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 prepare the *Assessment Methodology for The Biological Component of The Narrative Criteria in Wadeable Streams* rule (§47-CSR-2B). §47-CSR-2B provides a general assessment procedure, identifies attainment thresholds, and refers to this document to provide 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 referred to in §47-CSR-2B.

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

§47-CSR-2B Section 3, describing the 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.
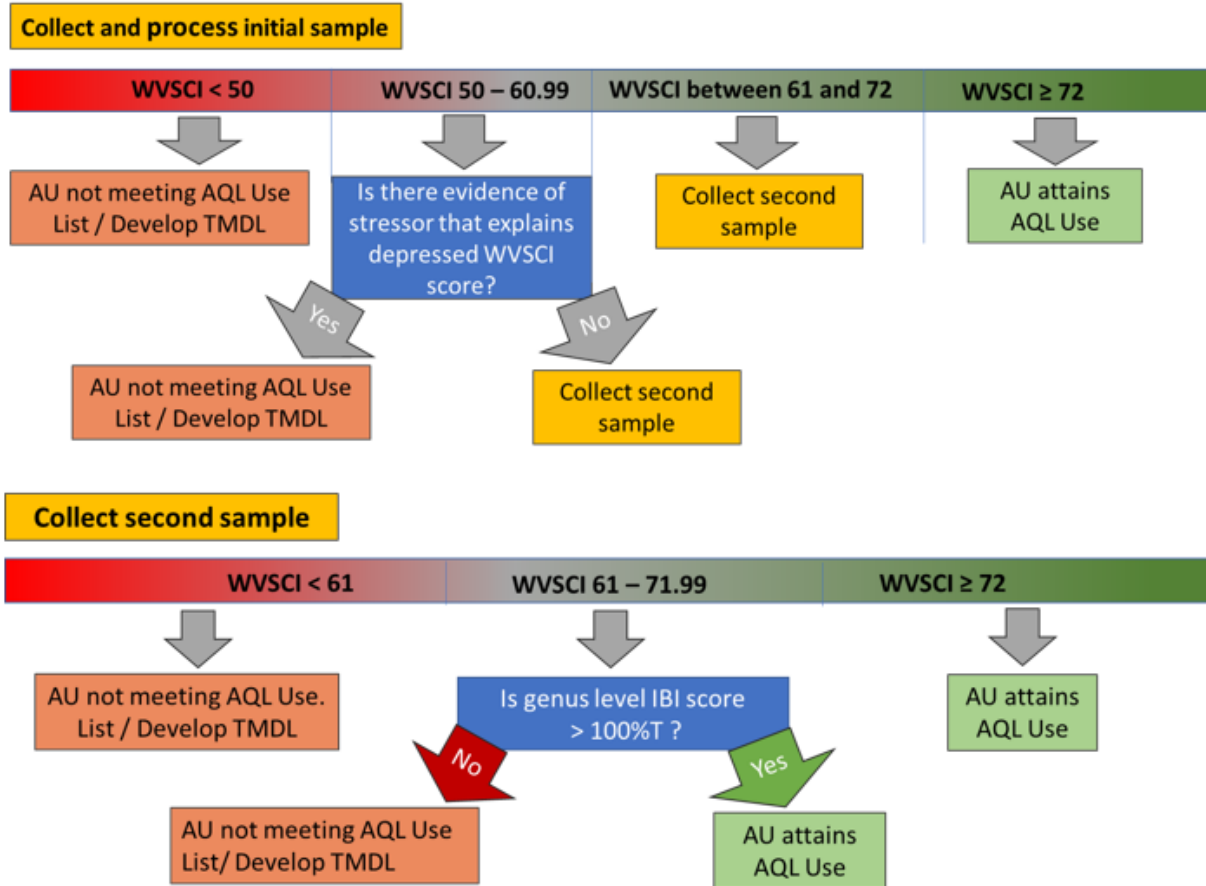
If conflicting results emerge from multiple monitoring stations within the same assessment unit, assessments decisions will be based on the preponderance of the data from recent samples. Data from the collection efforts will be re-examined to ensure sample comparability. The proximity of the stations 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.

§47-CSR-2B Section 3.1.b identifies an attainment threshold of a WVSCI score equal to 72, which is based on the 5th percentile of reference sample scores. The remainder of the rule 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 benthic macroinvertebrate sample assessment unit is available, an attainment decision can be made if the WVSCI score is < 50 or if it is ≥ 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.

Aquatic Life Use – Assessment Decision Flowchart

Collect and process initial sample

WVSCI < 50	WVSCI 50 – 60.99	WVSCI between 61 and 72	WVSCI ≥ 72

AU not meeting AQL Use List / Develop TMDL

Is there evidence of stressor that explains depressed WVSCI score?

Collect second sample

AU attains AQL Use

Yes → AU not meeting AQL Use List / Develop TMDL

No → Collect second sample

Collect second sample

WVSCI < 61	WVSCI 61 – 71.99	WVSCI ≥ 72

AU not meeting AQL Use. List / Develop TMDL

Is genus level IBI score > 100%T ?

AU attains AQL Use

No → AU not meeting AQL Use List/ Develop TMDL

Yes → AU attains AQL Use

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: [need to put info on GLIMPSS back on the website]

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, thus the "Reserved" statement in Section 3.4 of the procedural rule.

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:			

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.