**IN THE UNITED STATES DISTRICT COURT FOR
THE SOUTHERN DISTRICT OF WEST VIRGINIA**

CHARLESTON DIVISION

OHIO VALLEY ENVIRONMENTAL
COALITION, INC., WEST VIRGINIA
HIGHLANDS CONSERVANCY, INC.,
and SIERRA CLUB,

Plaintiffs,

v. CIVIL ACTION NO. 2:13-5006

FOLA COAL COMPANY, LLC,

Defendant.

MEMORANDUM OPINION AND ORDER

On August 19–22, 2014, the Court held a trial in this case on liability issues,[1] and the parties timely conducted post-trial briefing. As explained below, the Court **FINDS** that Plaintiffs have established, by a preponderance of the evidence, that Defendant has committed at least one violation of its permits by discharging high levels of ionic pollution, as measured by conductivity, into Stillhouse Branch, which have caused or materially contributed to a significant adverse impact to the chemical and biological components of the applicable stream's aquatic ecosystem, in violation of the narrative water quality standards that are incorporated into those permits.

I. BACKGROUND

Plaintiffs bring this action pursuant to the citizen suit provisions of the Federal Water Pollution Control Act ("Clean Water Act" or "CWA") and the Surface Mining Control and

[1] Pursuant to this Court's June 21, 2013, Scheduling Order, ECF No. 16, this case is proceeding in two phases: Phase I will resolve issues of jurisdiction and liability, and Phase II, if necessary, will resolve issues of appropriate injunctive relief and civil penalties.

Reclamation Act ("SMCRA"). Plaintiffs allege that Defendant Fola Coal Company, LLC ("Fola") violated these statutes by discharging excessive amounts of ionic pollution, measured as conductivity and sulfates, into the waters of West Virginia in violation of their National Pollutant Discharge Elimination System ("NPDES") permits and their West Virginia Surface Mining Permits. Before proceeding to the parties' arguments, the Court will first discuss the relevant regulatory framework.

The primary goal of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). To further this goal, the Act prohibits the "discharge of any pollutant by any person" unless a statutory exception applies; the primary exception is the procurement of an NPDES permit. 33 U.S.C. §§ 1311(a), 1342. Under the NPDES, the U.S. Environmental Protection Agency ("EPA") or an authorized state agency can issue a permit for the discharge of any pollutant, provided that the discharge complies with the conditions of the CWA. 33 U.S.C. § 1342. A state may receive approval to administer a state-run NPDES program under the authority of 33 U.S.C. § 1342(b). West Virginia received such approval, and its NPDES program is administered through the West Virginia Department of Environmental Protection ("WVDEP"). 47 Fed. Reg. 22363-01 (May 24, 1982). All West Virginia NPDES permits incorporate by reference West Virginia Code of State Rules § 47-30-5.1.f, which states that "discharges covered by a WV/NPDES permit are to be of such quality so as not to cause violation of applicable water quality standards promulgated by [West Virginia Code of State Rules § 47-2]." This is an enforceable permit condition. *Ohio Valley Envtl. Coal. V. Elk Run Coal Co., Inc.*, 24 F.Supp.3d 532, 537 (S.D. W.Va. 2014) ("*Elk Run*").

Coal mines are also subject to regulation under the SMCRA, which prohibits any person from engaging in or carrying out surface coal mining operations without first obtaining a permit from the Office of Surface Mining Reclamation and Enforcement ("OSMRE") or an authorized state agency. 30 U.S.C. §§ 1211, 1256, 1257. A state may receive approval to administer a state-run surface mining permit program under the authority of 30 U.S.C. § 1253. In 1981, West Virginia received conditional approval of its state-run program, which is administered through the WVDEP pursuant to the West Virginia Surface Coal Mining and Reclamation Act ("WVSCMRA"). W. Va. Code §§ 22-3-1 to -33; 46 Fed. Reg. 5915-01 (Jan. 21, 1981). Regulations passed pursuant to the WVSCMRA require permittees to comply with the terms and conditions of their permits and all applicable performance standards. W. Va. Code R. § 38-2-3.33.c. One of these performance standards requires that mining discharges "shall not violate effluent limitations or cause a violation of applicable water quality standards." *Id.* § 38-2-14.5.b. Another performance standard mandates that "[a]dequate facilities shall be installed, operated and maintained using the best technology currently available . . . to treat any water discharged from the permit area so that it complies with the requirements of subdivision 14.5.b of this subsection." *Id.* § 38-2-14.5.c.

West Virginia's water quality standards are violated if wastes discharged from a surface mining operation "cause . . . or materially contribute to" 1) "[m]aterials in concentrations which are harmful, hazardous or toxic to man, animal or aquatic life" or 2) "[a]ny other condition . . . which adversely alters the integrity of the waters of the State." *Id.* § 47-2-3.2.e, -3.2.i. Additionally, "no significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems shall be allowed." *Id.* § 47-2-3.2.i.

This Court has previously determined that a West Virginia Stream Condition Index

("WVSCI") score below the EPA-approved impairment threshold of 68 indicates a violation of West Virginia's biological narrative water quality standards, as embodied in § 47-2-3.2.e and -3.2.i. *Elk Run*, 24 F.Supp.3d at 556. In *Elk Run*, Defendants argued that liability based on conductivity levels would effectively create a water qualify effluent limit, which according to a federal district court in *Nat'l Mining Ass'n v. Jackson*, 880 F.Supp.2d 119, 137–42 (D.D.C. 2012), exceeded EPA authority. Though already recognized as inapposite to the issues presented in *Elk Run*—as well as the case at hand—the Court now also notes that *Jackson* has since been reversed. *Nat'l Mining Ass'n v. McCarthy*, 758 F.3d 243 (D.C.Cir. 2014) (concluding that EPA's Final Guidance amounted to a general statement of policy explaining how the agency would enforce existing rules and was not a final agency action subject to pre-enforcement judicial review).

This Court has also previously determined Plaintiffs' substantive burden in the case at hand upon Defendant's oral motion for a judgment on partial findings at the close of Plaintiff's evidence. *See* Memorandum Opinion and Order, ECF No. 114. After reviewing all the evidence then before the Court and legal arguments briefed by the parties, the Court denied Fola's motion, finding instead that Plaintiffs had provided some evidence that a pollutant had caused or materially contributed to biological impairment at Stillhouse Branch in violation of Fola's permits. *Id.* Specifically, the Court determined that Plaintiffs' burden is to show that the high conductivity measured at Stillhouse Branch is composed of some mixture of ions that is known to cause or materially contribute to impairment. *Id.* at 7. Upon reviewing Plaintiffs' evidence, the Court then concluded that Plaintiff had produced some evidence that high conductivity in central Appalachian waterways receiving alkaline mine drainage, e.g., Stillhouse Branch, is dominated by a unique mixture of ions and that particular variety of ionic pollution is known to cause or materially contribute to biological impairment. *Id.* at 21. While the Court previously reviewed the sufficiency of the evidence in terms of surviving a motion for judgment on partial findings, now the Court considers whether Plaintiffs have met their ultimate persuasive burden of showing that one or more violations occurred by a preponderance of the evidence.

II. LIABILITY

A. Legal Issues

Fola opens its post-trial briefing with a reiteration of arguments already defeated: permit shield defense and appropriateness of relying on WVSCI scores to determine violations of the narrative water quality standard. After briefly revisiting these settled questions of law, the Court will then address Fola's novel legal arguments relating to general and specific causation.

1. Permit Shield

In Defendant's 2009 application for renewal of its NPDES permit, Defendant submitted conductivity and sulfate measurements similar to the measurements relied upon in this case.[2] Despite reviewing these similar conductivity and sulfate levels, as articulated by Defendant, WVDEP "elected not to limit the concentration of conductivity or sulfate that Fola may discharge from any of the outlets covered by the permit, including Outlet 029." Def.'s Post-Trial Brief at 2, ECF No. 120. On that basis, Defendant alludes to the already settled argument that it may rely on the CWA "permit shield" defense. *Id.* at 2–3.

In an effort to defend WVDEP's permitting approach, Defendant directs the Court's attention to a recent West Virginia Supreme Court case, *Sierra Club v. Patriot Mining, Inc.*, No.

[2] Conductivity levels ranged from 3,000–4,000 µS/cm; and sulfate levels ranged from 1,000 – 2,000 mg/l. Motion for Summary Judgment, Ex. 5 at 23, 24, 31, and 33, ECF No. 57-8.

13-0256, 2014 WL 2404299 (May 30, 2014) (unpublished) ("*Patriot*").[3] In *Patriot*, Patriot Mining obtained a modification to an existing NPDES permit enabling expansion of surface mining activities at New Hill West Surface Mine in Monongalia County, West Virginia. *Id.* at *1. The modified permit included maximum daily discharge limitations for select materials, but only reporting requirements for others, including sulfate, specific conductance, and total dissolved solids ("TDS"). *Id.* Upon review, the Environmental Quality Board ("EQB") remanded the permit modification after finding that Petitioner demonstrated that levels of sulfate, conductivity, and TDS in the watershed were already "above limits known to cause harm to aquatic life, thereby violating West Virginia's narrative water quality standards." *Id.* at *2. On appeal, however, both the circuit court and the West Virginia Supreme Court of Appeals reached a contrary conclusion, upholding WVDEP's permitting decision. *Id.* at *2–3, *6. The West Virginia Supreme Court particularly explained that it was "not persuaded by the evidence of record that there is adequate agreement in the scientific community to trigger the WVDEP to conduct a reasonable potential analysis regarding sulfate, conductivity, or TDS under these circumstances." *Id.* at *5.

Despite the intervening issuance of the *Patriot Mining* decision, as Defendant's permit shield argument has failed in the past, so it fails again. Even without becoming mired in considering the appropriate precedential effect a federal district court might afford an unpublished memorandum opinion from a state court that would not itself cite to the opinion, Defendant's argument continues to fail for at least for two reasons. First, the opinion does not reveal the scope

[3] In *Pugh v. Worker's Comp. Comm'r*, 424 S.E.2d 759 (W.Va. 1992), the West Virginia Supreme Court unequivocally explained that "unpublished opinions of [that] Court are of no precedential value and for this reason may not be cited in any court of this state as precedent or authority, except to support a claim of *res judicata*, collateral estoppel, or law of the case." Thus, it is safe to assume that were similar arguments instead before the West Virginia Supreme Court of Appeals, that court would not itself cite to its decision in *Patriot*, 2014 WL 2404299.

of the record that was before the West Virginia Supreme Court of Appeals, though it is clear that the court heard no oral argument in the matter. *Patriot*, 2014 WL 2404299, at *1. Without a review or comprehensive summary of the record supporting that court's decision, this Court simply cannot determine the relative adequacy of the factual record there. As will be reviewed below, this Court's decision is informed by a considerable volume of agency findings, expert testimony, and numerous published, peer-reviewed journal articles, all offered over several days of testimony.

Second, and quite simply, permit holders are obliged under the law to comply with numeric and narrative water quality standards. *Elk Run*, 24 F.Supp.3d at 537. WVDEP's forward-looking assumptions about whether or not there is sufficient evidence to support a numeric effluent limit or trigger a reasonable potential analysis cannot be used to shield an operator from liability for discharges that later defy those assumptions and are ultimately discovered to cause or materially contribute to impairment. State court judgments regarding what forward-looking assumptions WVDEP should be making in lawfully executing its permitting duties simply do not help this Court to answer the question of whether or not Defendant has violated enforceable permit conditions.

2. Determining violations of narrative water quality standard

Defendant also restates previously unsuccessful arguments that (1) violations of the narrative water quality standard cannot be determined based solely on WVSCI scores and (2) the in-stream water quality standard is not an enforceable effluent limit. Def.'s Post-Trial Brief, ECF No. 120 at 3. As thoroughly examined and settled in *Elk Run*, notwithstanding WVDEP's contrary guidance, violations of narrative water quality standards must be determined based on a reasoned and meaningful methodology. *Elk Run,* 24 F.Supp.3d at 548–50. In the absence of advancing a meaningful methodological alternative to supplant WVDEP's previous reliance on WVSCI to determine in-stream impairment, this Court will continue to follow WVDEP's prescribed WVSCI methodology for determining compliance with biological narrative water quality standards. *Id.* at 554–56.[4]

3. Weight afforded to Ms. Carrie Kuehn's criticisms of EPA's Benchmark

In March 2011, EPA released "A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams" ("EPA's Benchmark" or "Benchmark"). Joint Ex. 58. The Benchmark is the product of four authors, eight contributors, and twenty-five reviewers—including Defendant's expert Dr. Charles Menzie—sixteen of whom were members of the Science Advisory Board ("SAB").[5] EPA's Benchmark at ix-xii, Joint Ex. 58. In short, the EPA's Benchmark is the studied product of "an eminent list of reviewers and authors." Tr. at 63. As it was relied upon in *Elk Run*, 24 F.Supp.3d at 556, Plaintiffs here rely upon EPA's Benchmark as a scientific study, among others, which supports Plaintiffs' general causation argument that high conductivity levels in streams impacted by alkaline mine drainage lead to the extirpation of some

[4] This continued reliance on WVSCI scores appropriate for judicial review is also the approach still prescribed by the EPA. In response to WVDEP's final submission of its 2012 Section 303(d) list, the EPA explained that "[f]or the reasons discussed in the enclosures, EPA partially approves and partially disapproves West Virginia's Section 2012 303(d) list consistent with the requirements of CWA Section 303(d) and 40 CFR 130.7. The basis of EPA's partial disapproval is WVDEP's decision not to evaluate existing and readily available data regarding whether certain waters are achieving West Virginia's narrative water quality criteria (W.Va. CSR § 47-2-3.2(e) & (i)) as applied to the aquatic life uses." Pl. Ex. 20 at PE302, Tr. at 57. In the Enclosures accompanying EPA's partial disapproval, EPA specifically added that "West Virginia's use of the "gray zone" is statistically unsupported." *Id.* at PE 319, Tr. at 58.

[5] The SAB Panel on Ecological Impacts of Mountaintop Mining and Valley Fills included fifteen reviewers, almost all of whom hold doctoral degrees and are faculty members at universities. Pl. Ex. 25 at PE374–75; Tr. at 62–63.

types of benthic macroinvertebrates. Pls.' Post-Trial Brief at 7–8, ECF No. 117. While Plaintiffs' reliance on the EPA's Benchmark is relatively unchanged, Defendant newly advances arguments that EPA's Benchmark suffers from fundamental analytical errors and should not be afforded determinative weight.

Defendant's argument discouraging reliance on EPA's Benchmark begins with note that the document marks EPA's "maiden voyage into the field of epidemiology." Def.'s Post-Trial Brief, ECF No. 120 at 1. Notwithstanding the agreed fact that EPA's Benchmark was reviewed by a panel of experts on the SAB, Defendant represents that the first qualified epidemiological reviewer of EPA's Benchmark is Fola's own expert, Carrie Kuehn. *Id.* at 5. Accordingly, Defendant urges that Ms. Kuehn's evaluation of EPA's Benchmark should be afforded great weight. *Id.* To determine the appropriate weight her opinions are due, the Court will review Ms. Kuehn's qualifications and credibility as a witness and then summarize and consider her critiques of EPA's Benchmark. Before doing so, however, it is appropriate to first outline how the Court must approach scientific determinations made by agencies.

"Particularly with environmental statutes such as the Clean Water Act, the regulatory framework ... requires sophisticated evaluation of complicated data.... [A court] therefore do[es] not sit as a scientific body in such cases, meticulously reviewing all data under a laboratory microscope." *Crutchfield v. Cnty. of Hanover*, *Virginia*, 325 F.3d 211, 218 (4th Cir.2003) (citation omitted) (internal quotation marks omitted). Instead, "[a] reviewing court must generally be at its most deferential when reviewing factual determinations within an agency's area of special expertise.... It is not the role of a reviewing court to second-guess the scientific judgments of the EPA." *Sw. Pennsylvania Growth Alliance v. Browner*, 121 F.3d 106, 117 (3d Cir.1997) (citation omitted) (internal quotation marks omitted); *see also Baltimore Gas & Elec. Co. v. Natural Res. Def. Council, Inc.*, 462 U.S. 87, 103, 103 S.Ct. 2246, 76 L.Ed.2d 437 (1983) ("[A] reviewing court must remember that the [agency] is making predictions, within its area of special expertise, at the frontiers of science. When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential."); *Envtl. Def. Ctr.*, 344 F.3d at 869 ("We treat EPA's decision with great deference because we are reviewing the agency's technical analysis and judgments, based on an evaluation of complex scientific data within the agency's technical expertise."); *Chem. Mfrs. Ass'n v. U.S. E.P.A.*, 919 F.2d 158, 167 (D.C.Cir.1990) ("[W]e give considerable latitude to the EPA in drawing conclusions from scientific and technological research, even where it is imperfect or preliminary."(internal quotation marks omitted)).

"[T]echnological and scientific issues ... are by their very nature difficult to resolve by traditional principles of judicial decisionmaking. For this reason, we must look at the decision not as the chemist, biologist or statistician that we are qualified neither by training nor experience to be, but as a reviewing court exercising our narrowly defined duty of holding agencies to certain minimal standards of rationality." *Reynolds Metals Co. v. U.S. E.P.A.*, 760 F.2d 549, 558–59 (4th Cir. 1985) (internal quotation marks omitted). "[A]n agency's data selection and choice of statistical methods are entitled to great deference, ... and its conclusions with respect to data and analysis need only fall within a zone of reasonableness." *Id.* at 559 (citations omitted) (internal quotation marks omitted). In the context of agency action, "if the agency fully and ably explains its course of inquiry, its analysis, and its reasoning sufficiently enough for us to discern a rational connection between its decision-making process and its ultimate decision, [a court] will let its decision stand." *Crutchfield*, 325 F.3d at 218 (brackets omitted) (internal quotation marks omitted).

In light of these precedents, and as previously analyzed by this Court in *Elk Run*, EPA's Benchmark must be afforded deference by this Court. 24 F.Supp.3d at 558–59. The EPA's Benchmark methodically defines its inquiry, explains its reasonable analysis, and supports its ultimate, rational conclusions. Additionally, the Benchmark underwent extensive scientific review, and it is respected as good—or even excellent—science within the relevant scientific community. Tr. at 75. It is against this background of deference to scientific determinations made by an expert agency that Defendant advances Ms. Carrie Kuehn's criticisms of EPA's Benchmark.

For the past six years, Ms. Kuehn has been employed in Exponent's Biomedical Engineering practice as a Senior Managing Scientist. Joint Ex. 67; Tr. at 394. In that role, she is responsible for consulting with clients, supervising reports, and helping to manage the practice. Tr. at 394–395. In recent years, Ms. Kuehn's responsibilities have included extensive work in medical device regulatory affairs. Tr. at 478. Ms. Kuehn identifies as a trained epidemiologist, having earned both a Master of Arts in Biocultural Anthropology and a Master of Public Health in Epidemiology from the University of Washington, Seattle. Joint Ex. 67; Tr. at 396–97. She holds no training in the study of ecology. Tr. at 482. Prior to being retained for purposes of this litigation, and unlike the other experts on record, Ms. Kuehn had never analyzed the type of ecological data that underlies the EPA's Benchmark. Tr. at 482–484.

Despite Ms. Kuehn's lack of training in the underlying subject matter—ecological data and systems—she nonetheless offered several critiques of the methodology and conclusions reached by the EPA. In light of Ms. Kuehn's repeated references to the importance of *a priori* knowledge in causation analysis,[6] the Court is left unsure how Ms. Kuehn remains confident in her analysis when she is without precisely that necessary knowledge-base. This is particularly curious given the extensive individual and collective experience of not only the authors of EPA's Benchmark, but also SAB reviewers and peer-reviewers on journals that accepted related articles for publication[7]—not to mention the individual and collective experience of researchers that have published corroborating articles.[8] And with respect to that latter collection of ecological experts, Ms. Kuehn was similarly willing to offer criticism outside her subject-area expertise and therefore

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[6] As explained by Ms. Kuehn, *a priori* knowledge "refers to our previous knowledge, knowledge we have that we bring to the analysis, knowledge that we are familiar with prior to conducting the study that we're doing." Tr. at 528. Ms. Kuehn further agreed that *a priori* knowledge was certainly important in ecological data analysis. *Id.*

[7] *See* Susan M. Cormier, Glenn W. Suter II & Lei Zheng, *Derivation of a Benchmark for Freshwater Ionic Strength*, 32 Envtl. Toxicology & Chemistry 263 (2013), Pls.' Ex. 3; Susan M. Cormier & Glenn W. Suter II, *A Method for Assessing Causation of Field Exposure–Response Relationships*, 32 Envtl. Toxicology & Chemistry 272 (2013), Pls.' Ex. 4; Susan M. Cormier et al., *Assessing Causation of the Extirpation of Stream Macroinvertebrates by a Mixture of Ions*, 32 Envtl. Toxicology & Chemistry 277 (2013), Pls.' Ex. 5; Glenn W. Suter II & Susan M. Cormier, *A Method for Assessing the Potential for Confounding Applied to Ionic Strength in Central Appalachian Streams*, 32 Envtl. Toxicology & Chemistry 288 (2013), Pls.' Ex. 6.

[8] *See* Gregory J. Pond et al., *Downstream Effects of Mountaintop Coal Mining: Comparing Biological Conditions Using Family— and Genus–Level Macroinvertebrate Bioassessment Tools*, 27 J.N. Am. Benthological Soc'y 717 (2008) ("2008 Pond"), Pls.' Ex. 15, Tr. at 39–41; Gregory J. Pond. *Patterns of Ephemeroptera taxa loss in Appalachian headwater streams (Kentucky, USA)*, 641(1) Hydrobiologia 185 (2010), Pl. Ex. 16, Tr. at 44–46; Gregory J. Pond, *Biodiversity Loss in Appalachian Headwater Streams (Kentucky, USA): Plecoptera and Trichoptera Communities*, 679 Hydrobiologia 1, 97 (Jan. 2012), Pls.' Ex. 17; M.A. Palmer et al., *Mountaintop Mining Consequences*, 327 Sci. 148 (2010), Pl. Ex. 13, Tr. at 37–39; Eric Merriam et al., *Additive Effects of Mining and Residential Development on Stream Conditions in a central Appalachian Watershed*, 30(2) J. N. Am. Benthological Soc. 399 (2011), Pl. Ex. 12, Tr. at 207; Bernhardt et al, *How Many Mountains Can We Mine?: Assessing the Regional Degradation of Central Appalachian Rivers by Surface Coal Mining*, 46(15) Environmental Science and Technology 8115 (July 2012) ("*How Many Mountains*"), Pl. Ex. 2; Pond et al., *Long-Term Impacts on Macroinvertebrates Downstream of Reclaimed Mountaintop Mining Valley Fills in Central Appalachia*, 54(4) Envtl. Mgmt. 919 (October 2014), Pl. Ex. 19, Tr. at 49–51.

without the benefit of *a priori* knowledge.[9] Yet, unlike all the other testify experts—and indeed perhaps as a function of her lack of *a priori* knowledge—it is not clear to the Court that Ms. Kuehn correctly understood the Benchmark when she conducted her review.[10]

For these reasons alone, Ms. Kuehn has neither the requisite qualifications nor the related credibility to unsettle this Court's previous and continuing conclusion that the scientific determinations made by the EPA in its Benchmark are owed deference by this Court. *Elk Run*, 24 F.Supp.3d at 558–59. The Court will thus properly defer to the EPA's determination that (1) mountaintop mining with valley fills is a substantial—if not the primary—source of conductivity in adjacent streams and (2) high conductivity in streams causes significant biological impairment to—including the localized extinction of—aquatic macroinvertebrates.

Even without such deference, the Court is not persuaded by Ms. Kuehn's criticisms of EPA's Benchmark. Substantively, Ms. Kuehn criticizes the EPA's Benchmark insofar as she claims that (1) EPA never adequately addressed concerns raised by SAB and (2) EPA's analysis of confounding factors was flawed. With respect to the first criticism, the reviewing SAB panel

[9] As she did with EPA's Benchmark, Ms. Kuehn noted fundamental errors in a paper recently published by Dr. Gregory Pond, Tr. at 475–76, motivating her surprise that it was accepted for publication at all, much less in a prestigious journal—one which she was evidently unfamiliar with but for purposes of her testimony. Tr. at 476–477.

[10] According to Ms. Kuehn's testimony at trial, she reviewed the EPA's Benchmark with the understanding that it was developed because the EPA was "examining the effect of conductivity on stream impairment as measured by the WVSCI and whatnot." Tr. at 518. In fact, and as recognized by all of the other testifying expert witnesses, the EPA's Benchmark identified genera of benthic macroinvertebrates extirpated by conductivity in Central Appalachian streams, with "nothing to do with informing us about GLIMPSS or WVSCI in terms of the benchmark value." Testimony of Dr. Menzie, Tr. at 656–657; *see also* Testimony of Dr. Palmer, Tr. at 61 ("The benchmark is describing work [EPA] did to establish a relationship between extirpation of organisms and conductivity"); and Testimony of Dr. King, Tr. at 240 ("[T]he Benchmark really is entirely based on the species sensitivity, and then they had some additional analysis where they looked at WVSCI, but it was not a huge component of their work").

indeed performed its basic function and offered constructive criticism of EPA's Benchmark. As noted by Defendant, such constructive criticism included the recommendation that, in addressing confounding factors, the EPA should:

> Consider further use of quantitative statistical analyses for understanding causality and the potential role of confounding factors. Because parametric procedures have been used successfully elsewhere to evaluate multivariate environmental data sets and can provide a relatively objective, quantitative framework for data analysis, a more rigorous statistical analysis should be contained in the document. Further, it would be helpful for the authors to clarify whether nonparametric multivariate methods, such as non-metric multidimensional scaling, were considered. At a minimum, the EPA document should discuss the pros and cons of multivariate statistical methods (such as multiple linear regressions, principal components analysis and canonical correlations, factor analyses, and partial correlations) and explain why these approaches were not applied.

Pls.' Ex. 25 at PE402. According to Ms. Kuehn, EPA failed to adequately address the Panel's concerns, first by not integrating multivariate statistical analysis into their weight of evidence technique, and second by improperly analyzing count data using linear regression. Tr. at 425–26. It is also worth noting, however, that the Panel's recommendation on how EPA might strengthen its confounding factor analysis is within a section that begins by applauding the EPA's confounding factor analysis:

> The Panel commends the authors for carefully considering factors that may confound the relationship between conductivity and extirpation of invertebrate genera. This was accomplished by: (1) removing some potentially confounding factors from the data set before determining the benchmark concentrations; and (2) considering weight-of-evidence of a suite of other potentially confounding factors that were not excluded from the data set—using correlations between potential confounding factors, conductivity, and aquatic genera (mayflies). The report has done a credible job in isolating the major, potential confounding factors and providing a basis for their assessment relative to the potential effect associated with conductivity.

Pls.' Ex. 25 at PE401. In the very least, these commending remarks by the SAB Panel reflect that while the Benchmark—like virtually any scientific enterprise[11]—does not exhaust all analytical or methodological avenues, it nonetheless passed muster with the SAB Panel.

In addition to publication of EPA's Benchmark, the lead authors submitted components of the Benchmark as individual papers to the journal *Environmental Toxicology and Chemistry*, the "flagship journal of the Society of Environmental Toxicology and Chemistry" ("SETAC").[12] Tr. at 257. As explained by Dr. King, these four independently published component articles demonstrate "not only how the method works," but also review the "causal analysis and confounding factor analysis and report the results." Tr. at 256. Ms. Kuehn's criticism, if valid, therefore impugns not only the judgment and qualifications of the individual scientists that contributed to drafting EPA's Benchmark, but also the reviewing scientists at the journal *Environmental Toxicology and Chemistry*.

It may well be the case that the scientific community will one day come to agree with Ms. Kuehn's evaluation. It is not, however, the role of this Court to reject the judgments of myriad experts conducting research within their field of expertise on the basis of uncorroborated opinions developed for purposes of litigation by an expert in a related, but distinct, field. Rather, the Court

[11] *See* Sir Austin Bradford Hill, *The Environment and Disease: Association or Causation?*, 58(5) Proceedings of the Royal Society of Medicine 295 (1965), Tr. at 550–51 ("All scientific work is incomplete—whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge that we already have, or to postpone the action that it appears to demand at a given time").

[12] *See* Susan M. Cormier, Glenn W. Suter II & Lei Zheng, *Derivation of a Benchmark for Freshwater Ionic Strength,* 32 Envtl. Toxicology & Chemistry 263 (2013), Pls.' Ex. 3; Susan M. Cormier & Glenn W. Suter II, *A Method for Assessing Causation of Field Exposure–Response Relationships,* 32 Envtl. Toxicology & Chemistry 272 (2013), Pls.' Ex. 4; Susan M. Cormier et al., *Assessing Causation of the Extirpation of Stream Macroinvertebrates by a Mixture of Ions,* 32 Envtl. Toxicology & Chemistry 277 (2013), Pls.' Ex. 5; Glenn W. Suter II & Susan M. Cormier, *A Method for Assessing the Potential for Confounding Applied to Ionic Strength in Central Appalachian Streams,* 32 Envtl. Toxicology & Chemistry 288 (2013), Pls.' Ex. 6.

must weigh the reliability of testimony in light of the collective judgments made within the scientific community, and as that community accepts the determinations of EPA's Benchmark, so too does this Court. Stated differently, while the Court is not deaf to Ms. Kuehn's criticisms—which if well-founded will presumably eventually enter the published literature—logically, the Court cannot help but conclude that it is likely that Ms. Kuehn is "baffled" (*see e.g.*, Tr. at 433–34), not because the cadre of EPA and independent scientists reviewing the Benchmark made fundamental and catastrophic missteps, but because she individually, lacking the requisite *a priori* knowledge, did not understand the analysis and methodology engaged by experts outside her field.

For the foregoing reasons, the Court finds that Ms. Kuehn's criticisms of EPA's Benchmark should not be afforded the great weight encouraged by Defendant. The Court will not discard the scientific consensus in support of the EPA's Benchmark based on opinions developed in preparation for litigation by one questionably qualified expert. More fitting to the role of courts in considering conflicting scientific and expert determinations, the Court will continue to defer to the analysis and conclusions reached by the EPA and corroborated by peer-reviewed publication in esteemed journals.

4. Specific Causation

With respect to specific causation, and contrary to arguments advanced in post-trial briefing by Defendant, Plaintiffs do not have a burden to exhaustively rule out alternative causes. Fundamentally, that is not Plaintiffs' burden because the applicable legal standard is met whether ionic pollution causes *or materially contributes to* chemical or biological impairment. 47 C.S.R. §2-3.2 (emphasis added). It is readily conceivable that multiple pollutants or stream characteristics might simultaneously materially contribute to impairment; and Plaintiff need only provide evidence showing it is more probable than not that ionic pollution as measured by conductivity is among some collection of material contributors.

Rulings requiring a "scientific 'ruling-out' of alternative causes" in a negligence action are simply inapposite. Def.'s Post-Trial Brief, ECF No. 120 at 30 (citing *Cavallo v. Star Enterprise*, 892 F.Supp. 756, 771 (E.D. Va. 1995) *aff'd in part, rev'd in part on other grounds,* 100 F.3d 1150 (4th Cir. 1996) and *In re Breast Implant Litigation*, 11 F.Supp. 2d 1217, 1230 (D. Colo. 1998)). Nor is there a need for a differential diagnosis ruling in the alleged cause and ruling out others. The need to rule out other potential causes in a specific causation analysis naturally only arises if the applicable standard requires one thing *cause* another. Indeed, in all the cases cited by Defendant in post-trial briefing, the applicable legal standard required the court to determine a "cause." *See e.g., Amorgianos v. Nat'l R. Passenger Corp.*, 303 F.3d 256, 268 (2nd Cir. 2002) (considering admissibility of expert testimony in a negligence action brought under New York law requiring that some negligent act "cause" harm); *Doe v. Ortho-Clinical Diagnostics, Inc.*, 440 F. Supp. 2d 465, 478 (M.D.N.C. 2006) (negligence and products liability action brought under a failure to warn theory and requiring that such failure "caused" harm); *Auto. Ins. Co. of Hartford v. Electrolux Home Prod., Inc.*, No. 08-cv-00623(A)(M), 2010 WL 3655743, *6 (W.D.N.Y. Sep. 15, 2010) (products liability action requiring that alleged defect "caused" harm); *Nelson v. Tennessee Gas Pipeline Co.*, 243 F.3d 244, 253 (6th Cir. 2001) (excluding expert testimony in action alleging negligence, trespass, nuisance, and strict liability claims—all requiring that some act "cause" harm—where expert (1) did not account for confounding factors *and* (2) could not identify any scientific literature supporting his causation theory); *Wills v. Amerada Hess Corp.*, 379 F.3d 32, 50

(2d Cir. 2004) (wrongful death action brought under the Jones Act and requiring identification of a "cause" of death); *Kilpatrick v. Breg, Inc.*, 613 F.3d 1329, 1342–43 (11th Cir. 2010) (negligence and products liability claims both requiring identification of a "cause").

Defendant argues that "[b]ecause Plaintiffs do not know the impact of other stressors in Stillhouse, they cannot show that conductivity is a principle cause of impairment, or even a 'material contribution' to impairment." Def.'s Post-Trial Brief, ECF No. 120 at 32. For all the inapposite case law on causation offered, Defendant has not offered a single case or other shred of legal authority justifying such an interpretation of "material contribution."[13]

Plaintiffs respond, and the Court agrees, that Defendant overstates the standard. "In the absence of any definition of the intended meaning of words or terms used in a regulation, they will be given their common, ordinary and accepted meaning in the connection in which they are used." *Lawyer Disciplinary Bd. v. Smoot*, 716 S.E.2d 491, 502 n. 23 (W.Va. 2010) (brackets omitted) (internal quotation marks omitted). Black's Law Dictionary (9th ed. 2009) presently defines "material" as "[o]f such a nature that knowledge of the item would affect a person's decision-making; significant; essential." "Contribute" may be defined as simply as "to help to cause something to happen." Merriam-Webster's Collegiate Dictionary (11th ed. 2003). As a matter of plain meaning and common sense, it is possible to identify a factor that is materially contributing to a given condition without conclusively eliminating contributions by additional factors in a dynamic system. While not ruling out alternative scenarios, such conclusions are possible where, as here, expert agency findings, a growing body of uncontroverted peer-reviewed

[13] For instance, a Pennsylvania state court turned to Black's Law Dictionary to develop an interpretation of "materially contributes," found in a state statute, and concluded that the phrase "means having a necessary influence or effect." *Com. v. Edwards*, 559 A.2d 63, 66 (Pa. Super Ct. 1989).

scientific literature, and multiple experts all agree that conductivity levels like those found at Stillhouse Branch materially contribute to impairment, at the very least.

B. Fact-Finding

1. General Causation

In order to prevail, Plaintiffs must first establish that high conductivity associated with surface mining activity is a general cause of impairment. As explained in *Elk Run*, 24 F.Supp.3d at 554–56, the Court continues to credit the EPA's specific finding under its Section 303(d) authority that a WVSCI score below the impairment threshold of 68 indicates a violation of West Virginia's biological narrative water quality standards, as embodied in § 47-2-3.2.e and -3.2.i, in the stream where the score was assessed.[14] However, even upon establishing impairment, it will still be necessary to determine whether a pollutant caused or materially contributed to such scores.

Plaintiffs' general theory of causation is that surface mining causes or materially contributes to high conductivity in adjacent streams and that, controlling for other potentially confounding factors, the unique ionic mixture of alkaline mine drainage is scientifically proven to cause or materially contribute to a significant adverse impact to the chemical or biological components of aquatic ecosystems. As reviewed below, through EPA's Benchmark, other peer-reviewed scientific publications, and expert testimony, Plaintiffs have shown, by a preponderance of the evidence, that high conductivity alkaline mine drainage causes or materially contributes to a significant adverse impact to the chemical and biological components of aquatic

[14] In a letter announcing partial disapproval of WVDEP's 2012 Section 303(d) list, the EPA specifically observed that "West Virginia's use of the 'gray zone' is statistically unsupported." Pl. Ex. 20 at PE319, Tr. at 58. "WVDEP's use of a precision estimate to establish the 'gray zone' is not statistically supportable because the potential variability for which the gray zone is purported to account already is accounted for by variability in the reference sites." Pl. Ex. 21 at PE358, Tr. at 58–59.

systems.

a. EPA's Benchmark

The Court finds that EPA's Benchmark supports Plaintiffs' theory of causation. As already discussed above, this Court owes deference to the EPA's scientific determinations made within its area of expertise so long as the agency's reasoning and conclusions are rational—a hurdle easily cleared by the Benchmark—a document characterized as "excellent science" by Dr. Palmer. Tr. at 75.

Designed with the purpose of protecting aquatic life in the region, EPA's Benchmark "uses field data to derive an aquatic life benchmark for conductivity that can be applied to waters in the Appalachian Region that are dominated by salts of Ca^{2+}, Mg^{2+}, SO_4^{2-} and HCO_3^- at circum-neutral to mildly alkaline pH." EPA's Benchmark, Joint Ex. 58 at JE381; *see also* Cormier & Suter, Pls.' Ex. 5 at PE88–89, Tr. at 263 ("Both mined and unmined sites have similar proportions of Ca^{2+}, Mg^{2+}, HCO_3^-, and SO_4^{2-} but very different concentrations. The difference between the ionic composition of mined watersheds and watersheds with other sources of ions such as brines is very large"). Because the "salt matrix and background is expected to be similar throughout the ecoregions," EPA's Benchmark is applicable to those parts of West Virginia and Kentucky within Ecoregions 68, 69, and 70. *Id.* at JE382. EPA's Benchmark notes that "prominent sources of salts in Ecoregions 69 and 70 are mine overburden and valley fills from large-scale surface mining, but they may also come from slurry impoundments, coal refuse fills, or deep mines."[15] *Id.* at JE386. It is precisely because water in the examined regions is so consistently and uniformly dominated by a distinct mixture of ionic pollutants that setting a benchmark for the Appalachian Region is

[15] "Other sources include effluent from waste water treatment facilities and brines from natural gas drilling and coalbed methane production." *Id.* at JE386.

possible. *Id.* ("Because relationships between conductivity and biological responses appear to vary among different mixtures of ions, this benchmark is limited to two contiguous *regions with a particular dominant source of salinity*.") (emphasis added).

In its nearly three-hundred page scientific Benchmark—after considering and then ruling out the potential confounding effects of habitat, organic enrichment, nutrients, deposited sediments, pH, selenium, temperature, lack of headwaters, catchment areas, settling ponds, dissolved oxygen, and metals—the EPA found that "salts, as measured by conductivity, are a common cause of impairment of aquatic macroinvertebrates" in central Appalachian streams. EPA's Benchmark, Joint Ex. 58 at JE429, JE472; *see also id.* at JE468 ("This causal assessment presents clear evidence that the deleterious effects to benthic invertebrates are *caused by, not just associated with*, the ionic strength[, i.e., conductivity,] of the water. . . . When [other potential] causes are absent or removed, a relationship between conductivity and ephemeropteran[, i.e. mayfly,] richness is still evident." (emphasis added)); *id.* at JE465 ("As conductivity increases, the occurrence and capture probability decreases for many genera in West Virginia . . . at the conductivity levels predicted to cause effects. The loss of these genera is a severe and clear effect."). The Benchmark also found that "of the [nine] land uses . . . analyzed, only mining especially associated with valley fills is a substantial source of the salts that are measured as conductivity." *Id.* at JE446.

The EPA ultimately concluded that "[a]t the benchmark of 300 µS/cm, the corresponding WVSCI score is 64, which is impaired based on West Virginia's biocriteria. Using logistic regression, the probability of impairment at 500 µS/cm is 0.72 and at 300 µS/cm is 0.59."[16] EPA's

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[16] In Appendix G, the Benchmark explains validation of EPA's findings in West Virginia by

Benchmark, Joint Ex. 58 at JE464; Tr. at 63–64. Stated differently, the EPA found that in central Appalachian streams, when conductivity reaches 300 µS/cm, it is more likely than not that the subject stream will be biologically impaired. In support of both the specific 300 µS/cm benchmark value and the general causal linkage between conductivity and extirpation of aquatic macroinvertebrates, the Benchmark contains a graph which charts, for 163 genera, the level of salt exposure above which a genus is effectively absent from water bodies in a region, with conductivity readings on the x-axis and proportion of genera extirpated on the y-axis. *Id.* at JE400, fig. 8. A fairly consistent line is formed as conductivity and extirpation both increase, illustrating the causal connection between conductivity and significant biological impairment which Plaintiffs seek to prove. *See id.*

Upon review, the SAB commented that "[b]uilding a strong case for causality between conductivity and loss of genera requires that two linkages be demonstrated: (1) a strong relationship between stream conductivity and the amount of [valley fill] in the upstream catchment, and (2) a strong relationship between elevated stream conductivity and loss of benthic macroinvertebrate taxa. The EPA document presents a convincing case for both linkages." Pls.' Ex. 25 at PE383, Tr. at 73. The SAB did not identify a need to conduct further analysis of temperature, embeddedness or habitat as potential confounding factors beyond Appendix B, wherein the EPA provided an "Analysis of Potential Confounders."

b. WVDEP's relatively conservative identification of "definite stressors"

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examining Kentucky data from the same ecoregions. EPA's Benchmark, Appendix G, Joint Ex. 58 at JE589–99. Using data independently collected by the Kentucky Division of Water ("KDOW"), the EPA found a remarkably similar benchmark value of 282 µS/cm. *Id.* at JE589; *see also* Cormier & Suter, *Assessing Causation of the Extirpation of Stream Macroinvertebrates by a Mixture of Ions*, 32(2) Envtl. Toxicology and Chemistry 277 (2013), Pl.'s Ex. 5.

In August 2010, the WVDEP released its "Justification and Background for Permitting Guidance for Surface Coal Mining Operations to Protect West Virginia's Narrative Water Quality Standards, 47 C.S.R. 2 §§ 3.2.e and 3.2.i." Joint Ex. 60. WVDEP explains that "[t]he Guidance is intended to facilitate compliance with applicable statutory and regulatory requirements and to provide reasonable means of effectuating the intent of the narrative criteria, as well as to enforce the mandate of the Clean Water Act ("CWA") that every permit contain effluent limitations that reflect the practicable pollution reduction a state can achieve." *Id.* at JE694 (citation omitted). While disagreeing with EPA's reasoned scientific conclusion on what conductivity limits are necessary to protect the chemical and biological integrity of West Virginia's streams, the WVDEP nonetheless did consider its own independent conductivity thresholds (though it did so without explaining scientific research justifying its conclusions). *Id.* at JE700. The WVDEP recognizes ionic strength as a "definite stressor" in alkaline drainage when conductivity surpasses 1533 µS/cm, sulfates surpass 417 mg/L, and chlorides surpass 230 mg/L. *Id.* Upon examining WVDEP's threshold levels, Dr. King remarked that the levels are "very conservative." Tr. at 251–52. However conservative, it is at least evident that the WVDEP accepts that increased conductivity causes or materially contributes to decreases in aquatic life.

c. Peer-reviewed scientific publications

Even without affording deference to EPA's Benchmark, relying on the extant collection of peer-reviewed scientific publications, the Court could still find that Plaintiffs have proven by a preponderance of the evidence that (1) alkaline mine drainage typical in central Appalachian surface mining operations causes or materially contributes to high conductivity in receiving streams and (2) the characteristic composition of such high conductivity alkaline mine drainage causes significant biological impairment to aquatic macroinvertebrates.

First, as mentioned above, the lead authors of EPA's Benchmark, Dr. Susan Cormier and Dr. Glenn Suter, subsequently published several peer-reviewed component sections of the Benchmark in the scientific journal *Environmental Toxicology and Chemistry*.[17] In one of these component articles, Cormier and Suter analyzed six characteristics of causation: co-occurrence, preceding causation, interaction, alteration, sufficiency, and time order, finding all but one strongly supported the causal relationship, with no evidence available for the outstanding characteristic. Susan M. Cormier et al., *Assessing Causation of the Extirpation of Stream Macroinvertebrates by a Mixture of Ions*, 32 Envtl. Toxicology & Chemistry 277 (2013), Pls.' Ex. 5, Tr. at 258–72. Cormier and Suter found that "[t]he conductivity at mined sites is 10 to 50 times greater than at unmined sties. The source of increased conductivity is independently corroborated and consistent." *Id.* at PE88, Tr. at 262–63. Relying on multiple lines of evidence, including not only their own findings in developing the Benchmark, but also based on the collection of research available in the published literature, Cormier and Suter conducted a formal causal analysis linking high conductivity and extirpation of sensitive macroinvertebrates in central Appalachian streams:

Through this assessment, the authors found that a mixture containing the ions

[17] *See* Susan M. Cormier, Glenn W. Suter II & Lei Zheng, *Derivation of a Benchmark for Freshwater Ionic Strength*, 32 Envtl. Toxicology & Chemistry 263 (2013), Pls.' Ex. 3; Susan M. Cormier & Glenn W. Suter II, *A Method for Assessing Causation of Field Exposure–Response Relationships,* 32 Envtl. Toxicology & Chemistry 272 (2013), Pls.' Ex. 4; Susan M. Cormier et al., *Assessing Causation of the Extirpation of Stream Macroinvertebrates by a Mixture of Ions,* 32 Envtl. Toxicology & Chemistry 277 (2013), Pls.' Ex. 5; Susan M. Cormier et al., *Relationship of Land Use and Elevated Ionic Strength in Appalachia Watersheds*, 32 Envtl. Toxicology & Chemistry 296 (2013), Pls.' Ex. 6; Susan M. Cormier & Glenn W. Suter II, *A Method for Deriving Water-Quality Benchmarks Using Field Data*, 32 Envtl. Toxicology & Chemistry 255 (2013), Pls.' Ex. 7; Glenn W. Suter II & Susan M. Cormier, *A Method for Assessing the Potential for Confounding Applied to Ionic Strength in Central Appalachian Streams,* 32 Envtl. Toxicology & Chemistry 288 (2013), Pls.' Ex. 8.

> [calcium, magnesium, bicarbonate, and sulfate], as measured by conductivity, is a common cause of extirpation of aquatic macroinvertebrates in Appalachia where surface coal mining is prevalent. The mixture of ions is implicated as the cause rather than any individual constituent of the mixture. The authors also expect that ionic concentrations sufficient to cause extirpations would occur with a similar salt mixture containing predominantly [bicarbonate, sulfate, calcium, and magnesium] in other regions with naturally low conductivity.

Id. at PE85, Tr. at 257–58.

Cormier and Suter independently published their confounding factor analysis as well. Cormier & Suter, *A Method for Assessing the Potential for Confounding Applied to Ionic Strength in Central Appalachian Streams*, 32(2) Envtl. Toxicology and Chemistry 288 (2013), Pls.' Ex. 8. Using a weight-of-evidence approach, that analysis considers twelve potential confounders: habitat, organic enrichment, nutrients, deposited sediments, pH, selenium, temperature, lack of headwaters, catchment area, settling ponds, dissolved oxygen, and metals. *Id.* at PE112, Tr. at 274. By adapting principles of epidemiology to the applied study of multivariate ecological field data, Cormier and Suter report examination and methodical elimination of each potential confounder.

Second, Plaintiffs presented numerous other scientific articles published in peer-reviewed journals, all supporting the conclusions reached by the Benchmark. As explained by Dr. King, "it's really getting to the point where we have a substantial literature that is arriving at this conclusion that conductivity associated with alkaline mine drainage is very strongly linked to biological degradation; and it seems to happen at levels around 300 [µS/cm] . . . and it continues to get worse as conductivity increases." Tr. at 245. As surveyed below, these articles address the relationship between mining and impairment in central Appalachian streams, observed extirpation of macroinvertebrates, and the relative significance of conductivity as opposed to other potentially confounding factors.

For purposes of this case, this line of published peer-reviewed scientific articles begins with Dr. Gregory Pond's findings based on a field study concluding that "[f]our lines of evidence indicate that mining activities impair biological condition of streams: shift in species assemblages, loss of Ephemeroptera taxa, changes in individual metrics and indices, and differences in water chemistry." Gregory J. Pond et al., *Downstream Effects of Mountaintop Coal Mining: Comparing Biological Conditions Using Family- and Genus-Level Macroinvertebrate Bioassessment Tools,* 27 J.N. Am. Benthological Soc'y 717 (2008) ("2008 Pond"), Pls.' Ex. 15; Tr. at 39–41. Dr. Pond's findings were published in the *Journal of the North American Benthological Society*—according to Dr. Palmer, the top stream ecology journal. Tr. at 40.

The connection between mining and impairment, not surprisingly, continued to be supported by subsequent studies examining the extirpation of macroinvertebrates. In 2010, Dr. Pond published a peer-reviewed scientific article in *Hydrobiologia* addressing patterns of taxa loss in headwater streams in eastern Kentucky. Gregory J. Pond. *Patterns of Ephemeroptera taxa loss in Appalachian headwater streams (Kentucky, USA)*, 641(1) Hydrobiologia 185 (2010), Pls.' Ex. 16, Tr. at 44–46. In the abstract, Dr. Pond reports that "mean mayfly richness and relative abundance were significantly higher at [reference] sites compared to all other categories; [mined] sites had significantly lower metric values compared to [residential] and [mixed mined/residential] sites." *Id.* at PE223, Tr. at 45. Agreeing with Dr. Pond's conclusion, Dr. Palmer restated his paper as "concluding that the abundance of mayflies declines dramatically in mined streams even in comparison to watersheds that have a little bit of mining and residential development in them." Tr. at 45. To Dr. Palmer's knowledge, no subsequent publication invalidates these findings. *Id.*

In 2012, Dr. Pond published an additional peer-reviewed scientific article in

Hydrobiologia, this time addressing the effect of coal mining on stoneflies and caddisflies. Gregory J. Pond, *Biodiversity Loss in Appalachian Headwater Streams (Kentucky, USA): Plecoptera and Trichoptera Communities*, 679 Hydrobiologia 1, 97 (Jan. 2012), Pls.' Ex. 17. Consistent with other published findings, Dr. Pond found, that while any disturbance can cause a reduction in the number of stoneflies and mayflies, the greatest reduction in numbers are suffered at sites impacted by mining. *Id.* at PE240, Tr. at 45–46 ("Core caddisfly genera . . . were extirpated from most disturbed sites. Species richness was significantly higher at reference sites and reference site mean tolerance value was lowest compared to all other categories; relative abundance of both orders was variable between disturbance groups").

As the body of scientific literature developed, conductivity emerged as a significant contributor to the observed biological impairment coincident to mining activities. In 2010, Plaintiffs' expert, Dr. Palmer, and Dr. Emily Bernhardt published a peer-reviewed scientific article in *Science* magazine—a prestigious scientific journal—reporting their finding that, in some 1058 West Virginia streams, as sulfates and other ions increased, "the stream condition index declined, as did the number of insect genera, the number of intolerant genera, and the number of mayfly genera." Tr. at 37–39 (explaining the significance of M.A. Palmer et al., *Mountaintop Mining Consequences*, 327 Sci. 148 (2010), Pls.' Ex. 13.

These findings by Dr. Plamer and Dr. Berhardt further confirmed Pond's earlier work examining the relative influence of various factors on stream quality. Table 5 in the 2008 Pond study shows correlation coefficients for the GLIPMSS and WVSCI and the significance of various factors, e.g., pH, specific conductance, and embeddedness. Pls.' Ex. 15 at PE213. According to Dr. Pond's findings, temperature and embeddedness have a relatively very small effect on

GLIMPSS and WVSCI scores, with conductivity having a much more significant effect. *Id.*, Tr. at 42. In Dr. Palmer's expert opinion, Dr. Pond's findings support the conclusion that conductivity related to mining is "the primary leading factor" in stream impairment.[18] Tr. at 43–44; *see also* Testimony of Dr. King, Tr. at 214 ("what they found was a very strong relationship between conductivity associated with alkaline mine drainage and both WVSCI and the GLIMPSS scores"). As of trial in this matter, and to Dr. Palmer's knowledge, the conclusions in the 2008 Pond paper continue to be supported by all subsequently published literature. Tr. at 41.

More recently, scientists have done more than note a connection between conductivity caused by mining and impairment; scientists have embarked on determining thresholds at which conductivity has devastating effects. In 2011, a collection of WVU researchers published a peer-reviewed scientific article in the *Journal of the North American Benthological Society* examining "the relationship between both mining and residential and commercial development on biological condition of streams," finding "that streams that had both relatively high levels of development and mining had lower biological condition than streams that had just development or just mining."[19] Tr. at 207 (explaining the findings of Eric Merriam et al., *Additive Effects of Mining and Residential Development on Stream Conditions in a central Appalachian Watershed*, 30(2) J. N. Am. Benthological Soc. 399 (2011), Pls.' Ex. 12). That study further explained that "specific conductance was the major stressor associated with mining," and that biological

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[18] As explained by Dr. King, because the 2008 Pond study examined conductivity data collected over the course of a year, that study included more conductivity data on streams than is available in the WVDEP database. Tr. at 214. Owing to better underlying conductivity data, the 2008 Pond paper shows that "[w]hen we have better conductivity estimates, you end up explaining a lot more variance in the WVSCI scores and in the GLIMPSS scores," with as much as 80% of the variance explained. Tr. at 214–15.

[19] The *Journal of the North American Benthological Society*—now known as *Freshwater Science*—is regarded by Dr. King as the "best journal for stream ecology." Tr. at 212.

impairment occurred at 250 µS/cm. *Id.* at PE166, PE167, Tr. at 209, 211.

> We found significant effects of mining on in-stream conditions. Increased levels of mining resulted in poorer water quality, primarily through increases in specific conductance and associated dissolved chemical constituents (i.e., [sulfate, calcium, magnesium, sodium, and nitrate]). [Selenium] concentrations exceeded US EPA water-quality standards in several mined sites. However, no relationship was observed between [selenium] and total [percent] mining. Mining also resulted in significant alterations to macroinvertebrate community structure through decreases in sensitive taxa (i.e., EPT richness, E richness, and [percent] E), and Ephemeroptera consistently showed the greatest decline. These alterations led to significant decreases in *m*WVSCI score. Mining had no measurable effect on habitat complexity or quality. . . . Increased specific conductance is consistently the dominant stressor in streams affected by mountaintop removal mining in southern West Virginia. . . . Furthermore, increased specific conductance is a consistently important predictor of ecological condition in these systems.

Id. at PE167–68 (citations omitted), Tr. at 209–10. As explained by Dr. King, Merriam et al., are "suggesting that the mixture of ions that constitute specific conductance or conductivity . . . is having a direct effect on aquatic macroinvertebrates, particularly mayflies, and that it's independent of many of these other factors that you might normally associate with degradation and biological impairment." Tr. at 211. "Consequently, conductance may be a reliable single indicator of coal-mining influence on aquatic ecosystems." Pls.' Ex. 12 at PE170, Tr. at 211.

Similarly, in 2012, Emily Bernhardt, Brian Lutz, and Dr. King, among other collaborators, published a peer-reviewed scientific article in *Environmental Science and Technology*, wherein two different methods were used to determine the biological impairment effects of conductivity: generalized additive regression models for three different biological response variables—including the number of intolerant taxa and WVSCI scores—and the Threshold Indicator Taxa Analysis ("TITAN") method, which Dr. King co-developed. Bernhardt et al., *How Many Mountains Can We Mine?: Assessing the Regional Degradation of Central Appalachian Rivers by Surface Coal Mining*, 46(15) Environmental Science and Technology 8115 (July 2012)

("*How Many Mountains*"), Pls.' Ex. 2. The research underlying *How Many Mountains* occurred coincident to development of the Benchmark, and the authors of *How Many Mountains* sought to screen and examine WVDEP data "in a very different way" in order to see how their results might compare to EPA's findings.[20] Tr. at 238–39. Upon completion, *How Many Mountains* reported results that were "remarkably consistent" with EPA's findings, identifying a WVSCI impairment threshold of 308 µS/cm and a threshold of 283 µS/cm using TITAN. Tr. at 241.

Most recently, in 2014, Dr. Pond, Margaret Passmore, Kelly Krock, and Jennifer Fulton—all with the EPA—along with Nancy Pointon, John Felbinger, Craig Walker, and Whitney Nash—colleagues from the OSMRE—published a peer-reviewed scientific article in *Environmental Management* finding, among other conclusions, that the vast majority of streams adjacent to reclaimed mine sites with valley fills were still impaired eleven to thirty-three years after reclamation. Pond et al., *Long-Term Impacts on Macroinvertebrates Downstream of Reclaimed Mountaintop Mining Valley Fills in Central Appalachia*, 54(4) Envtl. Mgmt. 919 (October 2014), Pls.' Ex. 19, Tr. at 49–51 ("Although these [valley fills] were constructed pursuant to permits and regulatory programs that have as their stated goals that (1) mined land be reclaimed and restored to its original use or a use of higher value, and (2) mining does not cause or contribute to violations of water quality standards, we found sustained ecological damage in headwater streams draining [valley fills] long after reclamation was completed"). The article explains that they "found that known sensitive taxa such as the mayflies *Ephemerella* and *Epeorus* and the caddisfly *Neophylax* were found at 100% of the reference sites but were absent from 12 of

[20] *How Many Mountains* relied on a small subset of the WVDEP database, screening the data for potential confounding factors, totaling approximately 223 data points. Tr. at 242–43. EPA's Benchmark relied on the WVDEP database for ecoregions 69 and 70 and a smaller EPA Region 3 dataset for the same ecoregions, totaling approximately 2,200 data points. Tr. at 243.

15 (~80%) of the [valley fill] sites." Pls.' Ex. 19 at PE294, Tr. at 54. As explained by Dr. Palmer, this most recent article by Dr. Pond and colleagues, based on a natural experiment, showed that "the exceptions to the—what [she] would call a rule, that when conductivity reaches a certain point you get impairment, were due to drifting organisms" from unmined upstream tributaries. Tr. at 50–51.

Furthermore, it is also of note that in selecting reference streams for this most recent study, Dr. Pond and his collaborators selected sites with comparable temperature and habitat regimes to the mined sites. Pls.' Ex. 19 at PE289, Tr. at 51–52 ("Local reference streams were sighted in close proximity (range .75 to 10.5 km) to paired [valley fills] . . . and had similar catchment areas, forest types, and base geology"). That methodological approach had the effect of eliminating temperature and habitat scores as potential confounding factors. Pls.' Ex. 19 at PE 298, Tr. at 52, 56 ("Habitat can be a limiting factor, but by design, we removed significant habitat degradation factors by selecting sample reaches with relatively good habitat and intact riparian vegetation at reference and [valley fill] sites"). The experiment also relied on reference sites that "were not pristine, as their catchments frequently had poorly maintained roads and culverts, utility right-of-ways, gas wells, or underground mining that did not discharge to the watershed," thereby further eliminating potentially confounding factors. Pls.' Ex. 19 at PE289, Tr. at 52. As explained by Dr. Palmer, in this study "[the researchers] took exactly the approach you would take in trying to control for variables that you weren't interested in measuring necessarily or that you weren't interested in testing." Tr. at 57.

Not only has the literature consistently supported the same conclusions regarding the relationship between mining, conductivity, and impairment in central Appalachian streams, that consensus has developed through reliance on different methodologies and data sets. Tr. at 70. For instance, as explained by Dr. Palmer at trial, through reliance on independent field data, the 2008 Pond study reaches the same conclusion as researchers relying on the WVDEP dataset. Tr. at 41. Thus, whether relying on data from West Virginia or Kentucky state databases (as the EPA did in developing and verifying the Benchmark), subsets thereof (as Bernhardt, Lutz, and King did in *How Many Mountains*), narrowing analysis to individual watersheds (as Merriam et al., did), or on the basis of independently collected field work (as was repeatedly done by Pond), researchers consistently observed not only biological impairment, but impairment occurring at remarkably similar conductivity thresholds. These results held not only with variation in the data, but also with variation in the analytical methodology applied to examine that data.

Scientific consensus and independent verification continues with respect to identification of taxa and species conductivity sensitivity. A comparison of *How Many Mountains* and the 2014 Pond paper shows that both studies identified similar taxa as sensitive to and tolerant of high sulfate concentrations—one of the main constituents of conductivity—and conductivity levels. Tr. at 222–25. Dr. King explained this similarity by noting that sulfates are a "predictive chemical component, part of the mixture of ions that are associated with alkaline mine drainage," and therefore "sulfates is just very highly correlated to [conductivity levels] because it's part of it." Tr. at 225. These similar findings regarding species sensitivities were shared not only by *How Many Mountains* and 2014 Pond, but are also consistent with the findings of EPA's Benchmark despite the fact that each study relied on different datasets.[21] Tr. at 228.

Defendant argues that none among these numerous peer-reviewed scientific articles makes

[21] It is important to also note that species sensitivity varies with the stressor. For instance, Dr. King explained that mayflies have a much greater tolerance to degradation relative to ionic stress.

any statements regarding causation, instead, merely reaching conclusions with respect to correlation. In response, the Court first notes EPA's Benchmark as well as Cormier and Suter's subsequently published component papers do report a causal relationship between high conductivity alkaline mine discharges and extirpation of aquatic insects. As discussed above, the deference owed to those findings by the Court readily survives the lone criticisms of a relatively under-qualified expert developed for purposes of litigation.

Even without the appropriate deference, through a survey of the uncontroverted scientific literature on the subject, the Court finds that Plaintiffs have proven their theory of general causation by a preponderance of the evidence. As already explained by the Fourth Circuit, "epidemiological studies are not necessarily required to prove causation, as long as the methodology employed by the expert in reaching his or her conclusion is sound." *Benedi v. McNeil-P.P.C., Inc.*, 66 F.3d 1378, 1384 (4th Cir. 1995); *see also United States v. W.R. Grace*, 504 F.3d 745, 765 (9th Cir. 2007) ("the fact that a study is associational—rather than an epidemiological study intended to show causation—does not bar it from being used to inform an expert's opinion"). In fact, even the Reference Manual on Scientific Evidence states that "epidemiology cannot prove causation; rather, causation is a judgment for epidemiologists and others interpreting the epidemiological data."[22] Manual at 597 (3rd Ed. 2011). "[A]n evaluation of data and scientific evidence to determine whether an inference of causation is appropriate requires judgment and interpretation." *Id.* at n.140. Plaintiffs have presented two experts with the requisite experience and judgment, whose opinions on the causal relationship between conductivity and

[22] Defendant's expert, Ms. Kuehn similarly testified that "[w]e cannot typically observe the cause and effect relationships we're interested in." Tr. at 399. She further explained that "we observe associations in samples because we cannot observe causation as it occurs." Tr. at 405.

impairment will be outlined below.

More fundamentally, Plaintiffs are required to meet a legal—as opposed to scientific—standard of proof. As a matter of law, Plaintiffs' burden is "not scientific certainty but legal sufficiency." *Ferebee v. Chevron Chem. Co.*, 736 F.2d 1529, 1536 (D.C. Cir. 1984). "[T]hat science would require more evidence before conclusively considering the causation question resolved is irrelevant." *Id.* It is with the *legal* standard in mind that the Court is able to find that the weight of evidence shows that it is more likely than not that high conductivity in streams impacted by alkaline mine drainage causes or materially contributes to chemical and biological impairment.

d. Expert testimony

The Court continues to find the testimony of Dr. Palmer and Dr. King to be very persuasive. First, Dr. Palmer, a professor at the University of Maryland, was admitted as an expert before this Court in aquatic ecology and stream restoration. Dr. Palmer has authored more than 150 peer-reviewed scientific articles in the field of aquatic ecology, including two papers particularly addressing the effects of ionic stress on impaired streams. Tr. at 16, 18–19. In addition to stream ecology research conducted in Dr. Palmer's laboratory at the University of Maryland, she also runs the Socio-Environmental Synthesis Center, a multi-million dollar project funded by the National Science Foundation that boasts 16 staff members, 10 post-doctoral scholars and roughly 500 visiting scholars each year. Tr. at 17–18. Dr. Palmer also has field experience relevant to this dispute; she is familiar with Appalachian headwater streams, mining impacts, and stream assessments, including physical, chemical, and biological assessments. Tr. at 19–20.

Second, Dr. King was accepted as an expert in aquatic ecology, entomology, and ecological data analysis.[23] Tr. at 206. He is a tenured professor at Baylor University in Waco, Texas, where he teaches courses in stream ecology, aquatic biology and taxonomy of aquatic insects, among others. Joint Ex. 24, Tr. at 199. He has published over fifty articles in his areas of expertise, and has served as a both a reviewer and a subject matter editor for *Ecological Applications* and *Freshwater Science*. Tr. at 199–200, 202–203. At Baylor, Dr. King is responsible for the Aquatic Ecology Lab, where he oversees five graduate students, three full-time technicians, and several undergraduate researchers. Tr. at 200. Currently, ongoing research projects in Dr. King's lab include the development of a water quality criteria for atrazine and an NSF funded project examining environmental implications of nanomaterials in aquatic ecosystems. Tr. at 200. Dr. King co-developed a technique called Threshold Indicator Taxa Analysis ("TITAN"). Tr. at 204. Since announcing TITAN via peer-reviewed journal publication in 2010, Dr. King reported that—though admittedly criticized by one ecologist—TITAN has been used in roughly 60 articles, including use by Connecticut and Massachusetts in biological condition work and the United States Geological Survey ("USGS") in the Northeast. Tr. at 204, 343. Additionally, Dr. King was recently selected by a joint committee of governor-appointed scientists from Oklahoma and Arkansas to lead an independent stressor response study related to phosphorus" in waterways in northeastern Oklahoma and northwest Arkansas. Tr. 201–02.

Upon summarizing the literature to date, Dr. Palmer explained that she was not aware of *any* publications or research contradicting the published findings linking mining, conductivity, and

[23] Dr. King prefers to identify as an expert in ecological data analysis as opposed to an expert in statistics because "ecological data analysis deals specifically with the unique idiosyncratic properties of ecological data, which makes them generally not amenable to traditional or conventional statistical procedures, particularly when you're talking about species assemblages and multiple predictors… [a]nd while I have a strong foundation in conventional statistics, that's my area of expertise." Tr. at 198–99.

impairment in central Appalachian streams. Tr. at 74. Similarly, in Dr. King's expert opinion, the body of scientific literature on the question available today demonstrates that conductivity is likely causing biological impairment: "there has not been a study that has generated results that lead to . . . any other conclusion other than conductivity being a very consistent, predictable causal factor in the impairment of Appalachian streams." Tr. at 252. Dr. King further explained that the significance of this collection of studies lies in the fact that the scientific method is itself based on the development of such consensus in the literature, "and when you have a consensus, that's where we get to the point where we say this is a fact of science." Tr. at 252–53. In fact, while the formal causal analysis conducted by EPA further shores up the relationship between conductivity and impairment, Dr. King explained that the literature alone reveals a "remarkably strong predictive relationship" and a "compelling" case that "conductivity associated with mine drainage causes biological impairment."[24] Tr. at 253–54. Thus, even without the Benchmark, "with all the other literature that is out there now, the consensus is, yes, [conductivity] is causing impairment." Tr. at 255.

Of course, as already reviewed, Plaintiffs' generally theory of causation does not rest solely on the literature. Rather, Plaintiffs have presented more than sufficient evidence supporting general causation through the published, peer-reviewed scientific literature, the reasoned, scientific judgments of an expert agency as expressed in EPA's Benchmark, the opinions of markedly qualified expert researchers in the field.

2. Specific Causation

[24] Furthermore, in Dr. King's opinion, while a formal causation analysis takes the reliability of these conclusions "to the next level," that analysis is neither necessary nor is it generally conducted in the course of answering most scientific questions. Tr. at 254.

There is no reason to doubt that Stillhouse Branch is biologically impaired. In 2003, WVDEP conducted macroinvertebrate sampling at Stillhouse Branch and found the stream's WVSCI score to be 47—well below the impairment threshold. Joint Ex. 43 at ¶12. In 2008, the WVDEP listed Stillhouse Branch as biologically impaired and identified ionic toxicity as the significant stressor. *Id.* at ¶13. Four years later, WVDEP sampling revealed an even lower WVSCI score of 31.6 at Stillhouse Branch—less than half the threshold impairment score. *Id.* at ¶14. Not surprisingly then, West Virginia's 2012 Section 303(d) List continued to report Stillhouse Branch as biologically impaired throughout the entire length of the stream, noting mining as the source of impairment. Joint Ex. 59 at JE693.

In addition to WVDEP's now long-standing determination that Stillhouse Branch is biologically impaired, Plaintiffs' experts also conducted sampling confirming the continuing biological impairment of Stillhouse Branch. Sampling conducted by Plaintiffs' expert, Dr. Christopher Swan, on September 30, 2013, returned a WVSCI score of 58.17, and a GLIMPSS score of 27.71, both below the respective impairment thresholds for each multimetric index. Joint Ex. 13.

Thus, the question is not whether the stream is impaired, but rather whether ionic pollution from Defendant's discharge is causing or materially contributing to the conditions at Stillhouse Branch. To answer that question, the Court will consider Plaintiffs' evidence showing that Defendant's discharge of ionic pollution is of a characteristic composition presently known in the scientific community to cause or contribute to impairment in Central Appalachian streams.

By stipulation of the parties entered June 3, 2014, Defendant reported pre-mining surface water quality data to WVDEP in its 1996 permit application. Joint Ex. 43, ECF No. 52. That baseline data included samples taken roughly monthly from December 1994, through May 1995, and reported conductivity ranging from 47 µS/cm to 104 µS/cm and sulfates ranging from 4 mg/L to 22 mg/L. Joint Ex. 43 at JE126.

Conductivity and sulfates notably increased after Defendant began mining in the watershed. Samples taken by WVDEP at Stillhouse Branch from 2003 through 2012 showed conductivity ranging from 2,610 µS/cm on May 9, 2012, to 3,964 µS/cm on May 12, 2004. *Id.* at JE127–28. All of the recorded samples taken by WVDEP during this time period reported conductivity levels above 300 µS/cm. *Id.* Dr. Palmer characterized these numbers as significantly elevated relative to the pre-mining sampling data. Tr. at 88–89. Similarly, samples taken by WVDEP at Stillhouse Branch showed sulfate levels consistently above 1,500 mg/L, in some instances nearly as high as 3,000 mg/L. Joint Ex. 43 at JE127–28. Not only are these measurements extremely high relative to the background sulfate levels, but the measurements are also well above the 50 mg/L threshold identified by WVDEP as indicative of mining impacts. *See* Tr. at 92; *see also How Many Mountains*, Pls.' Ex. 2 at PE23, Tr. at 247 (finding a sulfate threshold for impairment under WVSCI and TITAN at 50 mg/L and a threshold for impairment under GLIMPSS at 52 mg).

In addition to samples taken by WVDEP, the parties' own sampling reveals the same remarkably high levels of conductivity. First, more than half of the bi-monthly samples taken by Defendant at Outfall 029 from October 2011 through December 2012 showed conductivity above 3,000 µS/cm. Joint Ex. 43 at JE129. All bi-monthly samples collected by Defendant during this time period reported conductivity levels above 300 µS/cm. *Id.* Additionally, on behalf of Plaintiffs, on September 30, 2013, Dr. Evan Hansen, with Downstream Strategies, conducted sampling in Stillhouse Branch at Outfall 029 and just downstream. Dr. Hansen reported conductivity measurements of 2,826 μS/cm at Outfall 029 and 2,825 μS/cm in the stream. Joint Ex. 4.

Given the multifold increase in conductivity observed after mining commenced in the Stillhouse Branch watershed, it can be reasonably concluded that mining is more likely than not the cause of high conductivity levels at Stillhouse Branch. In fact, that arguably understates the degree of confidence the evidence allows. Over time, Defendant's mining operations stretched across over 90% of the Stillhouse Branch watershed. There is simply no evidence of another land use activity (e.g., agriculture, urbanization, industrialization) that could account for the significantly altered state of Stillhouse Branch.

In reporting to the EPA, WVDEP evidently reached the same conclusion, identifying mining as the source of impairment at Stillhouse Branch. 2012 303(d) List, Joint Ex. 59 at JE693. And that identification was made by WVDEP not only relative to other potential land uses, but also relative to the option to report "unknown" as the cause of impairment (sixteen of the twenty-two streams on the same page as Stillhouse Branch report "unknown" as the cause of impairment). Indeed, even Defendant's expert, Dr. Menzie agreed that Fola's mining operations caused impairment at Stillhouse Branch. Tr. at 651.

The evidence further showed that it is more likely than not that the aquatic macroinvertebrate community has been harmed because of ionic stress resulting from mining. As discussed above, multiple researchers have published findings identifying the how particular aquatic taxa respond to ionic stress, all reaching similar results. As ionic concentrations increase, mayflies (e.g., *Ephemerella*, *Epeorus*, and *Drunella*) dramatically decline, while other macroinvertebrates thrive (e.g., *Hydrophsyche*, *Cheumatopsyche*, and *Cricotopus*). Tr. at 219–29. The biological sample collected and analyzed by Dr. Swan contained no mayflies whatsoever, nor did it contain any of the conductivity sensitive genera identified by Dr. King. Joint Ex. 15. Instead, the sample was dominated by conductivity tolerant macroinvertebrates. Joint Ex. 15.

The complete extirpation of sensitive macroinvertebrates is unsurprising. As thoroughly reviewed above, experts anticipate extirpation once conductivity levels surpass 300 µS/cm. The conductivity levels at Stillhouse Branch have been reported to be tenfold that estimated benchmark. Indeed, conductivity levels at Stillhouse Branch are regularly twice the levels of even the WVDEP's most conservative estimate of the threshold at which conductivity becomes a "definite stressor."

With that, Plaintiffs have already made a compelling case that, at the very least, ionic pollution at Stillhouse Branch is materially contributing to chemical and biological impairment, and yet Plaintiffs' expert still have more to offer. After reviewing all the data and conducting her own on site analysis, Dr. Palmer concluded that habitat conditions could not explain the impairment she observed at Stillhouse Branch. Tr. at 97–98. She further analyzed rocks in the streambed, concluding that the level of embeddedness was not a function of sediment accumulation, but rather a function of chemical precipitates. Tr. at 94. Dr. Karen Prestegaard, a geochemist, later confirmed Dr. Palmer's hypothesis, determining that the accretions on the streambed were composed of manganese and either calcium sulfate or calcium carbonate, and are thus a result of ionic pollution. Tr. at 762–63. On the basis of all the evidence and in light of her considerable expertise, Dr. Palmer unequivocally concluded that elevated conductivity levels and sulfates are causing biological impairment at Stillhouse Branch. Tr. at 21, 25, 90–91, 117.

Dr. King similarly concluded that the conductivity levels at Stillhouse Branch would "unequivocally impair a stream." Tr. at 306. Dr. King considered neither temperature nor habitat to be causes of impairment at Stillhouse, noting a fairly average RBP score and a temperature range appropriate to support healthy aquatic life. *Id.* Dr. King explained lowering the temperature at Stillhouse "would have absolutely no effect."[25] Tr. at 308. Thus, on the basis of all the evidence and his considerable expertise, Dr. King remains "absolutely convinced" that Stillhouse Branch would still be biological impaired so long as conductivity levels were not addressed. Tr. at 308.

Given the large body of evidence presented by Plaintiffs and the lack of any meaningful counter-evidence, the Court **FINDS** that Plaintiffs have demonstrated, by a preponderance of the evidence, that high conductivity in downstream Stillhouse Branch is causing—or, at the very least materially contributing to—a significant adverse impact to the chemical and biological components of the stream's aquatic ecosystems.

III. CONCLUSION

In multiple ways, the chemical and the biological components of the aquatic ecosystems found in Stillhouse Branch have been significantly adversely affected by Defendant's discharges. The water chemistry of this stream has been dramatically altered, containing levels of ionic salts—measured as conductivity—which are scientifically proven to be seriously detrimental to aquatic life. The biological characteristics of the stream have also been significantly injured, in

[25] In full context, Dr. King opined that, at Stillhouse Branch, "unequivocally the principal cause [of impairment] is conductivity associated with the mine, and that if you were to reduce the conductivity to a level of, say, 200, that you would see a dramatic increase in the number of sensitive taxa. . . . However, if you were to, for example, lower the temperature by two or three degrees consistently, my opinion is that it would have absolutely no effect on this stream. . . . It would still be biologically impaired." Tr. at 307–08.

that species diversity—and, in some areas, overall aquatic life abundance—is profoundly reduced. Stillhouse Branch is unquestionably biologically impaired, in violation of West Virginia's narrative water quality standards, with current WVSCI scores falling well below the threshold score of 68.

Losing diversity in aquatic life, as sensitive species are extirpated and only pollution-tolerant species survive, is akin to the canary in a coal mine. This West Virginia stream, like the reference streams used to formulate WVSCI, was once a thriving aquatic ecosystem. As key ingredients to West Virginia's once abundant clean water, the upper reaches of West Virginia's complex network of flowing streams provide critical attributes—"functions," in ecological science—that support the downstream water quality relied upon by West Virginians for drinking water, fishing and recreation, and important economic uses. Protecting these uses is the overriding purpose of West Virginia's water quality standards and the goal of the state's permit requirements.

The Court thus **FINDS** that Plaintiffs have established, by a preponderance of the evidence, that Defendant has committed at least one violation of its permits by discharging into Stillhouse Branch high levels of ionic pollution, which have caused or materially contributed to a significant adverse impact to the chemical and biological components of the stream's aquatic ecosystem, in violation of the narrative water quality standards incorporated into those permits.

The Court **DIRECTS** the Clerk to send a copy of this written Opinion and Order to counsel of record and any unrepresented parties.

ENTER: January 27, 2015

ROBERT C. CHAMBERS, CHIEF JUDGE