – Evidence of Stressor[2]
	O/E PMA Model (Ionic strength)	na	> 0.3 – Evidence of Stressor[2]

Candidate Cause	Parameter	Elimination Threshold (Rule out stressors at these thresholds)	Strength of Evidence (Evidence for each Candidate Cause as stressor) Candidate Stressor Thresholds
4. Ionic Strength (cont.)	Benthic Taxa review	Professional judgment applied to benthic macroinvertebrate taxa and community metrics from sample station.	
	Qualitative Ionic Strength evaluation:	Professional judgment applied to combination of station observations including concentrations of constituent ions alkalinity, calcium, chloride, potassium, sodium, sulfate, magnesium. Concurrent (with bio sample) and mean specific conductance at station also considered. Station photography, GIS imagery evaluation, and field notes/source tracking observations.	
5. Sedimentation	% Fines (sand + silt + clay) - in Kicked Area	<10%	>= 25 - Evidence of Stressor[4]
	RBP: Embeddedness	16.0 - 20.0 (optimal)	< 9 - Evidence of Stressor[4]
	RBP: Sediment Deposition	16.0 - 20.0 (optimal)	< 8 - Evidence of Stressor[4]
	RBP: Bank Stability	16.0 - 20.0 (optimal)	< 12 - Evidence of Stressor[4]
	Silt Deposition Rating - in 100m Assessment Reach	Qualitative evaluation based on field rating of magnitude:	
		<2 (none or low)	> 2 (high or extreme) - Evidence of Stressor[1]
	Sand Deposition Rating - in 100m Assessment Reach	Qualitative evaluation based on field rating of magnitude:	
		<2 (none or low)	> 2 (high or extreme) - Evidence of Stressor[1]
	O/E Opportunistic Model (Sedimentation)	na	> 2.0 – Evidence of Stressor[2]
	O/E Sensitive Model (Sedimentation)	na	< 0.5 – Evidence of Stressor[2]
	O/E PMA Model (Sedimentation)	na	> 0.3 – Evidence of Stressor[2]
	Benthic Taxa review	Professional judgment applied to benthic macroinvertebrate taxa and community metrics from sample station.	
	Qualitative Sedimentation evaluation:	Professional judgment applied to combination of RBP embeddedness, sediment deposition, bank stability, bank vegetation, riparian vegetation, and total scores; supplemented with watershed erosion rating, reach substrate particle characterization, sediment layer profile, and field rating of sediment stress. Station photography, GIS imagery evaluation, and field notes/source tracking observations.	
7. Metals flocculation (habitat alteration)	Embeddedness due to metals flocculation	16.0 - 20.0 (optimal)	< 9 - Evidence of Stressor[4]
	Metal Flocculation Rating	Qualitative evaluation based on field rating of magnitude:	
		<1 (none)	> 1 (moderate to extreme) - Evidence of Stressor[1]

Candidate Cause	Parameter	Elimination Threshold (Rule out stressors at these thresholds)	Strength of Evidence (Evidence for each Candidate Cause as stressor) Candidate Stressor Thresholds
8. Organic Enrichment	Filamentous Algae	Qualitative evaluation based on field rating of abundance:	
		<2 (low or none)	> 2 (high or extreme) – Evidence of Stressor[4]
	Diatom Growth	Qualitative evaluation based on field rating of abundance:	
		<2 (low or none)	> 2 (high or extreme) – Evidence of Stressor[4]
	Dissolved Oxygen	>7.0 mg/L	< 6.0 - Evidence of Stressor[3]
	Total Phosphorus	<0.02 mg/L	> 0.05 – Evidence of Stressor[5]
	Total Nitrogen	<2.0 mg/L	> 2.0 – Evidence of Stressor[5]
	Fecal coliform	<150 counts/100 mL	> 500 - Evidence of Stressor[4]
	O/E Opportunistic Model (Organic Enrichment)	na	> 2.0 – Strong Indication of Stressor[2]
	O/E Sensitive Model (Organic Enrichment)	na	< 0.5 – Strong Indication of Stressor[2]
	O/E PMA Model (Organic Enrichment)	na	> 0.3 – Strong Indication of Stressor[2]
	Benthic Taxa review	Professional judgment applied to benthic macroinvertebrate taxa and community metrics from sample station.	
	Qualitative Organic Enrichment evaluation:	Professional judgment applied to combination of station observations such as atmospheric and water odors, presence of foam/suds, poorly treated domestic sewage, agriculture and livestock, residences, lawns, field biologist/specialist organic enrichment determination, field notes, station photography, GIS imagery evaluation, and information from sources tracking efforts.	
9. Temperature	Degrees F		Max >87 F May through November; or
			Max >73 F December through April.[3]
10. Chemical Spills	Various chemical parameters		Qualitative supplemental information (field notes and other sources listed below this table).

Notes:

-Elimination: Screening step to rule out particular stressors, based on unambiguous criteria.

-Strength of evidence: Data that provide evidence for identification of each particular candidate cause as a biological stressor.

-RBP: Rapid Bioassessment Protocol.

-Qualitative: Supplemental evidence to evaluate each candidate stressor.

-Benthic taxa review: Review taxa lists and metrics to find indicators of specific stressor.

-O/E Models: Observed over Expected models using benthic macroinvertebrate taxa; diagnose specific stressor.

Candidate Cause	Parameter	Elimination Threshold (Rule out stressors at these thresholds)	Strength of Evidence (Evidence for each Candidate Cause as stressor) Candidate Stressor Thresholds

References & Sources:

[1]WVDEP WAB Data Analysis. 2020.

[2]Tetra Tech Memo: Methods & Results of Site-Specific Biological Modeling (O/E) with Stressor Module Task (Feb. 26, 2019).

[3]West Virginia Code §47, Series 2. 2014. Requirements governing water quality standards.

[4]Gerritsen, J., L. Zheng, J. Burton, C. Boschen, S. Wilkes, J. Ludwig, and S. Cormier. 2010. Inferring Causes of Biological Impairment in the Clear Fork Watershed, West Virginia. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Cincinnati, OH. EPA/600/R-08/146.

[5]VDEQ. 2017. Stressor Analysis in Virginia: Data Collection and Stressor Thresholds. VDEQ Technical Bulletin WQA/2017-001.

[6]Novak, M.A. and R.W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. Journal of the North American Benthological Society 11(1): 80-85.

Actions based on Assessments and Stressor Identification

Listing on the 303d list as impaired, requires the development of TMDLs to prescribe reductions of pollutants causing impairment. Most often streams for which AQL Use is non-attaining are also impaired for associated numeric water quality criteria. For instance, because of the high iron content in West Virginia soils, streams stressed with sedimentation often also exceed the total iron water quality criterion. When a relationship is established through total suspended solids and iron correlations during TMDL development, a sediment reference watershed is used to test if reductions to pollutant sources prescribed in total iron TMDLs are as protective as those that would be prescribed through biological TMDLs for sedimentation. When those reductions are determined to be protective, total iron TMDLs are used as surrogates for biological TMDLs. In instances where total iron TMDLs are not appropriate surrogates, independent biological TMDLs are required to resolve the 303d listing.

Similar relationships can be seen between other common biological stressors and impairment of numeric criteria, such as organic enrichment and fecal coliform where there are sources of untreated human waste or influence from a pasture; acidity and low pH when there is acid precipitation; metals toxicity and dissolved aluminum when there is acid mine drainage. TMDLs that prescribe reductions to pollutant sources to attain fecal coliform, pH, and dissolved metals criteria act as surrogates to resolve stress from organic enrichment, acidity, and metals toxicity.

In the absence of a relationship between a stressor and an established numeric criterion, such as for ionic toxicity, biological TMDLs are required to prescribe reductions to ions to address the 303d listing. Prescribed reductions will meet a TMDL endpoint for specific conductivity that will be protective of aquatic life. WVDEP is aware that in some streams, biological impairment for the designated AQL Use associated with ionic toxicity may not be attainable. In those instances, a multisector variance or Use Attainability Analysis will be pursued for both an alternate biological attainment threshold and specific conductivity endpoint.