WEST VIRGINIA NUTRIENT CRITERIA DEVELOPMENT PLAN

West Virginia Department of Environmental Protection

Division of Water and Waste Management

Water Quality Standards Program

(Rev. 6-16)

I. Executive Summary:

In response to the Environmental Protection Agency's request for regional nutrient criteria, this plan outlines current West Virginia water quality standard nutrient criteria regulations [Requirements Governing Water Quality Standards Rule (47 CSR 2)] and presents the steps that are to be taken to continue the development of nutrient criteria for rivers and streams, including timelines and milestones. West Virginia has both scientifically defensible narrative and numeric nutrient criteria that is protective of all designated uses for waters of the state, as well as an extensive monitoring program to determine impairment due to nutrient pollution. In addition, a 303(d) algae bloom listing methodology has been developed. Once a waterbody is determined to be impaired and 303(d) listed due to nutrient pollution, a Total Maximum Daily Load (TMDL) shall be developed with associated discharge permit limits or an EPA approved alternative restoration approach shall be conducted. To date, after extensive evaluation of data and ongoing monitoring, nutrient pollution has been found to affect only specific waterbodies and/or waterbody segments and therefore needs to be addressed on an individual waterbody or watershed basis.

II. Background:

West Virginia has been very successful in developing nutrient criteria for certain waterbody types and will continue to strive to meet additional criteria goals in the near future. West Virginia is investigating nutrient criteria and issues within other Region III states, and will keep the U.S. Environmental Protection Agency (EPA) updated on the criteria development process. West Virginia's Water Quality Standards rule currently includes numeric nutrient criteria for lakes. A total phosphorus numeric criteria of .01 mg/L for the Greenbrier River in West Virginia was proposed to the state legislature in 2010.[1] The numeric criteria for the Greenbrier River was not adopted; instead, a narrative criteria was adopted that applies to all waterbodies.

Within 47 CSR 2, the following narrative criteria was adopted in 2011, applying to all waterbody types and identified as a condition not allowable in state waters:

> "Algae blooms or concentrations of bacteria which may impair or interfere with the designated uses of the affected waters."

West Virginia also adopted cool and warm water lake numeric nutrient criteria for aquatic and recreation designated uses in 2011. Under 47 CSR 2 § 8.3.a, the following nutrient criteria applies to lakes with a summer residence time greater than 14 days:

> "Total phosphorus shall not exceed 40 µg/l for warm water lakes and 30 µg/l for cool water lakes based on an average of four or more samples collected during the period May 1 to October 31. Chlorophyll-a shall not exceed 20 µg/l for warm water lakes and

[1] Based on EPA publication 822-B-00-020, December 2000-"Rivers and Streams in Nutrient Ecoregion XI"

10 µg/l for cool water lakes based on an average of four or more samples collected during the period May 1 to October 31."

A summary of West Virginia nutrient criteria that has been adopted to date is listed in Table 1 below:

Table 1 - Nutrient Criteria and Methodology:

Nutrient or Response Indicator Numeric Criteria All Waterbody Types	- **DO**: Not less than 5 mg/L at any time (All designated uses) - **Fecal Coliform** – shall not exceed 200/100 ml monthly geometric mean based on not less 5 samples or 400/100 ml > ten % of all samples (Water Contact Recreation) - **Nitrate:** 10 mg/l (Water Supply) - **Nitrite**: 1.0 mg/L and .060 mg/L-Trout (Aquatic Life Use) - **Temperature**: No more than 5^0 above background not to exceed 87^0 May-November or 73^0 December-April - **Turbidity**: Not to exceed 10 NTU over background when ≤ 50 NTU, or not to exceed > 10% turbidity when background ≥ 50 NTUs
Narrative Nutrient Criteria All Waterbody Types	- 47 CSR 2-Alge blooms or concentration of bacteria which impair or interfere with designated use of affected water is prohibited. - Taste or odor that would adversely affect the designated uses of the affected waters is considered a condition not allowable.
Numeric Nutrient Criteria Warm and Cool Water Lakes	**- Warm Water Criteria:** **TP** ≤ 40µg/l **Chla** ≤ 20µg/l **- Cool Water Criteria:** **TP** ≤ 30µg/l **Chla** ≤ 10µg/l (Average of 4 or more samples May 1 – Oct 31)

III. Nutrient Criteria Consideration for Streams:

West Virginia is currently evaluating the application of its narrative water quality criteria to see if nutrient impairment issues can be adequately addressed based on stream monitoring and algal bloom assessment programs. The following information is essential to the evaluation process:

A. Analytical Parameters – Determination of the major nutrient(s) of concern

Currently, West Virginia has experienced nutrient issues manifested from both point and non-point sources. Algal blooms at impaired levels have occurred on the Greenbrier, Cacapon, South Branch of the Potomac, and Tygart Valley Rivers, which all have been 303(d) listed as impaired for algal blooms. A Greenbrier River Restoration Project was

initiated (WVDEP-GRRP, 2013) and is ongoing, studying the effects of nutrients and associated algal blooms. Based on research conducted, it is believed that the primary limiting nutrient of concern is typically phosphorus, however, in some cases stream chemistry shows that Nitrogen from non-point sources may play a role as a limiting nutrient of concern (US EPA, 2000). In addition, the ratio of total nitrogen to total phosphorus (TN:TP) as it relates to algae growth within streams is being evaluated. The concentration thresholds of TN and TP that have a direct effect on designated uses of a stream are being evaluated. Other parameters of concern that are being evaluated are Nitrate-Nitrite Nitrogen, Ammonia Nitrogen, Total Kjeldahl Nitrogen (TKN), and fecal coliform bacteria. Response indicators, such as Chlorophyll a, periphyton coverage, % algae coverage/biomass, pH, dissolved oxygen, and turbidity, are being studied as well. Figures 1 and 2 below show Total Phosphorus and Nitrate-Nitrite distributions within watersheds across the state.

West Virginia has determined that nutrient impairment is affected by certain conditions such as water chemistry. Specifically, based on studies conducted it appears that algal blooms are more susceptible to those streams within the state where hardness falls below 120-150mg/L (Summers-AFA, 2008), See Table 2. In addition, algal blooms tend to appear where alkalinity is at least 30-40 mg/L. In general, calcite streams appear to be more prone to nutrient impairment issues such as algal blooms then dolomite streams.

Table 2 – Algae Severity / Water Hardness Concentration

River	Modified Ca-Mg Index	Avg. Hardness (mg/l)	Algae Development
Greenbrier River	3.26	65	Severe
North Fork Hughes River	3.24	63	Low [T]
Tygart Valley River	3.18	70	High
New River	3.1	79	Moderate [D]
Kanawha River	3.08	85	None [T]
Cacapon River	3.10	96	High
South Fork/South Branch Potomac River	2.95	112	Moderate
Bluestone River	2.94	121	Moderate-High
South Branch Potomac River	2.88	130	Low-Moderate
Guyandotte River	2.86	145	None
West Fork River	2.85	190	None
Monongahela River	2.84	149	None
Tug Fork	2.79	178	None
North Branch Potomac River	2.78	214	None
Shenandoah River	2.76	174	None
Birch River	2.74	221	None
Coal River	2.51	284	None
Mud River	2.49	373	None

T= Algae level reduced by turbidity. D= Algae level probably reduced by depth of pools in river.

Figure 1 – Total Phosphorus

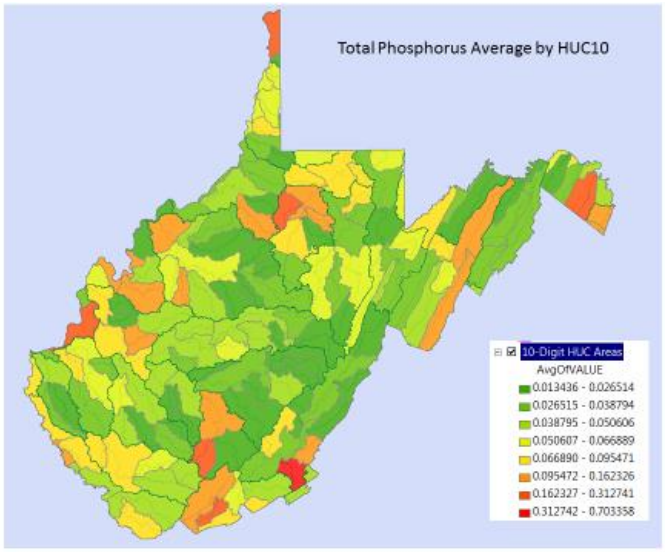
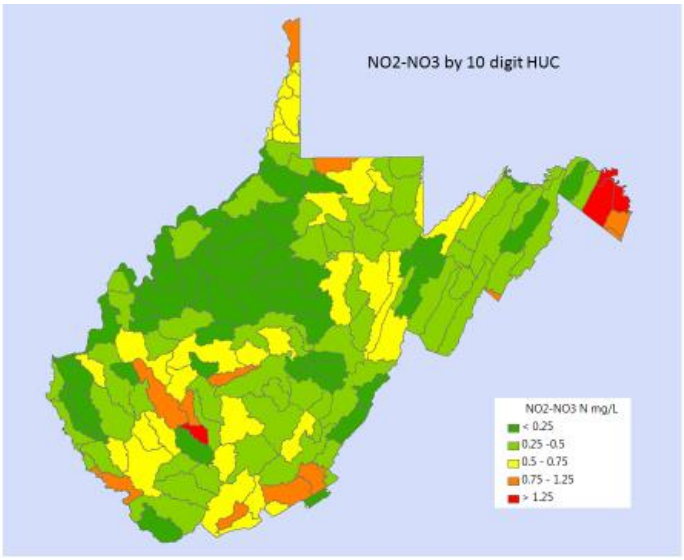


Figure 2 – Nitrate/Nitrite



B. Designated Uses – Determine what categories are affected

1. Water contact recreational designated uses have been affected in some streams due to nutrient impairment. In 2012, West Virginia contracted with a research firm to conduct a public survey to help determine what recreational tolerance levels the public has in relation to filamentous algae coverage within streams (Response Management, 2012).

Participants in the survey responded to photographs of algae coverage at varying levels to determine the public's threshold for algae coverage for various recreational usages. A summary of some of the user perception survey results are indicated in Figures 3-5.

Figure 3- Survey results comparing percent algae coverage to percent of survey respondents' recreational use tolerance (Responsive Management, 2012)

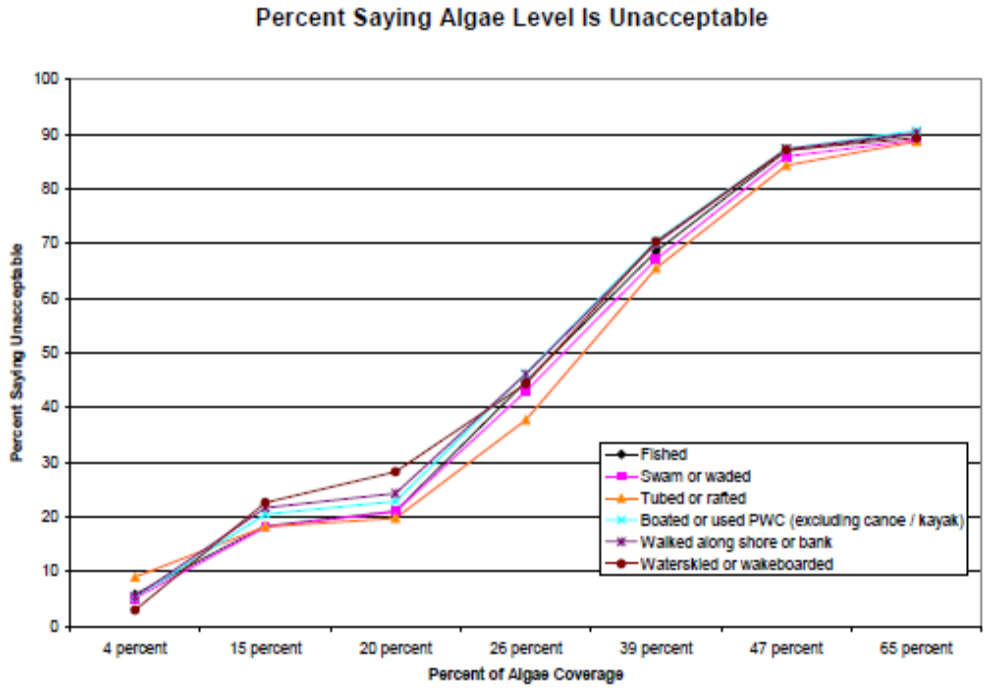


Figure 4 – Survey results showing the degree that different groups find 20 percent algae coverage unacceptable (Responsive Management, 2012)

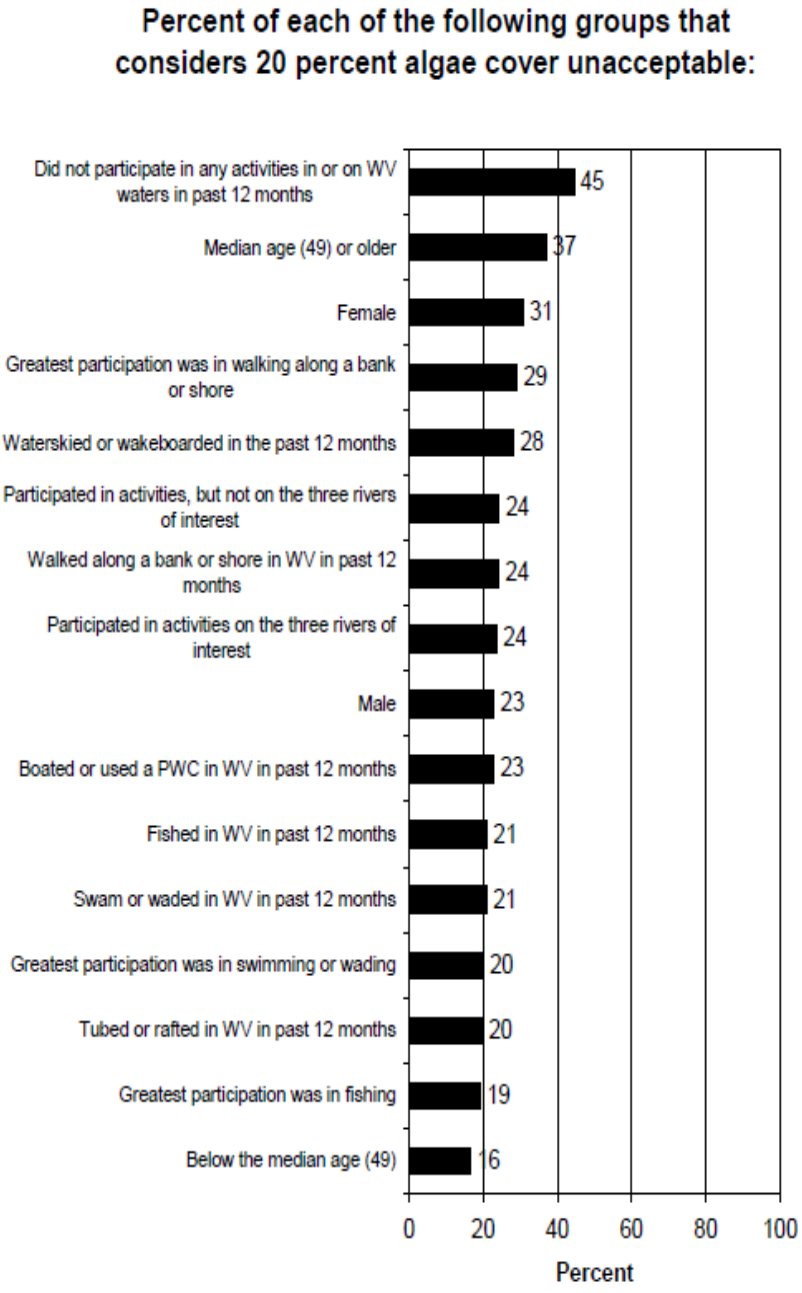
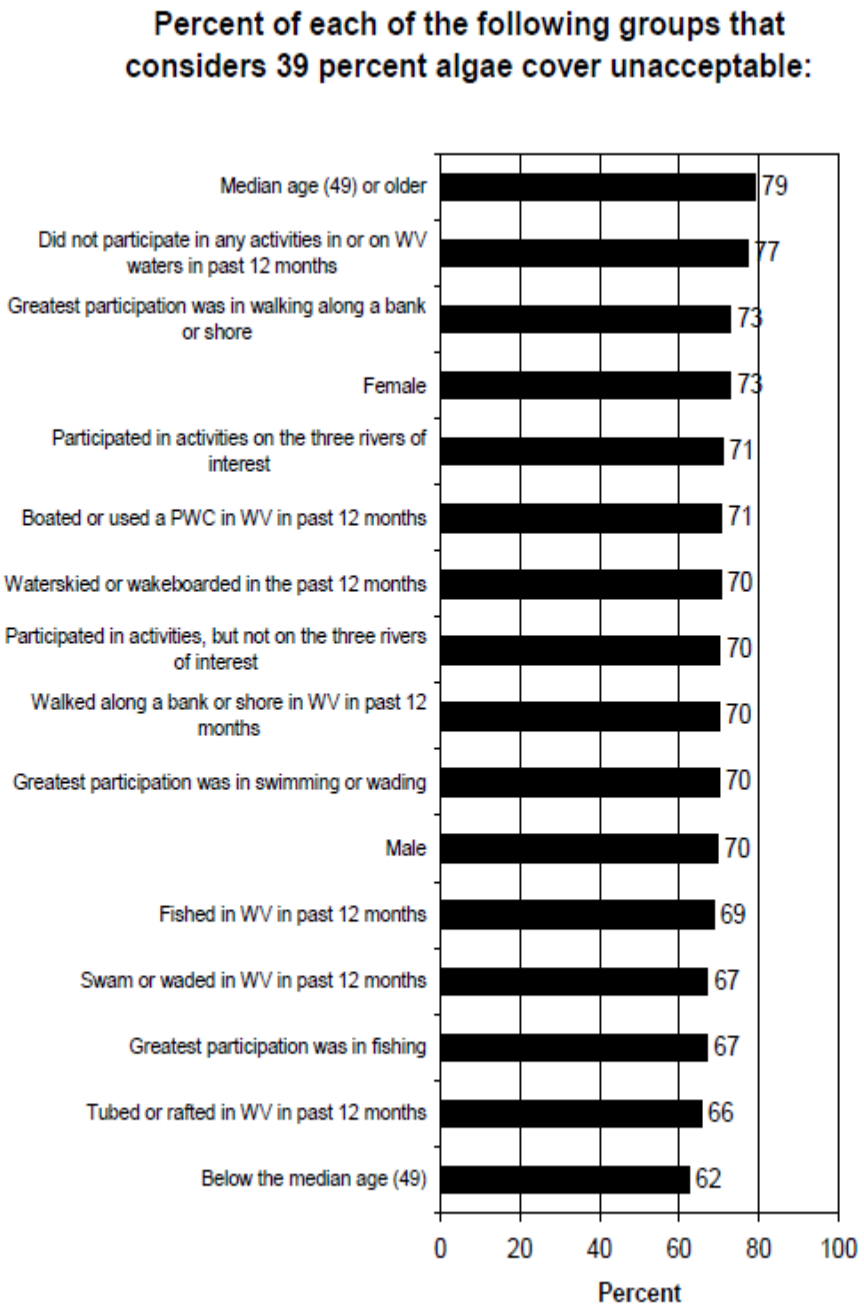


Figure 5 - Survey results showing the degree that different groups find 39 percent algae coverage unacceptable (Responsive Management, 2012)



WVDEP developed a "303(d) Listing Methodology for Algae Blooms", which is currently being used in lieu of Total Phosphorus or Total Nitrogen nutrient criteria for streams within the state (WVDEP-LM, 2013). To facilitate this approach, West Virginia has developed an Algae Monitoring and Assessment Standard Operating Procedure (WVDEP-SOP, 2015) for determining stream impairment due to excess filamentous algae.

The following SOP guidelines are used to evaluate compliance with the narrative water quality standard. Such guidelines will continue to be used to determine if streams impaired by filamentous algae blooms shall be 303(d) listed.

a) A filamentous algae cover of greater than 20% will be judged to interfere with the recreational use of a stream whenever that bloom extends for a longitudinal distance greater than three times the average stream width in the impacted segment of stream, as determined by a minimum of three stream measurements.
b) A filamentous algae cover of greater than 40%, regardless of the location or longitudinal extent of the bloom, will be judged to interfere with the recreational use of a stream.
c) Whenever a stream has filamentous algae covering more than 20% of a transect, and the algae bloom is located immediately adjacent to any occupied dwelling, campground, or developed public access site, DEP may determine that the recreational use of a stream is impaired.
d) Guidelines a-c are intended only for nontoxic filamentous algae blooms and do not address, for example, growth of periphyton, sestonic algae blooms, or bloom events involving toxic or otherwise harmful algae.
e) Relating to filamentous or any other algae blooms causing taste or odor that interferes with the use of the water and/or causing additional (unreasonable) treatment to be required at drinking water plants, DEP considers any treatment beyond "conventional treatment" that is required as a result of taste and/or odor complaints associated with algae blooms to be grounds for classifying a stream as impaired.

2. Aquatic Life Designated Uses - To date, West Virginia has not observed any significant adverse aquatic life effects in streams due to nutrient pollution. In conjunction with the EPA, WVDEP contracted Tetra Tech, Inc. in 2008 to conduct a study to analyze nutrients and biological data (Tetra Tech, 2008). The study concluded that there was a poor correlation between stream nutrient concentrations and biological response within streams in West Virginia. Aquatic effects due to nutrients will continue to be studied and evaluated within all waterbodies of the state to include such strategies as statistical methodology.

C. Data Inventory and Analysis

WVDEP-Watershed Assessment Branch samples streams within 32 U.S. Geological Survey (HUC 8) watersheds of the state gathering water quality, benthic macroinvertebrate, and fish community data. In order to identify potentially impaired streams, an inventory / analysis of water chemistry data and biological conditions has been ongoing and shall

continue to be investigated to determine if there is any cause-effect relationships in regard to nutrients. Such data is stored in an Oracle database (with an MS Access "front-end") called WABBASE. In addition, data from other divisions within WVDEP and other entities is gathered, reformatted, and brought into a MS Access based 'Decision Database' that is primarily used for 303(d) and 305(b) assessments. Other data providers include:

a. WV Department of Agriculture
b. ORSANCO (Ohio River Valley Water Sanitation Commission)
c. ICPRB (Interstate Commission on the Potomac River Basin)
d. USGS (United States Geological Survey)
e. WV Bureau of Public Health
f. US Army Corps of Engineers
g. NPDES
h. Volunteer monitoring
i. WVDNR (West Virginia Division of Natural Resources)
j. USEPA (ex. EMAP)
k. USEPA national Nutrient Criteria Database
l. USEPA Regional Database (Region 3)
m. NRCS data (National Resource Inventory)
n. University data
o. Data from other states
p. USFWS (United States Fish & Wildlife Service)

D. Spatial, Physical, and Temporal Considerations

Nutrient impairment may be related to the type of physical and chemical properties associated with a particular watershed or stream. Ecoregions will continue to be evaluated to determine what similarities and differences may exist related to nutrient impairment. To date, however, it has not been evident that nutrient pollution and impairment is more likely to occur in one ecoregion compared to another (See Figures 1 and 2). There are four Level III and seventeen Level IX ecoregions in the state of West Virginia (See Figure 6). West Virginia is located in the EPA nutrient ecoregion XI (See Figure 7). Eco-regions are being evaluated to determine if there is a link regarding stream chemistry and nutrient impairment using such methods as multivariate spatial analysis. In addition, water chemistry and associated nutrient concentration are being studied to determine potential seasonality effects.

Many factors are being evaluated to determine the cause of nutrient impairment issues within West Virginia streams and the associated effects on designated uses. Multiple parameters of concern are being evaluated through different monitoring methods and review of data from multiple sources. In addition, the role of watershed location and seasonality may prove to be a key factor of concern to help determine what correlations may exists.

Figure 6 – EPA Region 3 (West Virginia Included) Level III and IV Ecoregions (Map Source, US EPA 2003)

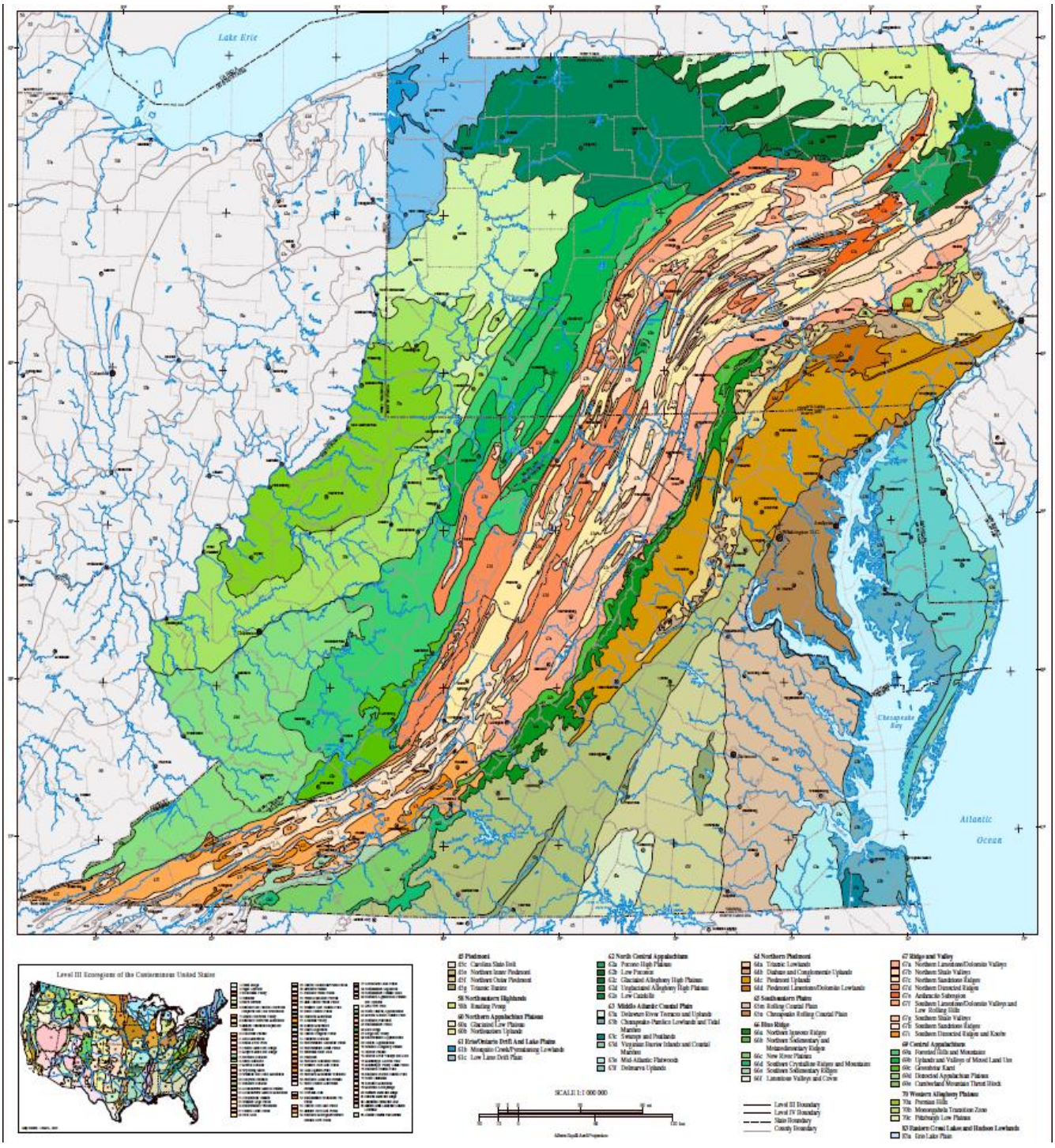
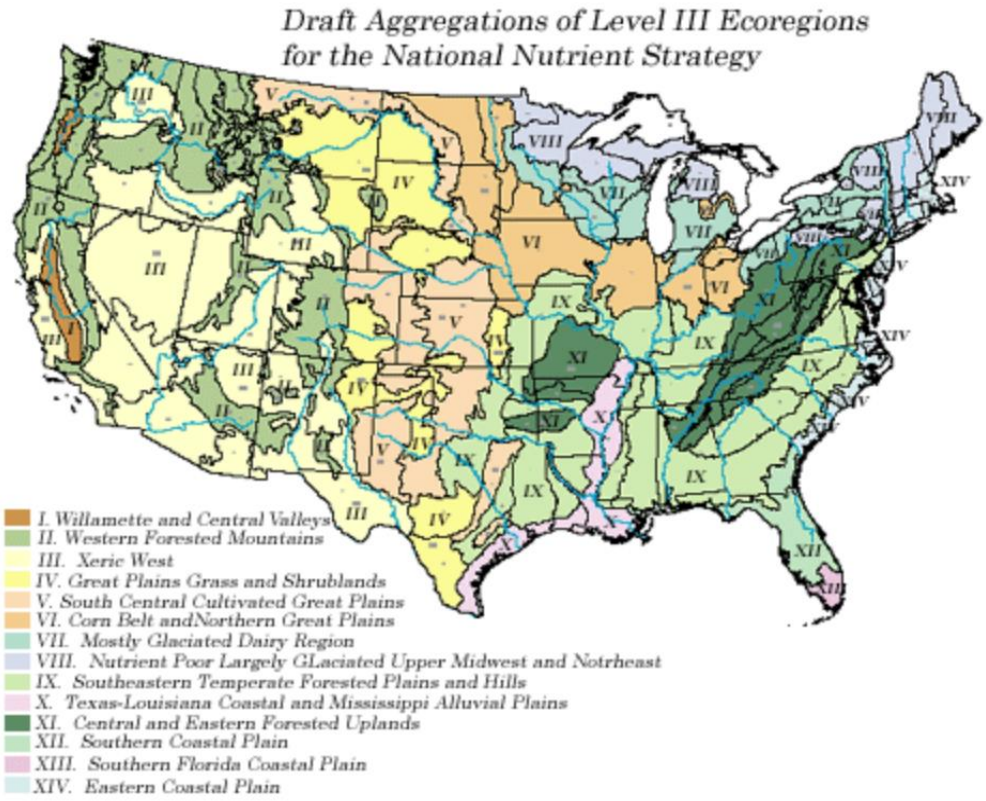


Figure 7 – EPA Nutrient Ecoregions (Map Source, EPA Nutrient Criteria Technical Guidance Manual-delineated by Omernik, 2000)



IV. Nutrient Criteria and Impairment Restoration Strategy:

West Virginia believes it has both a preventive and aggressive strategy for addressing nutrient impairment issues within state waters. The following step development process and associated flow chart (Figure 8) diagrams how this strategy is accomplished.

Step 1 - West Virginia shall determine if water bodies are impaired due to nutrient pollution based on both existing narrative and numeric water quality standard criteria.

Step 2 - West Virginia has an extensive stream monitoring program to determine if nutrient impairment issues exists. In addition to those sources of data listed in section IIC of this plan, annual statewide monitoring is conducted to gather data through the "Ambient (long-term monitoring for large streams), "Probabilistic"(ensure adequate coverage across all watersheds and ecoregions),"LiTMuS" (long-term monitoring for small streams), and deployable continuous water quality meter sampling programs. West Virginia also has a Watershed Management Framework program consisting of a five year rotating hydrological basin monitoring and assessment cycle. Five hydrological basin groups (A through E) have been established that are each made up of between 5 to

8 watersheds, Figure 9. Each group is assessed every five years for multiple parameters including nutrients. Both targeted (when resources are available) and pre-TMDL data is collected within a hydrological basin during a five year cycle period.

Step 3 - Every two years monitoring data is evaluated to determine which waterbodies may need to be 303(d) listed as impaired. A determination of impairment due to algal blooms is based on West Virginia's 303(d) Listing Methodology for Algae Blooms that was developed in 2013. Streams shall be listed as impaired due to algal blooms based on the percent algae coverage that may interfere with recreational and public water supply usage of a stream.

Step 4 - Once 303(d) listed as impaired due to nutrients, a TMDL shall be developed or an alternative EPA approved restoration approach shall be adopted if shown to be more immediately practicable and beneficial to meet Water Quality Standards. As part of the TMDL (or alternative) development process, stream monitoring and pollutant source characterization within a watershed shall be completed. Data collected will be used to qualify the relative contributions of causative source and/or categories of sources. The TMDL (or alternative) will specify reductions to the various contributing sources necessary to achieve water quality standards.

Step 5 - Non-point sources of nutrient pollution shall be determined and evaluated. Prioritization of nonpoint source Best Management Practice implementation shall be conducted. West Virginia's approach to reducing nutrients from nonpoint sources is voluntary and exists at both the state and watershed specific level. This multi-agency and non-government organizational effort involves the WVDEP-Watershed Improvement Branch (WIB) and the following agencies; the WV Conservation Agency, the WV Department of Agriculture, USDA Natural Resources Conservation Service, Farm Service Agency, and the WV Department of Health and Human Resources. Non-point sources include such areas as runoff from agriculture, failing septic systems, and urban storm water. West Virginia is subject to the Chesapeake Bay TMDL and has developed a Watershed Implementation Plan to help reduce nutrients. In addition, a Chesapeake Bay Watershed Model has been developed to help address nitrogen and phosphorus non-point issues. Education, outreach, and technical assistance are key methods to achieving these goals.

Step 6 - Point sources that are determined to be significant contributors of nutrient pollution shall be required to initiate corrective actions necessary to reduce nutrient loadings to receiving waters to meet water quality standards. Numeric discharge permit limits shall be developed based on the TMDL process. For those facilities that can demonstrate that it is not immediately economically feasible to upgrade their systems to meet water quality standards, a built in variance approach may be established giving time to come into compliance.

Step 7 - West Virginia will evaluate developing numeric nutrient criteria or establishment of a Treatment Technology approach should a Gulf of Mexico TMDL be created similar to that which has been developed and adopted for the Chesapeake Bay.

Such numeric limits would apply to national pollutant discharge elimination system (NPDES) permit limits.

Step 8 - Algae assessments will continue to be conducted seasonally until 2020 to see if the existing alternative restoration approach for the Greenbrier River is being protective of all designated uses. If the alternative restoration approach in combination with the existing narrative standard is not adequate, scientifically defensible numeric criteria shall be studied for development.

Figure 8 – Nutrient Strategy:

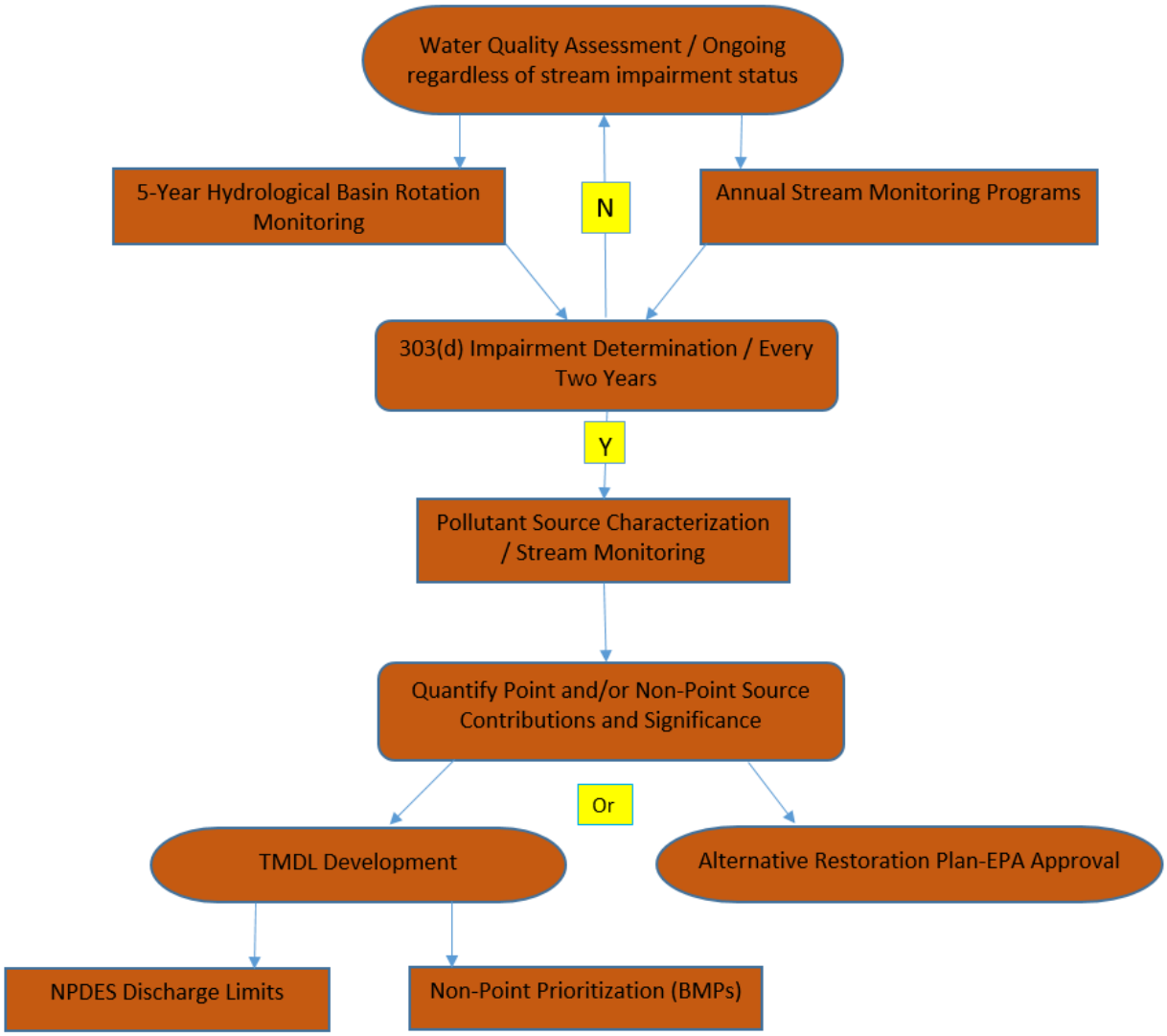
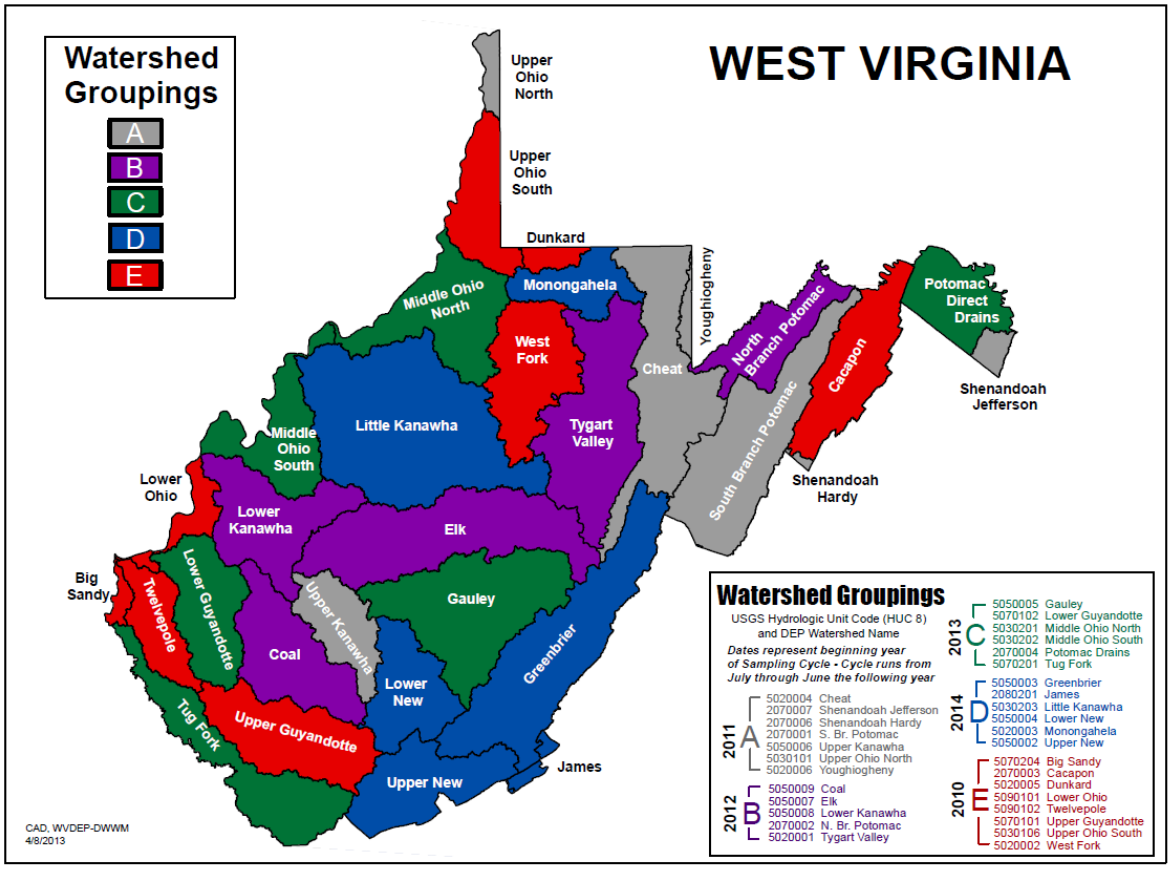


Figure 9 - West Virginia Watershed Framework Rotation Basin Map



V. Downstream Protection

West Virginia will continue to strive to be protective of downstream waters to ensure water quality standards are met and maintained. This shall be accomplished through current narrative and numeric nutrient water quality criteria, using the alternative EPA approved restoration approach process, Chesapeake Bay TMDL Initiative, and TMDL development process and associated permit discharge limits.

VI. Conclusion

West Virginia has an aggressive monitoring and assessment strategy to identify waterbodies impaired due to nutrient pollution. Existing narrative and numeric nutrient water quality criteria are used to make impairment determinations. TMDL development or an approved EPA alternative restoration approach shall continue to be pursued for those waterbodies not meeting nutrient water quality standards. West Virginia will continue to study and improve nutrient criteria if needed and will be open to any EPA guidance or

federal initiatives to help develop the process. To date, nutrient pollution issues within the state have largely been determined to be point source related. Funding to help nutrient pollution contributing sources maintain or adopt maximum technologies needed to reduce the concentration of pollution discharges and maintain water quality standards remains a challenge. As future funding may become available increased efforts can be directed toward continuing to reduce the point source nutrient problem within state waterbodies.

VII. References:

Omernik, J. A. 2000. Draft Aggregations of Level III Ecoregions for the National Nutrient Strategy. http://www.epa.gov/ost/standards/ecomap.html

Responsive Management. 2012. West Virginia Residents' Opinions On And Tolerance Levels Of Algae In West Virginia Water. http://www.dep.wv.gov/WWE/Programs/wqs/Documents/WVAlgaeSurveReport_ResMgmt_WVDEP_2012.pdf

Summers, James. 2008. West Virginia Department of Environmental Protection (WVDEP) / Division of Water and Waste Management. Assessment of Filamentous Algae in the Greenbrier River and other West Virginia Streams (AFA).

Tetra Tech, Inc. 2008. Analysis of West Virginia Stream Nutrient and Biological Data for the Nutrient Scientific Technical Exchange Partnership Support – N-STEPS.

United States Environmental Protection Agency. 2000. Nutrient Criteria Technical Guidance Manual - Rivers and Streams.

West Virginia Department of Environmental Protection (WVDEP) / Division of Water and Waste Management. 2013. Greenbrier River Restoration Plan (GRRP).

West Virginia Department of Environmental Protection (WVDEP) / Division of Water and Waste Management. 2013. 303(d) Listing Methodology for Algae Blooms (LM). http://www.dep.wv.gov/WWE/Programs/wqs/Documents/Greenbrier%20Algae/AlgaeListingMethodology2014.pdf

West Virginia Department of Environmental Protection (WVDEP) / Division of Water and Waste Management / Water Quality Standards Section. 2015. Filamentous Algae Monitoring and Sampling Standard Operating Procedure (SOP). http://www.dep.wv.gov/WWE/watershed/wqmonitoring/Documents/SOP%20Doc/2015WABSOP/WBAlgae.pdf