ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
200 FAIR OAKS LANE, 4TH FLOOR
FRANKFORT, KENTUCKY 40601
PHONE (502) 564-3410
FAX (502) 564-0111
www.dep.ky.gov

Leonard K. Peters
Secretary

R. Bruce Scott
Commissioner

Sandra L. Gruzesky
Director

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EPA West, Room 3334
Washington DC 20460

RE: Kentucky Department for Environmental Protection comments on the Aquatic Life Benchmarks for Conductivity

To whom it may concern:

The Kentucky Division of Water (DOW) appreciates the opportunity to comment on two draft U.S. Environmental Protection Agency documents, "A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams (EPA/600/R-10/023A)" and "The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields (EPA/600/R-09/138A)." Using data collected primarily from West Virginia, the field-based ("Benchmark") document derives an aquatic life benchmark for conductivity purported to protect all aquatic life in the region's streams. The second document ("Effects") provides a scientific-literature review and supplement to the benchmark document. In the "Effects" discussion, stream ecosystem alterations that have been identified as occurring as a result of "mountaintop" mines (surface coal mines) and valley fills are evaluated and potential impacts noted. Specific electrical conductivity, or total dissolved solids as measured by specific conductivity, was indicated as a primary measure of ecosystem degradation by mining.

The DOW recognizes that it is certainly within the purview of EPA under the authority of The Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act of 1977 to develop and promulgate water quality standards to be adopted by states. However, within Section 303 (33 U.S.C. 1313) Water Quality and Implementation Plans and Section 304 (33 U.S.C. 1314) Information and Guidelines of the Act no mention is made of "benchmarks" that could be developed and implemented instead of, or to replace water quality standards. Likewise, Kentucky's administrative regulations (401 KAR 10:001, 10:026, 10:029, 10:030 and 10:031) establish procedures to protect the surface waters of the Commonwealth, and thus protect water resources with water quality standards that do not include the employment of benchmarks.

Although the proposed conductivity levels are termed "benchmarks," the authors use toxicity information, literature reviews and procedures similar to those employed to develop water quality criteria. EPA is proposing that the "benchmarks" be applied in permitting in a similar manner to water quality criteria and be adopted as the interpretation of the narrative standard for conductivity in and by the affected Appalachian states (*e.g.*, Kentucky). In effect, EPA appears to be utilizing their permit objection authority to institute the "benchmarks" as numeric interpretations of narrative water quality standards for coal mining activities in central Appalachian states. The use of this benchmark as a numeric standard is a significant change in the DOW's interpretation of its own water quality standards. DOW is prohibited by KRS 13A.130 from modifying its water quality standards by implementing this "benchmark" as policy. Furthermore, KRS 224.16-050 (4) prohibits DOW from issuing a permit more stringent than regarding permit limits more stringent than what is applicable under federal regulation.

The two papers provide strong support for the use of conductivity as a measurement to detect potential impacts to aquatic life and as water quality "benchmark." However, it is premature for EPA to impose this benchmark as a numeric interpretation of a water quality standard or a permit limit. The DOW urges EPA to support permitting efforts that rely on the monitoring of outfalls and receiving streams to gather site-specific information while EPA moves forward in the development of an appropriate and applicable water quality standard.

Unlike other multi-constituent water quality measurements such as pH, a given conductivity level (*e.g.*, 300 µS/cm) may result in various toxic responses in aquatic life depending upon which ions are present. Specific conductance measures how well water can conduct electrical current, the higher the conductivity the higher the concentration of ionic (dissolved) constituents. In general, calcium (Ca^{+2}), magnesium (Mg^{+2}), sodium (Na^{+1}), potassium (K^{+1}), bicarbonate (HCO_3^{-1}), sulfate (SO_4^{-2}) and chloride (Cl^{-1}) are the most common ionic contributors to the conductivity measurement in environmental samples, but metals other than the common cations noted may be paired with a sulfate, chloride or bicarbonate anion to result in a conductivity measurement (e.g., Hg, Cd, Zn). A conductivity measurement determined for a mercuric sulfate solution likely will show a distinctly greater toxicity than the same conductivity level resulting from a calcium sulfate solution. Even a mercuric sulfate versus a mercuric chloride solution of similar specific conductance may demonstrate a different toxic response.

As noted in the U.S. EPA Guidelines for Deriving Numerical Water Quality Criteria by Stephan *et al.* (1985), "if feasible, a freshwater numerical aquatic life national criterion for a material should be determined by conducting field tests" by "adding various amounts of the material to an unpolluted water body and determining the highest concentration that would not cause unacceptable long-term or short-term effect on aquatic organisms." Although the benchmark study did not add salts at various concentrations to an unpolluted stream, analytical information was supplied in both of the documents that mining activities was dosing the streams with salts that could be quantified with conductivity measurements. The studies further indicated that in the study area (West Virginia) few other contaminants were present in the water including some pollutants (e.g., heavy metals) historically found to be associated with mining activities (*e.g.*, Tables 4-6, "Effects" document), thereby discounting cofactors (e.g., metals) that could have influenced the toxic response of conductivity in area streams.

Numerical national water quality criteria have utilized, since the 1970's (details outlined in Stephan *et al.* 1985), results from laboratory conducted toxicity tests on a number of species of fish, benthic invertebrates, zooplankton, plants and algae. The organisms to be tested represent several kingdoms, phyla, orders, families, genera and species. The goal of this approach was to choose concentrations of a particular constituent that would be protective of 95% of all species of organisms that could be present in a water body. The proposed conductivity benchmarks evaluate toxic impacts on many species and genera of insects, but only those genera and species in one order, *Ephemeroptera* (mayflies). Obviously, the diversity of organisms routinely used in laboratory derivations of criteria is missing from the consideration of one group, but a case can certainly be made that depuration of a number of genera of any order of aquatic organisms from an area is sufficient to define a pollution link. Especially in smaller (wadeable) Appalachian streams, the families, genera and species of *Ephemeroptera* are ecologically significant and may be a keystone to stream health for many organisms.

The benchmark conductivity study focused on data collected from Tier III Ecoregions 69 and 70 (Figure 1, "Effects" document) primarily collected in West Virginia and verified with a smaller data set from Ecoregions 68, 69 and 70 in Kentucky. Although the causation arguments appear fairly strong for conductivity levels and impacts, or at least conductivity as a measure of impacts, the applicability of the benchmarks beyond these ecoregions (68, 69, and 70) was not necessarily supported in the study. The primary ionic constituent represented in the conductivity measurements was sulfates (not cation-specific). In areas of Kentucky beyond the three ecoregions, the streams are dominated by carbonate bedrock influences and bicarbonates and in still other areas by chloride salts. Conductivity benchmarks and criteria developed and based on chemical conditions in one area likely are not applicable in other ecoregions. If sulfates are the presumptive causative ionic agent responsible for the elevated conductivity levels and the corresponding toxicological affects on *Ephemeroptera*, it would seem appropriate to develop water quality criteria for sulfates themselves, especially since a given conductivity level (*e.g.*, 300 uS/cm) can be the result of a number of salts of potentially varying toxicity. Water quality criteria using laboratory procedures, and in the case for Kentucky Water Quality Standards confirmed by field studies, have been developed for another salt anion, chloride. A similar approach could be used for sulfates and yet retain conductivity as a general indicator of impacts.

To assess the applicability of conductivity benchmarks across Kentucky, the Kentucky Division of Water evaluated its collective conductivity data versus its macroinvertebrate index (MBI) ratings used to evaluate stream designated uses in Kentucky's seven ecoregions. It should be noted that except for data collected with regards to specific pollutant surveys (*e.g.*, PCBs) all sampling data and MBI ratings were included in the analysis. Additional screening of the data for known sources of pollution that may be identified by the MBI ratings will be necessary to evaluate realistically the conductivity cause-effect benchmark across Kentucky. Although data from over 19,000 samples were evaluated, approximately eleven percent of the 92,000 miles of stream in Kentucky has been assessed for impairment and is represented in the 19,000 sample data set. Of the streams assessed statewide, approximately 60% of the streams were impaired using the MBI rating (fair, poor or very poor); approximately 75% of streams had conductivity measurements of 500 μS/cm or less and 45% fell at or below 300 μS/cm. Of the streams in this category (< 300 μS/cm), half were impaired and half were not. This would suggest that conductivity alone is not an adequate predictor of stream health.

In addition to the general comments provided above, DOW offers the following specific comments for your consideration.

Comments on A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams (EPA/600/R-10/023A).

1. p. 1, line 19. Although Na^{+1}, Ca^{+2}, Mg^{+2} and K^{+1} may be the more common cations contributing to salinity in the surface waters evaluated in these two studies, iron (Fe, primarily as ferrous and ferric forms) has been found in the past to be a significant contributor to stream water-quality challenges in the area. If Fe is considered by EPA as no longer part of the water-quality challenges present by coal surface mining (presumably due to the use of limestone treatments of releases of iron-rich water), it would seem appropriate to discuss this shift in environmental impacts and focus in the introduction.

2. Sources of conductivity. While coal mining activities, wastewater treatment plants and other activities are mentioned as sources of conductivity others are not addressed, such as silviculture and road building. The impact of these activities should be elucidated as well.

3. p. 5, line 26. It is indicated that the WABbase contains data from Ecoregions 66, 67, 69, and 70 as illustrated in Figure 1. Figure 1 (p. 27) only appears to indicate Ecoregions 69 and 70.

4. Data-set characteristics. The introduction states that all sites are < 155 km^2. When comparing probabilistic sites to reference sites and impaired reaches, was some calculation made to ensure that catchment size or flow was not skewing the data? Are the reference sites as large as the impaired? Do the probabilistic sites consider the full spectrum of catchments equally?

5. p. 6., lines 26-27. "Excluded if the mixture was dominated by Cl^- rather than SO_4^{-2}." Does this statement preclude the use of the conductivity standard for oil and gas, wastewater releases and areas where shales are dominated by chloride salts?

6. p. 7. Genera were excluded from the analysis based on their presence at fewer than 30 sampling locations. What is the nature of the halogenic tolerance of these genera? How would the data look if it included these 30 genera? Would any of the excluded genera include species that are categorically endangered? If endangered, should consideration be included in the standard for their protection? The goal of a water quality standard and presumably a benchmark is to provide protection for 95% of the species present, elimination of 30 genera could include more than 5% of the species present.

7. p. 10, line 28. Other confounders were not partitioned from the data. It would seem appropriate to provide a list here of all the confounders evaluated that were not portioned from the data.

8. p. 18, lines 3-4. All mussels (bivalves) were not include in the analysis. Some mussels such as *Corbicula sp.* were included. Native mussels were not included (?).

9. Estimating background. Were the reference sites used from the WABbase all of a similar catchment area? If not, does this skew the results?

10. p. 50, lines 7-10. Although a measure of lethality may not reflect the total possible impacts to a population, lethality is a population-level effect. If the organisms are dead the population is unlikely to continue. Perhaps this is what has happened to the rare genera precluded from the analysis.

11. p. 52, Summary. The problem with laboratory toxicity tests and salinity is the same problem with that seen in the field studies: salts exist as an anion and cation mixture, and the conductivity is only a measure of the ability of an aqueous solution to carry an electrical current. Sulfates or chlorides do not exist in the water by themselves but rather with the corresponding cation-portion of the salt mixture (*e.g.*, Na^{+1}, K^{+1}, Mg^{+2}, $Fe^{+2,+3}$, Mn^{+2}, or any of a number of metals). Laboratory testing, as well as criteria development, has focused on the metal portion of the salts (*e.g.*, Na^{+1}, Mg^{+2}, Fe^{+2}) rather than the sulfates, chlorides and carbonates portion; laboratory studies indicate that the cation part of the salt is also likely important. The conductivity benchmark may only be applicable to those areas where sulfate salts predominate, therefore requiring additional monitoring to support its use. Laboratory tests could test the association, and/or published laboratory-derived data could be evaluated to determine if these associations were necessary (*e.g.*, compare toxicity for iron sulfate vs. iron chloride vs. iron carbonate vs. iron nitrate).

12. p. 73, lines 5-7. The conclusion that *Ephemeroptera* are more sensitive to conductivity than pH appears to be a significant stretch of the information. The results reported in Table B-15, B-16 could be related to one genus or one species that was tolerant of low pH, or the mediating factor of

carbonates that could be influencing the results noted. Noting that some members of a large group are present does not indicate a trend if 99% of the group do not fit the trend.

13. p. 73, line 24-27. The conclusion statement that temperature is moderately correlated with conductivity requires a qualifying statement. The analytical measurement of conductivity (specific conductivity) is temperature dependent; conductivites are normalized to 25°C. In addition, temperature is not an unrelated influence: elevated temperature will eliminate Ephemeroptera. Perhaps there was no noticeable effect within the range the study evaluated (17 to 22°). A similar statement to that made for pH can be made for temperature; "some" does not mean the majority.

The write-up provides strong support for the use of conductivity as a measurement to detect potential impacts to aquatic life and as water quality "benchmark." As with pH, conductivity is a combination factor that measures a number of potentially toxic factors under one general factor. This "benchmark" may only be applicable to areas where sulfates are the primary ion controlling the conductivity levels.

Comments on The Effects of Mountaintop Mines and Valley Fill on Aquatic Ecosystems of the Central Appalachian Coalfields (EPA/600/R-09/ 138A).

1. Flow alteration. When considering the aquifer capacity and the statistics with regards to the valley fills, how long was the fill complete before analyzed? Was temporal component considered?

2. p. 27, lines 1-2. It is highly likely that any land disturbance (e.g., residential, road construction) will result in elevated conductivity levels, including corresponding sulfate levels.

3. p. 27, lines 25-26. Although PAHs may demonstrate low bioavailability from sediments, invertebrates likely will ingest them and once ingested the level that can result in toxic impacts is quite low.

4. p. 35, Toxicity tests. Although acute toxicity tests seldom are as sensitive to toxic substances or conditions as chronic tests, the two most commonly used species noted (*Ceriodaphnia dubia* and *Pimephales promelas*) also may be tested with "standard" chronic tests that do include sensitive endpoints (*e.g.*, egg development). The tone in which the section is written indicates that it was not possible to conduct such studies in a standard manner; that really is not true. Fathead minnow (*Pimephales promelas*) is native to Kentucky streams in the area (the type locality for the species was in Kentucky), although it may have been more widely distributed as a bait minnow in the state. It may be that the fathead minnows found in West Virginia streams have also been supplemented by bait introductions, although distributional atlases indicate that it does occur widely. Although *Ceriodaphnia sp.* occurs in Kentucky, they are a lake/pond group. It should be noted that toxicity testing with fathead minnows was developed at the U.S. EPA Newtown Fish Toxicology Laboratory, Ohio with fish collected originally in Kentucky (personal communication, Quentin Pickering U.S. EPA).

5. p. 42, lines 23-24. Mallard ducks may be a good surrogate for aquatic birds but they are not a good surrogate for fish eating (piscivorous) birds since they eat primarily insects and aquatic vegetation.

6. p. 79, Section 8.3.5, 1st paragraph. This paragraph does provide the framework necessary to support that what is proposed will answer the question regarding selenium transfer through the food chain. Extensive data currently exists on accumulation of selenium into fish eggs. Is the proposal to correlate a known sediment concentration to a fish egg and resultant fish concentration or is something else proposed?

Summary:

1. Unlike other multi-constituent water quality measurements such as pH, a given conductivity level (e.g., 300 μS/cm) may result in various toxic responses in aquatic life depending upon which ions are present.

2. Especially in smaller (wadeable) Appalachian streams, the families, genera and species of *Ephemeroptera* are ecologically significant and may be a keystone to stream health for many organisms.

3. Although the causation arguments appear fairly strong for conductivity levels and impacts, or at least conductivity as a measure of impacts, the applicability of the proposed benchmarks beyond these Ecoregions (68, 69, and 70) was implied, but it was not supported in the study.

4. The primary ionic constituent represented in the conductivity measurements was sulfates. In areas of Kentucky beyond the three ecoregions, the streams are dominated by carbonate bedrock influences and bicarbonates and in still other areas by chloride salts. If sulfates are the causative agent responsible for the elevated conductivity levels, it seems appropriate to develop water quality criteria for sulfates themselves, especially since a given conductivity level (e.g., 300 μS/cm) can be the result of a number of salts of potentially varying toxicity.

5. As noted, the conductivity benchmark may only be applicable to those areas where sulfate salts predominate, therefore requiring additional monitoring to support its use. Laboratory tests could test the association and/or the lab data evaluated to determine if these associations were necessary (*e.g.*, compare toxicity for iron sulfate vs. iron chloride vs. iron carbonate vs. iron nitrate).

6. A statement to the effect that the benchmark may not provide protection for sensitive genera including endangered species may be necessary.

The Division of Water appreciates the opportunity to provide comments on these two papers. Thank you for your consideration of these comments. If you have any questions regarding these comments or other matters pertaining to the issue, please do not hesitate to contact Peter Goodman, Assistant Director, or Albert Westerman, Ph.D.

Sincerely,

Sandra L. Gruzesky, Director
Kentucky Division of Water

Attachments

SLG/ptg/aw

C: R. Bruce Scott, Commissioner
James Giattina, Director, Water Protection Division , EPA R4