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July 30, 2015

VIA E-MAIL

Ms. Lenka Berlin
US EPA Region III, 3WP30
1650 Arch Street
Philadelphia, PA 19103
berlin.lenka@epa.gov

RE: Comments on Draft Wissahickon Creek Total Phosphorus TMDL

Dear Ms. Berlin:

Following are comments submitted on behalf of the Wissahickon Creek Municipal Coalition regarding the Wissahickon Creek TMDL. The Coalition consists of the following members: Abington Township, Ambler Borough, Upper Gwynedd Township, and related MS4 dischargers. This Coalition has been formed to address the stringent phosphorus limitations being applied by the EPA and PADEP to the Wissahickon Creek watershed. We are opposed to the application of the new standards being imposed by the Agency. The legal and technical basis of our position is outlined in the attached comment document.

The Coalition appreciates the opportunity to comment on the proposed draft revision of the Wissahickon Creek TMDL. Please do not hesitate to contact us, should the Agency have any questions concerning the attached comments.

Sincerely,

/s/ *John C. Hall*

JOHN C. HALL

/s/ *William T. Hall*

WILLIAM T. HALL

Comments on Draft Total Phosphorus TMDL for the Wissahickon Creek Watershed, Pennsylvania (May 2015)

INTRODUCTION

The May 2015 Draft Total Phosphorus TMDL for the Wissahickon Creek Watershed, Pennsylvania (USEPA Region 3; hereafter, "Draft TMDL") is premised on the following major claims:

- The final 2003 Nutrient and Siltation TMDL Development for Wissahickon Creek, Pennsylvania is insufficient to address alleged nutrient-related aquatic life use impairment that is currently ongoing in the Wissahickon Creek watershed;

- Pennsylvania Department of Environmental Protection (PADEP) requested that EPA undertake this action due to its finding that the prior TMDLs adopted and approved by USEPA for this watershed were under protective and failed to meet applicable standards;

- The residual, post 2003 TMDL implementation aquatic life use impairment was demonstrated to be caused by excessive plant growth;

- The alleged excessive plant growth occurring in Wissahickon Creek was demonstrated to be occurring post-2003 TMDL implementation and to be caused by elevated total phosphorus concentrations;

- Because the 2003 TMDL was confirmed to be insufficient to address nutrient-related aquatic life use impairment, USEPA Region 3 applied PADEP's narrative criteria interpretation procedures to derive the necessary total phosphorus (TP) numeric endpoint for the Wissahickon Creek watershed;

- The TMDL (and underlying Tetra Tech, Inc. analyses) demonstrated that attaining a 40 µg/l TP concentration in the Wissahickon Creek will eliminate excessive plant growth and restore a balanced aquatic life assemblage;

- The TMDL confirmed that nutrient loadings from point and non-point sources occurring outside of the growing season (October – March) settle in the creek and significantly affect plant growth in the growing season;

- Based on the supporting documents prepared by Tetra Tech, TP (not ortho-phosphorus or dissolved inorganic phosphorus (DIP)) controls plant growth in the Wissahickon Creek watershed. Consequently, the Draft TMDL addresses TP as the basis for eliminating excessive algal growth and restoring aquatic life uses to the watershed;

- MS4-related TP loadings significantly affect plant growth in the Wissahickon Creek even under storm flow conditions;

- Nutrients were the primary factors controlling aquatic life in Wissahickon Creek and other habitat factors were not the cause of the reduced invertebrate population condition;

- Plant growth can be controlled at a much higher TP concentration than EPA concluded in 2003 TMDL and published literature; and,

- The TMDL determined that it is reasonable to assume that MS4 and non-point TP loadings can be reduced by over 90% through implementation of best management practices.

It is axiomatic that (1) EPA must have demonstrable, scientifically defensible analyses and information it its administrative record to support its detailed regulatory and scientific conclusions and (2) there must be a rational connection between the information presented and the conclusions reached in seeking to impose water quality-based requirements. *Bowen v. Am. Hosp. Assn*., 476 US 610, 626 (1986). None of the above claims contained in the TMDL are even remotely demonstrated by the information presented in the Draft TMDL or its supporting documents that have been released by EPA for public review. The detailed comments presented below, submitted on behalf of the Wissahickon Creek Municipal Coalition (representing POTW and MS4 interests), demonstrate that the proposed Draft TMDL is unsupported by any rational scientific evidence and fails to implement applicable regulatory requirements.

LEGAL COMMENTS

Reservation of Right to Submit Supplemental Comments

EPA has not created a public docket on this matter nor has the agency made the data and back up analyses used to create the TMDL recommendations available for public review. This has prevented the full assessment of EPA's proposed action and has prevented the submission of complete comments by the required deadline (July 30, 2015). The Wissahickon Creek Municipal Coalition reserves its rights to submit additional comments once the agency makes available the records that have been requested under FOIA – as directed by EPA Region 3. (See Attachment 1 – List of FOIA Requests for Wissahickon TMDL Records).

Statutory and Regulatory Background

EPA's proposed TMDL action is governed by the Clean Water Act, the agency's implementing regulations and the federal Administrative Procedures Act (APA). Under the Clean Water Act ("CWA" or "the Act"), 33 U.S.C. §§ 1251 et seq., more restrictive water quality-based effluent limitations are imposed as "necessary" to attain applicable water quality standards ("WQS"). See 33 U.S.C. § 1311(b)(1)(C); 40 C.F.R. § 122.44(d). All water quality-based limitations are based on a causation analysis - the pollutant reduction "necessary" to achieve applicable "water quality standards." 33 U.S.C. § 1311(b)(1)(C); 40 C.F.R. § 130.7(b)(4) ("The list … shall identify the pollutants causing or expected to cause violations of the applicable water quality standards"); 40 C.F.R. § 122.44(d)(1) ("[E]ach NPDES permit shall include… (d) any requirements… necessary to (1) achieve water quality standards … including narrative criteria for water quality."). In short, the entire Clean Water Act water quality program is premised on regulating only when "necessary" (assessing causes and effects) to ensure one is regulating the proper pollutant at the proper level. For instance:

- All EPA WQS/criteria are based on a cause/effect demonstration or at the level necessary to protect use; (See 40 C.F.R. § 131.3(c); 40 C.F.R. § 131.2(a))

- Water quality-based effluent limitations when dischargers are interfering with attainment of water quality; (33 U.S.C. § 1312(a))

- EPA guidance on nutrient regulation explicitly requires cause and response relationship; (See, EPA Rivers and Streams Criteria Development Guidance, passim; see also USEPA 1991 Technical Support Document for Water Quality-based Toxics Control "[t]he purpose of this [guidance document] is to provide the most current procedural recommendations and guidance for identifying, analyzing, and controlling adverse water quality impacts *caused* by toxic discharges to the surface waters of the United States." at xxiii.).

Under the Federal APA, an agency action is arbitrary and capricious if "the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (U.S. 1983). Thus, it is not enough for EPA to claim a particular demonstration was made; such averments must be supported by evidence and the public must have had an opportunity to challenge that evidence and those findings. *In re Town of Ashland Wastewater Treatment Facility*, 9 E.A.D. 661, 665 n.8 (EAB 2001) (conclusory contention without more is insufficient to demonstrate review is warranted under 40 C.F.R. § 124.19); *see also In re Charles River Pollution Control Dist*., Order Denying Review, 16 E.A. D. ___, 5 (EAB 2015); *In re Dist. Of Columbia Water and Sewer Auth.*, 13 E.A.D. 714, 758-760 (EAB 2008). *Defenders of Wildlife v. Babbitt***,** 958 F. Supp. 670, 685 (D.D.C. 1997) (An agency "basing its decision on unsupported conclusory statements as well as facts which are directly contradicted by undisputed evidence in the Administrative Record" is "arbitrary and capricious"); *American Tunaboat Ass'n v. Baldrige*, 738 F.2d 1013, 1016 (9th Cir. 1984) ("The Court will reject conclusory assertions of agency "expertise" where the agency spurns unrebutted expert opinions without itself offering a credible alternative explanation.").[1]

The appropriateness of EPA's actions is not to be based on a hand-selected administrative record, but is to be based on the full record before the Agency (i.e., those documents both

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[1] *See also generally Leather Industries of Am. v. EPA*, 40 F. 3d. 392 (D.C. Cir 1994), for the proposition that an assumption is not the same as having data or analysis to support a proposition and *Columbia Falls Aluminum Co. v. EPA*, 139 F.3d 914 (D.C. Cir. 1998), for the principle that EPA is not authorized to make regulatory decisions on "generalizations" when the case specific facts indicate that the generalized approach is inappropriate.

supporting and contradicting the need for the proposed requirements). *See Citizens to Preserve Overton Park, Inc. v. Volpe*, 401 U.S. 402, 420 (1971) ("That review is to be based on the full administrative record that was before the Secretary at the time he made his decision."); *Envtl. Def. Fund v. Blum,* 458 F. Supp. 650, 661 (D.D.C. 1978) (finding the agency "may not, however, skew the 'record' for review in its favor by excluding from that 'record' information in its own files which has great pertinence to the proceeding in question.").

All TMDL actions (like other broad EPA regulatory actions) must be undertaken with an opportunity for notice and comment. As part of the APA notice and comment requirement, EPA is required to grant the public access to the full administrative record to allow for meaningful public input. 40 CFR Part 25. Absent access to such records and a fair opportunity to inspect the underlying information, EPA's actions are declared void, until due process rights have been respected. *See Lujan v. Defenders of Wildlife*, 504 U.S. 555, 572 n.7 ("The Supreme Court has also indicated that when plaintiffs seek to enforce procedural requirements 'the disregard of which could impair a separate concrete interests of theirs,' they can assert that right without meeting all the normal standards for redressability and immediacy.").

Finally, all EPA actions must be taken in accordance with the powers and authorities granted to EPA by Congress. EPA may not usurp state authority or act beyond the limits set forth by Congress under the Clean Water Act. *See Iowa League of Cities v. EPA*, 711 F.3d 844 (8th Cir. 2013).

1. **EPA Lacks Authority to Issue the TMDL**

The CWA requires states to take certain affirmative regulatory actions that control and influence water quality-based permitting. For instance, states possess the primary authority to establish WQSs. 33 U.S.C. § 1313(a)-(c). The states, not EPA possess the responsibility for producing TMDLs under Section 303(d) of the Act. It is only where a state fails to act in a timely fashion or where EPA rejects a TMDL that EPA obtains authority to complete a TMDL on behalf of the state agency. *Scott v. Hammond*, 741 F.2d 992, 996-97 (7th Cir. 1984). The Third Circuit recently held that EPA may act in a cooperative fashion to assist in the development of a TMDL, where affected states request such assistance. *Am. Farm Bureau Fed'n v. U.S. EPA*, 984 F. Supp. 2d 289 (M.D. Pa. 2013). However, in this instance, there are no documents in the record showing that PADEP asked EPA to issue this TMDL. Rather, EPA, *sua sponte*, decided that, based on decade old data, EPA would declare that (1) the 2003 Nutrient/Sediment TMDL was insufficient to control nutrient impacts and restore aquatic life impairments and (2) existing aquatic life impairments (i.e., insect populations) should be presumed to be caused by nutrients. Putting aside whether or not either statement is factually true, they are irrelevant to determining whether or not EPA has federal authority to issue this TMDL.

A similar circumstance arose in 2010, where EPA attempted to issue a TMDL to regulate arsenic discharges in the Upper Mississippi River. The State of Iowa objected to his action as beyond EPA's authority that was referenced in a federal consent decree:

> *"These two TMDLs are being established by EPA to meet the requirements of the 2001 Consent Decree, Sailors, Inc., Mississippi River Revival, and Sierra Club v. EPA, Consolidated Case No. C98-134-MJM." The only references to impairments of segments of the Mississippi River identified in the consent decree appear to be for impairments due to sediment and turbidity. As such, these TMDLs would not be subject to the deadlines in this consent decree. The department would appreciate the opportunity to take the time to work with the EPA to 1) develop TMDLs that are implementable and protect the designated uses of the Mississippi River, and/or 2) re-evaluate the attainability of the human health uses. Iowa DNR March 10. 2010 to USEPA Region VII.*

Based on these comments, EPA withdrew the Arsenic TMDL for the Upper Mississippi River concluding that there was no present need for EPA to act, despite the arsenic impairment listing for those waters. To date, a federal TMDL has yet to be issued in that instance. This case is no different.

A recent EPA Region 3 TMDL case is particularly instructive on the scope of EPA authority under the TMDL program. *Am. Farm Bureau Fed'n v. U.S. EPA*, 984 F. Supp. 2d 289, 314 (M.D. Pa. 2013) –

> After reviewing Section 303(e), the court agrees that *EPA is not authorized to establish or otherwise take over TMDL implementation plans*. However, here again, it would go too far to say that EPA has no role in developing state implementation plans. In fact, EPA is required to review and approve or disapprove each state's CPP, and, once its process has been approved, occasionally review it to ensure that it stays consistent with the Act. 33 U.S.C. § 1313(e)(2). Thus, here too, EPA has supervisory authority. EPA's supervisory authority is consistent with the CWA's requirement that EPA "ensure that management plans are developed and implementation is begun by signatories to the Chesapeake Bay Agreement to achieve and maintain . . . the nutrient goals of the Chesapeake Bay Agreement . . . [and] the water quality requirements necessary to restore living resources to the Chesapeake Bay ecosystem." 33 U.S.C. § 1267(g). Nevertheless, Plaintiffs are correct that *Section 303(e) stops short of giving EPA authority to enact its own implementation plan where it has determined that the state's effort has fallen short*. EPA may not, for example, dictate to a state what measures the state must undertake to reduce pollution from a particular source. (Emphasis added)

In this case there is no "state effort that has fallen short" – in fact, the state has yet to decide how it wishes to proceed, assuming that nutrient levels are actually part of the ongoing problem (See, Attachment 2 – PADEP PowerPoint, Modeling for the Wissahickon Watershed TMDL). Consequently, EPA is without authority to proceed as it has proposed.

In summary, the Clean Water Act provides very specific direction and procedures for the development and issuance of TMDLs. Section 303(d) specifies that states, not EPA, are authorized to issue TMDLs, and that EPA may only develop and publish a federal TMDL where EPA concludes that a state's proposed TMDL action is insufficient to achieve applicable water quality standards. 33 USC § 1313(d)(2); 40 CFR § 130.7. EPA has never provided Pennsylvania with the formal deficiency notices required under Section 303(d), and there has been no allegation that the State ever submitted a deficient nutrient TMDL for Wissahickon Creek. Also, there is no letter from PADEP asking for EPA to complete this TMDL on behalf of PADEP. Thus, this is clearly not a case in which EPA was under a mandatory duty to issue the TMDL because of an insufficient or deficient state TMDL action or a case of allowable discretionary authority. As such, EPA has no authority, be it statutory or court-ordered, to issue the proposed TP TMDL.

2. Illegal Modification of Applicable State Standard/CALM (Section 303(d) Listing) Procedures (New Endpoints, More Restrictive Endpoints, Endpoints Unrelated to Any Impairment Threshold; Unrelated to DO/algal Impacts)

The CWA sets out a very specific process by which states adopt and EPA reviews state water quality standards. *See* 33 USC § 1313(c) ("CWA § 303(c)"). Specifically, states are to submit all new and revised standards to EPA, and, once every three years, the states must submit the results of their triennial water quality standard reviews to EPA. *See* 33 USC §§ 1313(c)(1) & (c)(2); *see also Defenders of Wildlife v. EPA*, 415 F.3d 1121, 1124 (10th Cir. 2005) ("[S]tates have the primary role … in establishing water quality standards," and "EPA's sole function, in this respect, is to review those standards for approval."). Upon receipt of the standards, EPA then reviews the submissions and revisions, and provides the state with a formal approval or objection. *See* 33 USC § 1313(c)(3). If EPA objects to the standards, it must supply the state with the basis for its objection in writing. *Id.* If the state does not make the requested amendments, EPA is tasked with developing the standards itself. *Id.*; *see also Ky. Waterways Alliance v. Johnson*, 540 F.3d 466, 471-472 (6th Cir. 2008). However, EPA must follow the same CWA § 303(c) process as it does with all other state water quality standards.[2]

[2] Sometimes refinements [to water quality standards] take place concurrently with the development of a Total Maximum Daily Load (TMDL) for a specific water body . . . . In this example the regulatory authority could revise the standard concurrently with the establishment of the TMDL . . . . In these situations, it will be particularly important . . . because the TMDL must be established for the "applicable" water quality standard, which is the approved water quality standard. 65 Fed. Reg. 24641, 24647 (April 27, 2000). Additionally, several cases have found, under § 1365(a)(2), that EPA has an affirmative duty to comply with WQS adoption/revision procedures *whenever* a water quality standard is revised. *See e.g., Miccosukee Tribe of Indians of Florida v. EPA*, 105 F.3d 599 (11th Cir. 1997) (EPA has a mandatory duty to review and approve all documents that effectuate water quality standard revisions, regardless of whether the state believes it has revised its standards); *Florida Public Interest Research Group Citizen Lobby, Inc. v. EPA*, 386 F.3d 1070 (11th Cir. 2004) (same).

DEP does not have numeric criteria for nutrients. Instead, DEP regulates nutrients through its narrative criteria found at 25 Pa. Code § 93.6(a) and related implementation guidance ("Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life."). In short, this regulation prohibits parameters, such as nutrients, to be found at levels that are *causing* harm to a specific waterbody. Under these narrative criteria, a Pennsylvania waterbody is impaired by nutrients only when excessive plant or algal growth causes a decrease in DO such that the DO level goes below the required amount necessary to support the designated use of that waterbody. DEP, Implementation Guidance for Section 95.9 Phosphorus Discharges to Free Flowing Streams (1997), at 7. Similarly, DEP's 303(d) listing methodology (the standard by which DEP determines whether a stream is nutrient impaired) specifically requires nutrients to be causing excessive plant growth and/or violations in the dissolved oxygen standard. DEP's narrative criteria for nutrients and the published methodology interpreting these criteria are not based on the levels of macroinvertebrates present (a generic term intended to include aquatic insects, mollusks, crustaceans, and other aquatic invertebrate animals). (See, Court Opinion in Indian Creek TMDL case, *Telford Borough Auth. v. U.S. EPA,* 2013 U.S. Dist. LEXIS 162776, *14 (E.D. Pa. Nov. 15, 2013), confirming applicable state narrative criteria interpretation).[3]

Despite Pennsylvania's published methodology for interpreting its narrative standard with respect to nutrients and identifying nutrient impairments, the Draft Wissahickon Creek TMDL assumed, rather than demonstrated, causation. Similarly, the TMDL was based on macroinvertebrates rather than dissolved oxygen or excessive plant growth. Finally, the TMDL created a numeric threshold for nutrients identifying the level by which Pennsylvania waterbodies will be deemed nutrient impaired. This fails to apply the "applicable" water quality standard as mandated by the CWA and implementing regulations (40 CFR 130.7 and 122.44(d)) which is required to implement the state's published narrative rule interpretation. *In re Ina Road Water Pollution Control Facility,* 2 E.A.D. 99 (CJO 1985).

[3] Opinion, at 5. "The Department of Environmental Protection uses narrative criteria to regulate nutrients in Pennsylvania waterways. 25 Pa. Code §93.6(a) ("Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life."). In sum, these criteria prohibit nutrient levels that are harmful to the specific water body in question but do not set a numerical cap on different levels of nutrients. Based on this narrative criteria, "a Pennsylvania waterbody is impaired by nutrients when excessive plant or algal growth causes a decrease in [dissolved oxygen] such that the [dissolved oxygen] level goes below the required amount necessary to support the designated use of that waterbody." (Doc. No. 1, at 9; *see also Implementation Guidance for Section 95.9 Phosphorous Discharges to Free Flowing Streams,* PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (Oct. 27, 1997), http://www.elibrary.dep.state.pa.us/dsweb/ Get/Document-48364/391-2000-018.pdf.) As such, "the DEP's 303(d) listing methodology (the standard by which DEP determines whether a stream is nutrient impaired) specifically requires nutrients to be causing excessive plant growth and/or violations in the dissolved oxygen standard." (Doc. No. 1, at 10.)

For example in determining whether an individual nutrient limit is needed under 40 C.F.R. § 122.44(d)(1)(vi)(A) the following is required:

> State narrative water quality criteria provide the legal basis for establishing effluent limits under paragraphs (d)(1)(v) and (d)(1)(vi) of today's regulations…. When a state adopts a narrative water quality criteria, EPA's regulations at 40 CFR 131.11(a)(2) require the state to 'provide information identifying the method by which the state intends to regulate point source discharges of toxic pollutants on water quality limited segments based on such narrative criteria.'…

54 Fed. Reg. 23,868, 23,877 (June 2, 1989). Thus, in all NPDES permitting actions EPA is required to utilize the state's published methods, where available, in implementing narrative criteria. "[T]he permitting authority must establish effluent limits using one or more of the following options (A)… a proposed State criterion, or an explicit State policy or regulation interpreting its narrative water quality criterion, supplemented with other relevant information;…" 40 C.F.R. § 122.44(d)(1)(vi)(A); *see also Am. Paper Inst. v. United States EPA*, 996 F.2d 346, 351 (D.C. Cir. 1993) ("The general language of narrative criteria … does not mean that the language of a narrative criterion does not cabin the permit writer's authority at all; rather, it is an acknowledgement that the writer will have to engage in some kind of interpretation to determine what chemical-specific numeric criteria--and thus what effluent limitations--are most consistent with the state's intent as evinced in its generic standard.").[4] Language requiring EPA to use published state methods is also specified in 40 CFR 130.7 and 130.10.

EPA's own Section 303(d) impairment listing guidance directs states to establish specific procedures for interpreting narrative standards and to include <u>those procedures in CALM documents</u>:

> "Where a state, territory, or authorized tribe adopts narrative criteria for non-toxic pollutants to protect designated uses, it should provide information identifying the method by which it intends to regulate point sources discharges on water quality limited segments based on such narrative criteria in the state, territory, or authorized tribe's WQS *or alternatively in other implementing regulations or policies and procedures documents such as the continuous planning process of consolidated assessment and listing methodology*."

[4] *See also In re Ina Road Water Pollution Control Facility*, 2 E.A.D. 99 (CJO 1985) (Region should ordinarily defer to State's interpretation of its own water quality standard regulations unless that interpretation is clearly erroneous); *Kentucky Waterways Alliance v. Johnson*, 540 F.3d 493, 469 n.1 (6th Cir. 2008) ("In interpreting a state's water quality standard, ambiguities must be resolved by 'consulting with the state and relying on authorized state interpretations."); *Marathon Oil Co. v. Envtl. Prot. Agency*, 830 F.2d 1346, 1351-1352 (5th Cir. 1987) (EPA is merely an "interested observer" as to how a state interprets its WQS provisions).

See USEPA, 2002 - Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices at 3-4 (emphasis added).[5] EPA is clearly not free to modify regulatory requirements for the sake of convenience. *See Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs.*, 545 U.S. 967, 981 (2005) ("Unexplained inconsistency is… a reason for holding an interpretation to be an arbitrary and capricious change from agency practice under the Administrative Procedure Act."). Therefore, as EPA plainly failed to use the *applicable water quality standard* for nutrients as described in the PA DEP CALM document (Section 303(d) listing methodology and published state guidance documents) and, instead, relied on its own "invertebrate-based" interpretation to impose nutrient restrictions, EPA's permit action is based on a clear error of law. Therefore, as EPA's proposed TMDL fails to use the applicable WQS, as defined in state narrative implementation documents, it must be withdrawn because *"*[t]he agency has relied on factors which Congress has not intended it to consider". *State Farm,* 463 U.S. at 43 (1983).

3. Failure to Use Current, Post-2003 TMDL Implementation Data to Base Decision Making

Generally speaking, EPA must base its regulatory decisions on the latest and most current scientific information. *See Sierra Club v. United States EPA*, 671 F.3d 955, 968 (9th Cir. 2012) ("But we should not silently rubber stamp agency action that is arbitrary and capricious in its reliance on old data without meaningful comment on the significance of more current compiled data. We hold that EPA's failure to even consider the new data and to provide an explanation for its choice rooted in the data presented was arbitrary and capricious.").[6] Similarly, the EPA permitting regulation mandates that "the permitting authority *shall use* procedures which account for *existing* controls on point and nonpoint sources of pollution." 40 C.F.R. § 122.44(d)(1)(ii) (emphasis added). Decision making under Section 303(d) of the Act is also required to be based on current information and latest loadings from point and non-point sources. 40 CFR § 130.7. In developing Section 303(d) lists, States are required to assemble and evaluate all existing and readily available water quality related data and information, including, at a minimum, consideration of existing and readily available data and information about the following categories of waters: (1) waters identified as partially meeting or not meeting designated uses, or

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[5] Available at http://water.epa.gov/type/watersheds/monitoring/upload/2003_07_24_monitoring_calm_calm_ch3.pdf. *See also* 40 C.F.R. § 131.11(a)(2) *("*Where a State adopts narrative criteria …, the State must provide information identifying the method by which the State intends to regulate point source discharges … based on such narrative criteria. Such information may be included as part of the standards *or may be included in documents generated by the State in response to the Water Quality Planning and Management Regulations* (40 CFR part 35).") (emphasis added).

[6] *See, e.g.,* 33 U.S.C. § 1314(a)(1) ("The Administrator … shall develop and publish . . . criteria for water quality *accurately reflecting the latest scientific knowledge* ….") (emphasis added); 40 C.F.R. § 130.7(b)(5) ("Each State shall assemble and evaluate *all existing and readily available* water quality-related data and information to develop the list required by §§130.7(b)(1) and 130.7(b)(2).") (emphasis added).

as threatened, in the State's most recent Section 305(b) report; (2) waters for which dilution calculations or predictive modeling indicate nonattainment of applicable standards; (3) waters for which water quality problems have been reported by governmental agencies, members of the public, or academic institutions; and (4) waters identified as impaired or threatened in any Section 319 nonpoint assessment submitted to EPA. See 40 CFR §130.7(b)(5). In addition to these minimum categories, States are required to consider any other data and information that is existing and readily available.

The analysis used to evaluate a waterbody's narrative criteria impairment status under Section 303(d) parallels the analysis needed to demonstrate whether a discharger is causing or contributing to an exceedance under 40 C.F.R. § 122.44(d) (*e.g.,* both use current loading and ambient conditions, consider available dilution, project whether pollutant may "cause or contribute" to an existing or projected impairment. The analysis must be based on current data and pollution control measures, supplemented by relevant studies of the waters in question. The analysis must account for major factors affecting the endpoint of concern, applying a rational cause and effect analysis to demonstrate that nutrient reduction is "necessary" to achieve compliance.

The TP limit derived by EPA, however, violated each of these regulatory requirements. EPA failed to comply with 40 C.F.R. § 130.7 by failing to utilize current water quality/plant performance information in evaluating the need for this TMDL and concluding that the prior TMDLs were insufficient to ensure use protection. The instream data presented on the results of implementing the 2003 TMDL were from 2005 and 2006, *prior to the implementation of either the sediment or nutrient/DO TMDLs.* This was clear error. This TMDL must be demonstrated to be necessary, however, using actual post-2003 TMDL information and confirmation that the sediment TMDL mandates were actually achieved in this watershed. No such information is presented anywhere in this document – EPA just presumes that 2006 was the date by which all TMDL implementation occurred – a presumption that is plainly in error. *Infra* at 20-21. Unlike Agency predictions, simple findings of fact are not afforded deference. *Upper Blackstone Water Pollution Abatement Dist. v. U.S. EPA*, 690 F.3d 9, 20-21 (1st Cir. 2012) (*citing Balt. Gas & Elec. Co. v. Natural Res. Def. Council, Inc.,* 462 U.S. 87, 103 (1983).

Consequently, as EPA's claim regarding the necessity of this TMDL action (insufficient improvements were obtained from the prior TMDL) is obviously flawed – EPA's assessment was based on information and analyses that were not actually "post TMDL implementation". Thus, there is no demonstrated legal need for this TMDL. As EPA has "offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise" this TMDL is arbitrary and capricious. *See, e.g., State Farm*, 463 U.S. at 43 (1983).

4. **Supplemental Comments/deficient Administrative Record – FOIAs**

To date, EPA has refused to provide the public with access to the background documents that formed the basis for this TMDL action (See, Att. 3 - Email Exchange between EPA Region 3 and H&A directing that FOIA be used to allow access to such documents). Subsequently, EPA claimed that H&A, who represents the majority of municipal interests in the basis, must pay over $13,000 to have access and copies of that information and that such records will not be released until assurance of payment is received. (See, USEPA FOIA Response to H&A dated July 23, 2015). Through this convoluted procedure, EPA has effectively prevented public access to the documents necessary to complete a full review of EPA's proposed TMDL action.

It is axiomatic that federal regulatory actions, including the establishment of the TMDLs review "is to be based on the full administrative record that was before the [agency] at the time [it] made [its] decision." *Citizens to Preserve Overton Park, Inc. v. Volpe*, 401 U.S. 402, 420 (1971) (footnote omitted); *see also Envtl. Def. Fund, Inc. v. Costle*, 657 F.2d 275, 284 (D.C. Cir. 1981). "If the record is not complete, then the requirement that the agency decision be supported by 'the record' becomes almost meaningless." *Pac. Coast Fed'n of Fishermen's Assoc./Inst. for Fisheries Res. v. Gutierrez,* 2007 U.S. Dist LEXIS 25846 (E.D. Cal. 2007) *citing Portland Audubon Soc. v. Endangered Species Comm.*, 984 F.2d 1534, 1548 (9th Cir. 1993). Pursuant to *Overton Park*, the administrative record consists of all materials "before the agency at the time the decision was made." 401 U.S. at 420. This would include all documents that the agency "directly or indirectly considered." *City of Duluth v. Jewell*, 968 F. Supp. 2d 281, 287 (D.D.C. 2013); *Bar MK Ranches v. Yuetter*, 994 F.2d 735, 739 (10th Cir. 1993). The record would also consist of "the order involved, any findings or reports on which that order is based, and 'the pleadings, evidence, and other parts of the proceedings before the agency.'" Fed. R. App. P. 16(a); *Am. Wildlands v. Kempthorne*, 530 F.3d 991, 1002 (D.C. Cir. 2008).

Under the APA, courts will set aside an agency's final action if made "without observance of procedure required by law." 5 U.S.C. § 706(2)(C). When the issue is whether the agency followed the requisite legal procedures for adopting new rules, the Court's review is "exacting." *Natural Res. Def. Council, Inc. v. Sec. & Exch. Comm'n*, 606 F.2d 1031, 1048 (D.C. Cir. 1979). EPA's NPDES public participation rules unequivocally mandate that the public is to have access to the information that forms the basis of EPA's permitting action. 40 C.F.R. § 124.8(b); *Costle v. Pacific Legal Found.*, 445 U.S. 198, 215-216 (1980).[7] *Nat'l Ass'n of Clean*

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[7] As President Johnson said when he signed it into law in 1966, FOIA "legislation springs from one of our most essential principles: a democracy works best when the people have all the information that the security of the nation will permit." Congress enacted FOIA to promote transparency across the government. *See* 5 U.S.C. § 552; *Quick v. U.S. Dep't of Commerce, Nat'l Inst. of Standards & Tech.*, 775 F. Supp. 2d 174, 179 (D.D.C. 2011) (citing *Stern v. FBI*, 737 F.2d 84, 88 (D.C. Cir. 1984). The Supreme Court has explained that FOIA is "a means for citizens to know 'what their Government is up to.' This phrase should not be dismissed as a convenient formalism. It defines a

Water Agencies v. EPA, 106, 734 F.3d 1115, 1148 (D.C. Cir. 2013) (purpose of notice-and-comment provisions is "to ensure that affected parties have an opportunity to participate in and influence agency decision making at an early stage, when the agency is likely to give real consideration to alternative ideas."). This due process harm constitutes prejudice regardless of whether EPA would have ultimately changed its position. See *Sugar Cane Growers Co-op of Florida v. Veneman*, 289 F.3d 89, 97 (D.C. Cir. 2002) ("[F]ailure to comply with notice and comment cannot be considered harmless if there is any uncertainty at all as to the effect of that failure."). *Connecticut Light & Power Co. v. Nuclear Regulatory Com'n.*, 673 F.2d 525, 530 (D.C. Cir. 1982) ("To allow an agency to play hunt the peanut with technical information, hiding or disguising the information that it employs, is to condone a practice in which the agency treats what should be a genuine interchange as mere bureaucratic sport."). Accord, *New York v. Heckler*, 742 F.2d 729, 738 (2d Cir. 1984) ("Where the Government's secretive conduct" is present, not enforcing judicial review restrictions "until such time as plaintiffs had a reasonable opportunity to learn the facts concerning the cause of action"). Thus, an EPA failure to follow its rules to ensure that CWA public participation mandates are met represents clear error. 33 U.S.C. § 1251(e); 40 C.F.R. Part 25; 40 C.F.R. § 130. This TMDL action must be withdrawn until EPA complies with applicable public participation mandates which apply to all of EPA's regulatory activities. See, 33 U.S.C. § 1251(e).

5. The EPA Administrative Record Is Missing Critical Information

EPA has determined, through its 40 C.F.R. § 25.2 and, *inter alia*, § 130.7, 130.10 regulations, that formulation of a TMDL is an activity requiring public comment/access to relevant records and improper completion of public participation will nullify a draft TMDL. The TMDL and several primary support documents are summary in nature. These documents rely on data and analyses that are not available for public review as part of those summary documents. The list of "missing" information includes, inter alia:

1. Database used by Tetra Tech to create all of the graphs used to support the TMDL endpoint concentration that controlled the TMDL TP reductions for all of the permittees (*How can we know that the Tetra Tech graphs were properly derived without access to the database*?).

2. Documentation that attaining the target instream TP concentration will actually reduce plant growth and restore invertebrate populations (*Where else has this happened, how do you know it will work*?).

3. Documentation of the plant growth and invertebrate populations in Wissahickon Creek Watershed after full implementation of 2003 TMDLs (*EPA claimed data confirmed the*

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structural necessity in a real democracy." *Nat'l Archives & Records Admin. v. Favish*, 541 U.S. 157, 171-72 (2004). The actions taken by the U.S. EPA undermine the basic intent of the FOIA legislation.

last group of TMDLs was inadequate – where is this post-2003 TMDL implementation database?).

4. A modeling report that explains the basis for the input and controlling model parameters used to make various algal and DO related predictions. (*How is it possible to know that the model is based on scientifically defensible calibration without knowing the basis for the key components of the model?).*

5. Documentation showing how MS4 TP loads from large storm event could possibly cause increased plant growth in the Creek when such loads remain in the system for a fraction of a day (*Where is the justification for this assumption by Tetra Tech*?)

6. Data from this stream or some other Eastern PA stream showing that meeting a 40 µg/l TP level will control filamentous plant growth as claimed by Tetra Tech. (*Why did EPA use Maryland data from streams with very low TP levels rather than the Eastern PA streams with much higher TP levels?).*

7. Documentation showing the fate of TP entering Wissahickon Creek Watershed during non-growing season (*The TMDL recommended year round TP control over claims that winter TP loadings settled in the stream bed – where is this analysis*?).

8. Documentation showing that MS4 discharges are capable of achieving 80% plus TP reduction (*EPA claimed the TMDL demonstrated "reasonable assurance" that the limits are attainable and would be met – where*?).

9. Evidence/analyses confirming that other non-nutrient factors are not the primary factors precluding aquatic life use attainment in the Wissahickon Creek Watershed (*Where is this analysis Tetra Tech claims to have completed*?).

10. Documentation showing that the reduced invertebrate populations are occurring in response to excessive plant growth (*This is the central underlying premise of the TMDL and it is nowhere evaluated in the TMDL?*).

Without a review of this information, one cannot know that the TMDL is either necessary or appropriate to achieve its stated objective – restoration of invertebrate assemblages to Wissahickon Creek. Consequently, the release of this information is vital to informed public comment during the comment period, as is required under 40 C.F.R. § 25.4(b).

Region 3 staff informed H&A that a "public record" or Docket is not being maintained on the matter and that entities may, instead, file a FOIA request for particular supporting documents desired for the comment process. (See, Att. 3). The communities represented by H&A have consequently submitted over a dozen FOIA requests to obtain critical records. This approach, chosen by EPA to meet its Part 25 and related Part 130 public participation rules, effectively prevents public access to records until EPA responds under FOIA. This "FOIA approach" does not appear to be allowable under Part 25 since a public docket on the TMDL is not being maintained. Nonetheless, since such records are not presently available for public review, as required by 40 C.F.R. § 25.4(b) and 130.7, and are vital to the public's ability to comment in an informed manner on the TMDL, the public comment period cannot close until such records have been made available and a reasonable time has been allowed for the assessment of that information.

EPA's failure to provide access to the records, prior to the closure of the public comment period is a major due process violation. Until this violation is remedied further action on this TMDL is, *per se*, arbitrary and capricious. *See Sugar Cane Growers,* 289 F.3d 89 (D.C. Cir. 2002).

6. **Issuance of TMDL Based on Known Incorrect Assumptions and Purposefully Flawed/biased Technical Analyses Indicates Agency/consultant Malfeasance**

As noted previously, when assembling the "full record," an agency "may not, however, skew the 'record' for review in its favor by excluding from that 'record' information in its own files *which has great pertinence to the proceeding in question*." *See Envtl. Def. Fund v. Blum,* 458 F. Supp. 650, 661 (D.D.C. 1978) (emphasis added); *see also Fund for Animals v. Williams,* 245 F.Supp.2d 49, 55 (D.D.C. 2003) (an agency may not exclude pertinent but unfavorable information); *Home Box Office, Inc. v. FCC,* 567 F.2d 9, 54 (D.C. Cir. 1977) (an incomplete record must be viewed as a "fictional account of the actual decision-making process.").

Inexplicably, neither Tetra Tech nor USEPA used or mentioned an existing Wissahickon Creek hydrodynamic and water quality model developed in 2003 also by Tetra Tech (Rui Zou, Principal Engineer; Leslie Shoemaker, Vice President; Andrew Parker, Director) and USEPA Region 3 (Thomas Henry, TMDL Program Manager) (Att. 4 - Zou et al., 2006). The model report found that periphyton was a major cause of low DO conditions, but:

> […] it was finally determined to be infeasible to control periphyton through reducing nutrient load from the point sources. Several model sensitivity runs show that the phosphorus concentrations from the dischargers need to be reduced by almost 99% before we can impose a significant limiting effect on periphyton growth […] At the same time, periphyton only needs very low concentration of phosphorus to support its growth. Consequently, the TMDL has to be focused on reducing loadings rates of BOD and other oxygen consuming constituents such as organic nitrogen and NH_4. (at 564).

This paper, published by the same "experts" that developed the TMDL, concludes that it is essentially impossible for the plant growth to be reduced at the TP level chosen by the TMDL. Despite the consultant knowing this scientific fact, they created a TMDL document that attempted to present the *opposite* conclusion by ignoring this information and other watershed specific information confirming that the proposed approach was not scientifically defensible.

If this was a criminal conspiracy to undertake illegal activity, EPA's and Tetra Tech's rendition of the facts would be considered "willful blindness" -- as EPA has "buried its head in the sand" and "deliberately closed [its] eyes to what would otherwise have been obvious…." (*United States of America vs. Clay*, 618 F.3d 946, 953-54 (8th Cir. 2010)). The EPA proposed TMDL and expert reports by Tetra Tech *completely ignored* any and all information that confirmed that this proposed TMDL action is unnecessary and will produce no meaningful change in the ecology of Wissahickon Creek. These omitted records include:

- Tetra Tech's peer reviewed and published papers that confirmed TP reduction will produce no material change in plant growth in this system;
- The analyses of the consultant that collected plant growth for this system which concluded that the HIGHEST levels of plant growth were occurring where the lowest TP levels (14-35 µg/l) were occurring in the system;
- Repeated Region 3 studies of other PA and VA waters that confirmed plant growth will not be controlled at a 40 µg/l level;
- Prior technical agreement of Tetra Tech that using a higher algal growth rate to "manufacture" the appearance that TP control will be effective in controlling plant growth is scientifically unsupportable;
- Repeated studies, performed by Tetra Tech at the request of USEPA which confirmed there is no demonstrable relationship between TP levels and any invertebrate index or population measure (See, e.g., analyses EPA conducted for State of Florida water quality criteria development);
- Claiming that MS4 control of loading associated with high stream flows is necessary to restore the invertebrate populations when analyses confirmed such conditions do not even contribute to increased plant growth; and,
- Claiming that year round TP reduction is necessary because winter loadings (including dissolved forms of phosphorus) settle in the system when stream sampling data confirmed this simply does not occur and settling of dissolved phosphorus forms is physically impossible.

Courts do not countenance obvious attempts to skew an administrative record or bias an agency's analysis. *Ethyl Corp. v. EPA*, 541 F.2d 1, 84 (D.C. Cir. 1976) ("To the contrary, we only submit that *a responsible Administrator would not materially rely on recently acquired, uncommented upon studies - especially when the results of previous studies had been undermined severely* by the unanimous criticism of other independent government agencies.") (emphasis added). It is arbitrary and capricious for an agency to rely on an approach document whose own author has admitted is flawed. *See Texas Oil & Gas Ass'n v. U.S. EPA*, 161 F.3d 923, 935 (5th Cir. 1998) ("When an agency adopts a regulation based on a study [that is] not designed for the purpose and is limited or criticized by its authors on points essential to the use sought to be made of it the administrative action is arbitrary and capricious and a clear error in judgment."). *Rollins Envtl. Srvcs. v. EPA*, 937 F.2d 649, 653 (D.C. Cir. 1991) (where agency has given "conflicting advice" on how to interpret a regulation it is arbitrary and capricious to conclude the rule has a plain meaning); *United States v. Hoechst Celanese Corp.*, 964 F. Supp. 967, 980 (D.S.C. 1996), *rev'd on other grounds* (same).

To justify this TMDL action, Tetra Tech conducted a repeat of the technical analyses that EPA's Science Advisory Board (hereafter, "2010 SAB") determined was not scientifically defensible. In this instance EPA, via Tetra Tech, created a supposed "weight of evidence" analysis that simply ignored any and all evidence which confirmed the analysis was misplaced, contrary to explicit federal guidance that such an approach is improper. See, e.g., ENDOCRINE DISRUPTOR SCREENING PROGRAM - Weight-of-Evidence: Evaluating Results of EDSP Tier 1 Screening to Identify the Need for Tier 2 Testing (USEPA, 2011).[8] That is, EPA and Tetra Tech purposefully ignored all of the site-specific evidence for this system which confirmed, beyond any shadow of a doubt, that this TMDL was simply unnecessary and the level of TP control could not possibly result in a reduction of "excessive" plant growth – to the degree it even exists. The purposeful skewing of an administrative record constitutes "bad faith" implementation of TMDL responsibilities and Tetra Tech's willing assistance in this undertaking is a serious breach of professional responsibilities and would appear to constitute an "intentional tort". It seems obvious that both EPA and Tetra Tech took care to scour the record of adverse information so this would improve the chance of defending the action upon appeal to an independent tribunal. That is a seriously improper implementation of the Act's duties and responsibilities. *See Aoude v. Mobil Oil Corp.*, 892 F.2d 1115, 1118 (1st Cir. 1989) (A "fraud on the court" occurs where a party has clearly and knowingly interfered with the court's ability to impartially adjudicate a matter by improperly influencing the trier or unfairly hampering the presentation of the opposing party's claim).

EPA is requested to immediately withdraw this TMDL action and to expand the record with the various highly relevant, discarded analyses that confirmed this TMDL was not scientifically defensible and that TP control, as proposed by EPA, would produce no meaningful ecological improvement for this system.

[8] "Generally, WoE is defined as the process for characterizing the extent to which the available data support a hypothesis that an agent causes a particular effect (USEPA 1999; 2002a; 2005). This process involves a number of steps starting with assembling the relevant data, evaluating that data for quality and relevance followed by an integration of the different lines of evidence to support conclusions concerning a property of the substance. WoE is not a simple tallying of the number of positive and negative studies (USEPA 2002a). Rather it relies on professional judgment. Thus, transparency is important to any WoE analysis. A WoE assessment explains the kinds of data available, how they were selected and evaluated, and how the different lines of evidence fit together in drawing conclusions. The significant issues, strengths, and limitations of the data and the uncertainties that deserve serious consideration are presented, and the major points of interpretation highlighted." (at 27).

7. TMDL Based on Series of Speculative/unsupported Assumption – Regulation Based on Speculation per se Arbitrary and Capricious

All TMDLs are to be based on demonstrated "cause and effect" relationships for the specific waters of concern. (See, USEPA, 1999 – Protocol for Developing Nutrient TMDLs). That is, when one claims that a pollutant is the cause of a given impairment and that a high level of reduction is necessary to eliminate that impairment, one must demonstrate, not presume, such claims based on detailed site-specific information and analyses. *See also Nat'l Metal Finishers Ass'n v. EPA*, 719 F.2d. 624, 640 (3rd Cir. 1983) ("that neither the language of the Act nor the intent of Congress appears to contemplate liability without causation.") *rev'd on other grounds Chemical Mfrs. Ass'n v. Natural Res. Def. Council*, 470 U.S. 116 (1985); *Ark. Poul. Fed. v. Envtl. Prot. Agency*, 852 F. 2d 324, 328 (8th Cir. 1988) (stating the discharge must at least be "a cause" of the violation); *supra*, at 12 (*State Farm* – failure to consider an important factor). *See also, Upper Blackstone Water Pollution Abatement Dist. v. EPA*, 690 F.3d 9, 14 (1st Cir. 2012) ("State water quality standards generally supplement these effluent limitations, so that where one or more point source dischargers, otherwise compliant with federal conditions, *are nonetheless causing a violation of state water quality standards*, they may be further regulated to alleviate the water quality violation.") (emphasis added); *id.*, at 25-26 ("The EPA found that '[b]oth the MERL tank experiments and the data from the Providence/Seekonk River system *confirm a clear correlation* between nitrogen loadings, dissolved oxygen impairment, and chlorophyll *a* levels' in those water bodies. Both the MERL model and the field measurements demonstrated that as nitrogen loadings increase, dissolved oxygen decreases and chlorophyll *a* increases, with both becoming less stable and subject to greater swings at higher levels of nitrogen. The EPA concluded that the *basic causal relationship* demonstrated in the MERL experiments 'corresponds to what is actually occurring in the Providence/Seekonk River system.'") (emphasis added); *id.*, at 27 ("Here, the EPA states, and the record reflects, that the MERL *model demonstrated the relationship between nitrogen loading, dissolved oxygen, and chlorophyll a production* for a range of loading scenarios in a water environment similar to the Bay's.") (emphasis added).

EPA guidance explains how to use ambient data to make valid cause and effect predictions for nutrients. See, USEPA, 2010 - Using Stressor-response to Derive Numeric Nutrient Criteria (hereafter, "Stressor-response Guidance") at 6, 32. When evaluating nutrient impacts using stressor-response relationships (as conducted by EPA and Tetra Tech) a key component is confirming that the nutrient level, and not some other "confounding factor" is actually the root cause of the impairment that has been found to exist in the receiving waters. (Id -*passim*; USEPA Science Advisory Board April 10, 2010 opinion on proper use of stressor-response methods for nutrient criteria development). Given (1) the plain causation language of 40 C.F.R. §130.7 and 122.44(d) and the state's narrative criteria, and (2) the lack of such analyses or confounding factors assessment presented by Tetra Tech, it was clear error for EPA to conclude it was “necessary” to impose state-of-the-art TP reduction requirements on the entire Wissahickon Creek watershed using what are, at best, “correlations”.[9] Most of the assessments had extremely low statistical power (meaning the relationship was poor to non-existent) yet EPA and Tetra Tech claimed these assessments “demonstrated” TP was the cause of the alleged ongoing system impairment.

This TMDL, however, provides no information or analyses whatsoever regarding the following key claims made by EPA in the TMDL documents:

- Excessive plant growth is the cause of macroinvertebrate aquatic life use impairment in this system;
- TP levels are controlling and causing the excessive plant growth;
- Stream water quality monitoring data, following implementation of the 2003 TMDL load reductions, confirm that TP is the cause of any ongoing macroinvertebrate aquatic life use impairment in this system;
- That MS4 or other non-point type contributors of TP can achieve 88-94% reduction levels;
- Reducing TP to 40 µg/l has been demonstrated to restore, or necessary to restore, invertebrate assemblages in other streams;
- A sufficient “confounding factors” assessment has been completed which confirmed, to a reasonable scientific certainty, that TP was the primary cause of macroinvertebrate aquatic life use impairment in Wissahickon Creek.

This TMDL decision record is plainly deficient as EPA presents no information, whatsoever, to confirm this TMDL is necessary or even has a likelihood of restoring the identified impairments. Consequently, this plainly deficient proposal should be withdrawn and reconsidered. *See Defenders of Wildlife v. Babbitt*, 958 F. Supp. 670, 685 (D.D.C. 1997) (An agency “basing its decision on unsupported conclusory statements as well as facts which are directly contradicted by undisputed evidence in the Administrative Record” is “arbitrary and capricious”); *see, e.g., American Tunaboat Ass'n v. Baldrige*, 738 F.2d 1013, 1016 (9th Cir. 1984) (“The Court will reject conclusory assertions of agency "expertise" where the agency spurns unrebutted expert opinions without itself offering a credible alternative explanation.”).[10] *Kent Cnty., Del. Levy*

[9] It goes without saying “correlation does not demonstrate causation.”

[10] *See also generally Leather Industries of Am. v. EPA*, 40 F. 3d. 392 (D.C. Cir 1994), for the proposition that an assumption is not the same as having data or analysis to support a proposition and *Columbia Falls Aluminum Co. v. EPA*, 139 F.3d 914 (D.C. Cir. 1998) for the principle that EPA is not authorized to make regulatory decisions on “generalizations” when the case specific facts indicate that the generalized approach is inappropriate.

Court v. United States EPA, 963 F.2d 391, 397 (D.C. Cir. 1992) (Court held agency action that ignores expert recommendations without justification as arbitrary and capricious).

8. **Failure to Provide Reasonable Assurance**

A basic part of all TMDL actions involving both point and non-point source reductions is a "reasonable assurance demonstration".[11] In this instance EPA is seeking to impose unattainable point and non-point source TP reductions. For example, MS4 and non-point TP reductions necessary to attain EPA's stated 40 µg/l growing season average TP concentration generally exceed 90% which is physically impossible to attain. Generally, 99% point source load reduction from wastewater facilities is also impossible to attain. Consequently, the TMDL contains no information or analyses showing that either the WLA or the load allocation can ever be achieved in this watershed. Given this lack of information and analyses, it is clear that EPA failed to meet its burden to provide "reasonable assurance" as required of all federally approved TMDL *Am. Farm Bureau*, 984 F. Supp. 2d. at 314.

Moreover, EPA's claim that TP is the cause of invertebrate impairment is directly contradicted by analyses conducted by PADEP (See Att. 5 - Wissahickon Watershed Stakeholder Meeting, March 5, 2015). DEP claims other, non-nutrient factors are also controlling the invertebrate populations in the Creek. Therefore, it is clear that the degree to which TP control is necessary and will be effective in restoring uses is completely unknown at this time. Consequently, until such assurance can be provided that (1) the proposed limitations can be attained and (2) if attained will restore uses, this TMDL must be withdrawn.

TECHNICAL COMMENTS

1. **Insufficiency of 2003 TMDL Not Demonstrated**

EPA published a 2003 TMDL to control algal growth sufficient to meet DO water quality standards, consistent with the state's published narrative criteria implementation procedures. The 2003 TMDL established load restrictions on ammonia-nitrogen, nitrate-nitrite, ortho-phosphorus, and CBOD to ensure attainment with the state's narrative criteria for nutrients (as published and utilized in all Section 303(d) decisions). The 2003 Sediment TMDL controlled excessive sediment contributions from MS4 sources which would also impair invertebrate communities. The 2015 Draft TMDL now claims that (1) the 2003 TMDLs were not sufficient and (2) ongoing benthic community aquatic life impairments exist due to <u>excessive algal biomass</u> (eutrophic conditions). (Draft TMDL at 1). For this reason, EPA claims that the stream segments previously addressed in the 2003 nutrient TMDL are still impaired and a new TMDL is required to specifically target excessive plant growth.

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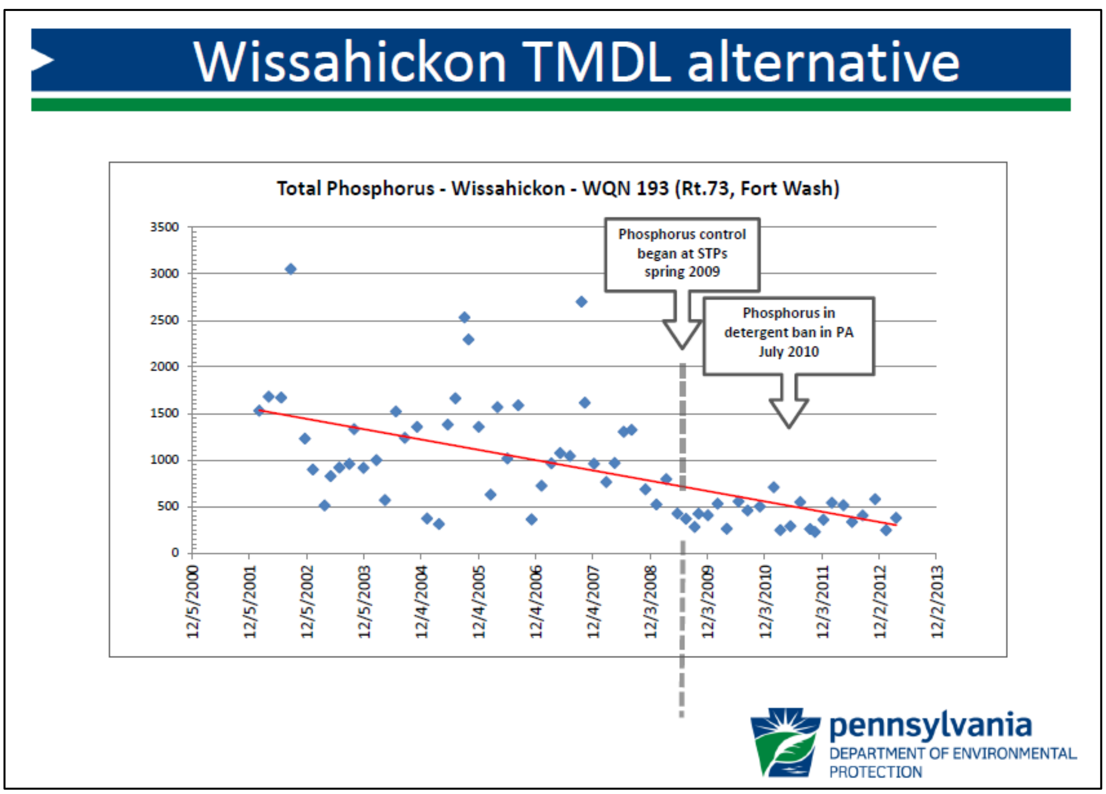
[11] http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/final52002.cfm

This TMDL <u>addresses the nuisance algal growth</u> by focusing on TP, a nutrient that did not have water quality goal in the 2003 Nutrient TMDL. (Draft TMDL at 1).

EPA further asserts that it is justified in taking this action because, when the 2003 TMDL was developed, PADEP indicated that <u>controlling nuisance algae</u> may require additional reductions to instream concentrations of phosphorus (below those contained in the 2003 TMDL), but site-specific data had not yet been collected to determine the levels of TP that would be necessary to control the growth of algae beyond DO considerations (Draft TMDL at 3). EPA has based the assertion that excessive plant growth still exists, post TMDL implementation, based on data collected *prior to 2006*, just two years after the 2003 TMDLs were finalized.

EPA's "database" for concluding that the 2003 TMDLs were not protective is clearly flawed – this is not a "post-TMDL implementation" database. It is inconceivable (and the record contains no evidence showing) that the pollution reduction requirements specified in the 2003 TMDL were implemented in advance of the nuisance algae monitoring data used by EPA to justify this action. (2006 Carrick Hunter Report – see Tetra Tech Stressor Verification Study) The only periphyton data for the Wissahickon Creek watershed presented in the Stressor Verification Study *were collected in 2005*.

In fact, significant reductions in phosphorus by the WWTPs did not begin until 2009 as indicated in a presentation made by the PADEP to the Wissahickon Creek Watershed stakeholders on March 5, 2015.



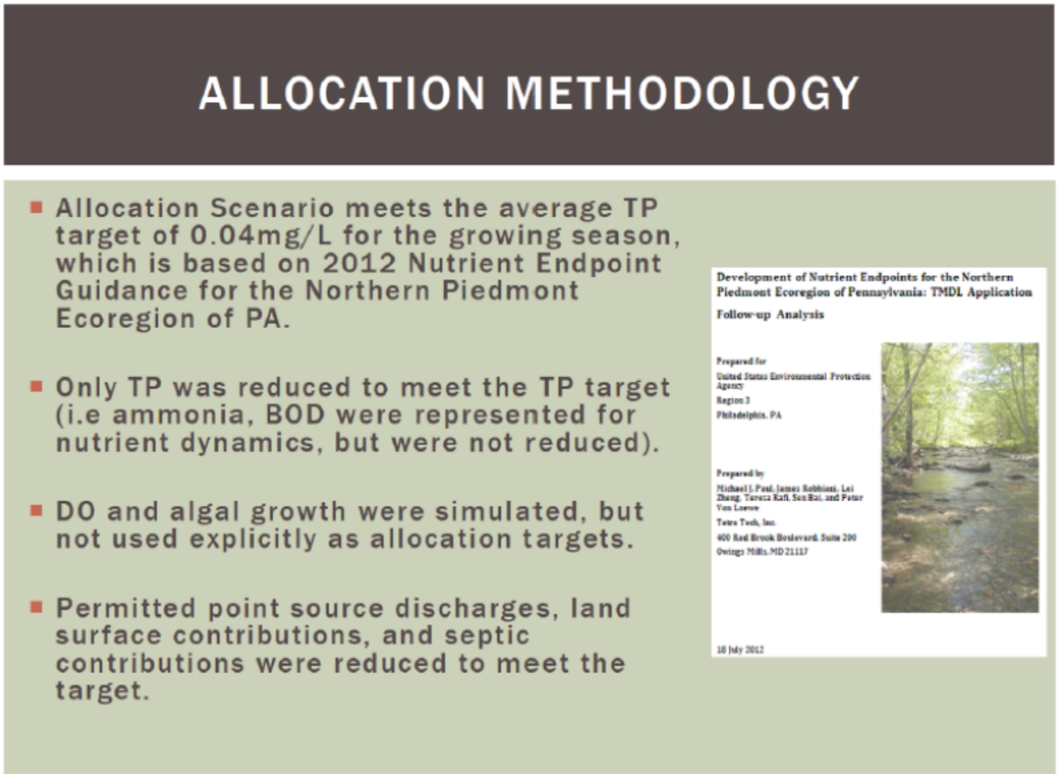
Moreover, there is no information presented in the record that confirms the 2003 Sedimentation TMDL has been fully implemented. As confirmed by these data, none of the plant growth readings were collected after the 2003 TMDL load reductions had been implemented. While the TMDL did present invertebrate data through 2013 (TMDL at 7) there are no plant growth readings associated with those data and no way to know what could be the cause of that ongoing condition (which could certainly still be sedimentation – see, Att. 5). EPA has certainly not produced any reliable or objective evidence that the prior TMDLs have been fully implemented or that the remaining invertebrate population condition is associated with excessive plant growth, occurring post-2003 TMDL implementation. Before any new TMDL is established for the watershed, the 2003 TMDL must be fully implemented. Only then should the stream be evaluated to see whether additional controls are necessary and what is the likely cause. Consequently, the claim that the Draft TMDL is necessary to address deficiencies of the 2003 TMDL is unsubstantiated. Therefore, this Draft TMDL should be withdrawn.

2. **Draft TMDL Does Not Connect TP to Excessive Algal Growth and Excessive Algal Growth to Aquatic Life Use Impairment (as Required to Implement PADEP's Narrative Criteria)**

As discussed above, and reiterated frequently throughout the introduction to the Draft TMDL, the claimed cause of aquatic life use impairment in the Wissahickon Creek Watershed has been attributed to nuisance algal growth, with excessive nutrient loads directly responsible for such growth. Given this linkage, we would expect that the narrative criteria assessment would first identify the numeric level of algal growth necessary to cause aquatic life use impairment and then identify the numeric nutrient concentration necessary to prevent such nuisance algal growth. Such an approach is recommended in EPA's *Nutrient Criteria Technical Guidance Manual - Rivers and Streams* (USEPA, July 2000; hereafter, "Rivers and Streams Document").

> However, fish and macroinvertebrates do not directly respond to nutrients, and therefore may not be as sensitive to changes in nutrient concentrations as algal assemblages. It is recommended that relations between biotic integrity of algal assemblages and nutrients be defined and then related to biotic integrity of macroinvertebrate and fish assemblages in a stepwise, mechanistic fashion. (Rivers and Streams Document at 85).

EPA's 2010 Science Advisory Board review of the then proposed stressor –response guidance made the same observation – TP is not toxic to insect life and impacts are mediated through excessive plant growth. Nonetheless, there is no such excessive plant growth/poor invertebrate life assessment anywhere in the Draft TMDL or support documents. In fact, the Draft TMDL does not even illustrate the predicted level of algal growth prior to or following implementation of the TMDL. However, the presentation slides from the June 10, 2015 public meeting at the Temple University Ambler Campus indicate that algal growth was simulated but not used explicitly as allocation targets. (See, Att. 2, below, third bullet).



Given the asserted cause of aquatic life impairment, excessive algal biomass adversely affecting aquatic macroinvertebrates, the necessity or sufficiency of this TMDL cannot be assessed since no attempt was made to show whether or how the designated instream TP numeric objective - 40 µg/l would actually reduce the alleged excessive plant growth. This is a fundamental deficiency of EPA's assessment.

As noted several times, the endpoint was based on aquatic life protection, but EPA also was interested in keeping the algal biomass below the 150 to 200 mg/m^2 range.[12] In a decision memorandum dated October 10, 2007, and other EPA nutrient TMDL actions for southeastern PA streams, EPA interpreted excessive algal biomass as chlorophyll-a ranging as high as 200 mg/m^2 on average or 300 mg/m^2 maximum. (Response Document for Nutrient and Sediment TMDLs in Pennsylvania for Southampton Creek, Indian Creek, Chester Creek, Paxton Creek and Sawmill Run, June 30, 2008 at 80). Since the level of periphyton chlorophyll-a considered excessive has not been defined in the present TMDL, we have no way to assess whether conditions in the watershed are excessive and in need of further control or whether the excessive algae threshold is consistent with prior EPA actions. EPA's TMDL is based on sheer guesswork at this point – an approach that certainly is not permissible. *Leather Industries of Am. v. EPA*, 40 F. 3d. 392, 408 (D.C. Cir 1994).

[12] See, Evaluation of Nutrients as a Stressor of Aquatic Life in Wissahickon Creek at 17.

3. Draft TMDL Endpoint of TP = 0.040 mg/L Incapable of Reducing Nuisance/excessive Algal Growth in the Wissahickon Creek Watershed

In 2003, EPA developed a nutrient and sediment TMDL to address aquatic life use impairment in the Wissahickon Creek Watershed and meet applicable narrative criteria for nutrients. The nutrient TMDL was developed to specifically address compliance with the DO criteria which is the "mode of action" by which invertebrate population protection from nutrients is achieved in Pennsylvania. (*Supra* at 7-9). The 2003 nutrient TMDL was based on water quality modeling that linked nutrients to periphyton growth and periphyton biomass to diurnal DO variation. Following the completion of that TMDL, EPA and Tetra Tech (EPA's contractor who prepared the nutrient water quality model used in the TMDL) authored a peer-reviewed scientific paper[13] discussing the model development and conclusions regarding the ability to control periphyton growth in the Wissahickon Creek Watershed. While the TMDL was sufficient to address compliance with DO water quality standards and protect aquatic life uses (i.e., invertebrates), the paper concluded that it was infeasible to control periphyton through reducing nutrient load from the point sources because periphyton only need a very low concentration of phosphorus to support its growth to very high levels. (Zou et al., 2006 at 564). Similar observations have been made by Dodds (2006)[14], Hall (2009), Suplee (2012), and Chapra et al. (2014).[15] Site specific studies in Southeastern PA for this watershed and Indian Creek also confirmed this was true. (Carrick 2006); Klienfelder (2014)).

Other researchers have reported similar results. Kiffney and Bull (2000)[16] evaluated periphyton accrual during the summer in headwater streams with natural phosphorus levels below 0.002 mg/L. Streams with open canopies exhibited periphyton biomass up to 190 mg chlorophyll-a/m^2. Closed canopy sites experienced significantly lower periphyton biomass. Bourassa and Cattaneo (2002)[17] studied the effect of nutrient manipulation in a lake outlet stream in Montreal, Quebec. They reported that the effect of nutrient enrichment (from 0.007 – 0.021 mg/L TP to 0.017 –

[13] Zou, R., S. Carter, L. Shoemaker, A. Parker, and T. Henry. 2006. Integrated Hydrodynamic and Water Quality Modeling System to Support Nutrient Total Maximum Daily Load Development for Wissahickon Creek, Pennsylvania. Journal of Environmental Engineering. April 2006. 555-566.

[14] Dodds. W. 2006. Eutrophication and trophic state in rivers and Streams. Limnol. Oceanogr. 51(1, part 2): 671-680. "[A]ttached algae might be able to attain impressive biomass in nutrient-poor water because periphyton can use the small amounts of nutrients that continuously flow by." At 677.

[15] Chapra, S., K. Flynn, and J. Rutherford. 2014. Parsimonious Model for Assessing Nutrient Impacts on Periphyton-Dominated Streams. J. Environ. Eng., 140(6), 04014014. This paper presents a method for evaluating nutrient criteria necessary to meet a maximum periphyton biomass. As an example, the phosphorus concentration necessary to limit periphyton growth to 150 mg chl-a/square meter is 3 µg/L. At 11.

[16] Kiffney, P. and J. Bull. 2000. Factors controlling periphyton accrual during summer in headwater streams of Southwestern British Columbia, Canada. Journal of Freshwater Ecology. 15(3).

[17] Bourassa, N. and A. Cattaneo. 2002. Response of a lake outlet community to light and nutrient manipulation: effects on periphyton and invertebrate biomass and composition. Freshwater Biology. 44: 629 – 639.

0.088 mg/L TP) was not detectable, although benthic algal growth was, on average, three times less in shaded channels. This would suggest that benthic algal growth was already saturated at the lower concentrations. Hill and Fanta (2008)[18] evaluated periphyton growth rates in large flow-through laboratory streams. They reported that periphyton growth rates plateaued at soluble reactive phosphorus (SRP) concentrations in excess of 0.022 mg/L, suggesting that nutrient SRP criteria ≥ 0.025 mg/L will have virtually no effect on controlling periphyton growth. These researchers also noted that the effect of light availability was much stronger than the effect of phosphorus concentration. While changes in SRP concentration increased growth two-fold over a concentration range of 0.005 – 0.300 mg/L, the effect of light exhibited a ten-fold increase in periphyton growth. In yet another study (See, Att. 6)[19], installation of biological nutrient removal (BNR) at the City of Waynesboro, VA WWTP resulted in significant TP reduction in the South River (a tributary to the Shenandoah-Potomac River system and a major tributary to the Chesapeake Bay) below the outfall (from 0.5 mg/L to 0.03 mg/L). Although the instream TP concentration was less than the TP endpoint used in this Draft TMDL, benthic algal surveys of the river showed no change in algal growth (consistent with the other results reported in the literature). The data collected for Indian Creek, PA in EPA's possession also showed precisely the same results. Typical background TP ranged approximately 70-200 µg/l and periphyton growth was extremely high – with no relationship to actual instream TP concentration, as demonstrated in the figure below:

[18] Hill, W. and S. Fanta. 2008. Phosphorus and light colimit periphyton growth at subsaturating irradiances. Freshwater Biology 53: 215-225.

[19] Brent, R., R. Morland, D. Berberick, S. Davis, B. Foltz, and K. Drummond. 2014. Mercury falling. How a facility upgrade intended to reduce algae growth resulted in unintended (yet favorable) consequences. Water Environment and Technology. August 2014. 62 – 65.

In fact, the TP Endpoint Report[20] (used as the basis to set the TP endpoint used in this TMDL) arrived at the same conclusion based on an evaluation of periphyton growth in similar streams in southeastern Pennsylvania.

> The samples with the highest algal biomass were collected by the PADEP - Pennsylvania State University periphyton study, which focused on the targeted watersheds. Surprisingly, the highest algal biomass occurred at sites where TP concentrations *were relatively low (14–35 µg/L).* It is possible that algal growth has been saturated even at this low level. (Endpoint Report at 13).

All of these evaluations confirm that the growth of periphyton biomass is not limited when the bio-available phosphorus concentration is 0.040 mg/L. In fact, the literature suggests that the bio-available phosphorus would need to be less than 0.010 mg/L to limit periphyton growth in streams similar to those in the Wissahickon Creek Watershed. This level of TP is expected to be exceeded naturally throughout this system. In short, there is no information presented in this TMDL showing that regulating TP at the recommended level will produce any reduction in plant growth whatsoever. The available studies certainly confirm it will not. Consequently, the TP endpoint used in the Draft TMDL cannot reduce excessive algal growth and the stated goal of the Draft TMDL, to address the nuisance algal growth by focusing on TP (Draft TMDL at 1) cannot be achieved with this endpoint. Since the natural TP level is expected to exceed the level that allows for unrestricted plant growth, it is apparent that TP is not the factor causing "excessive" plant growth in this system. This is a fundamentally flawed action that must be withdrawn as it cannot achieve its stated purpose.

4. TMDL Addressed the Wrong Form of Phosphorus to Control Algal Growth

As discussed in the comment above, periphyton growth is expected to be saturated at very low levels of bio-available phosphorus. Bio-available phosphorus is typically considered to be dissolved inorganic phosphorus (ortho-phosphate). Even the conceptual model used by EPA in its Stressor Verification Study indicates that aquatic plant growth is in response to the dissolved inorganic form of phosphorus (See, Figure 1 at page 7 of the Stressor Verification Study below) – not the total phosphorus parameter.

[20] Paul, M. and L. Zheng. November 20, 2007. Development of Nutrient Endpoints for the Northern Piedmont Ecoregion of Pennsylvania: TMDL Application.

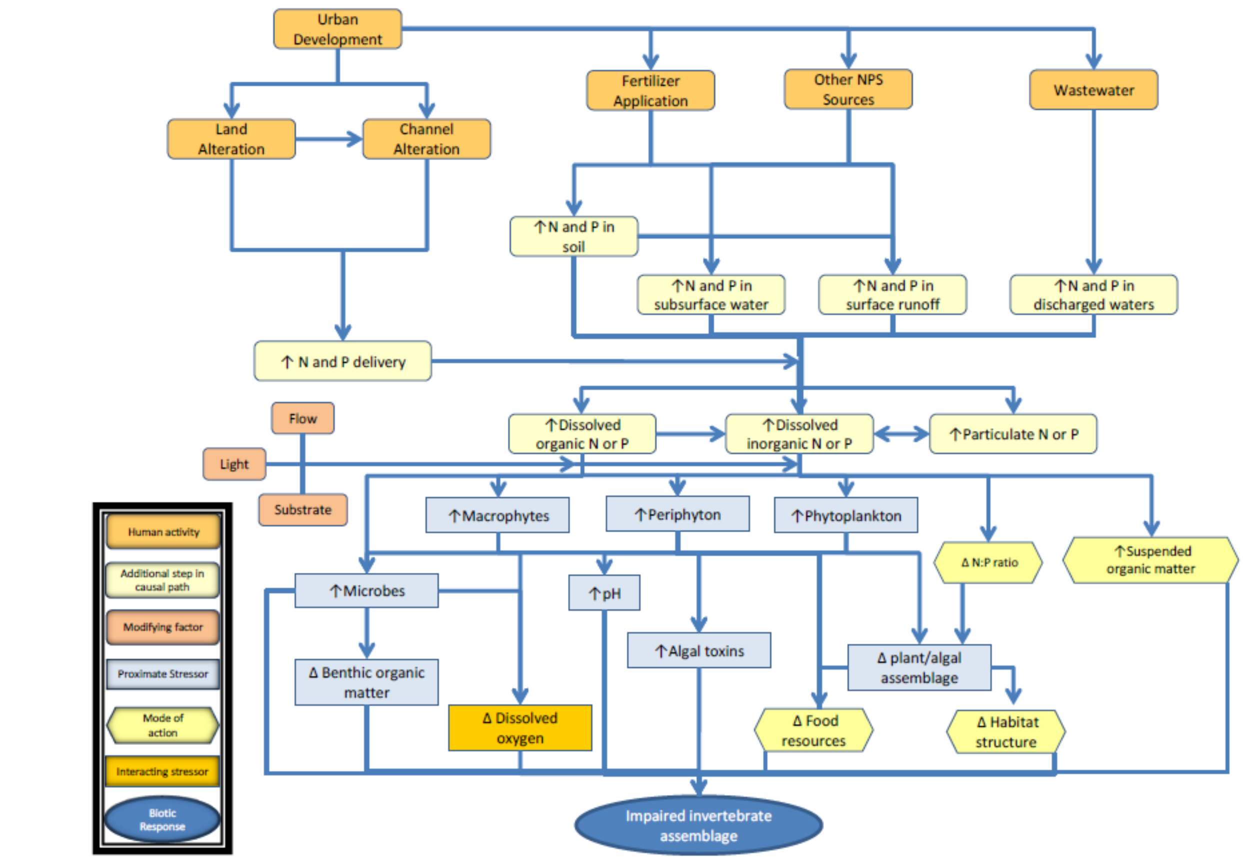


Figure 1 - Conceptual model of nutrient effects on invertebrates in Wissahickon Creek, PA

While the conceptual model shows a link between particulate phosphorus and DIP, there is no analysis in the TMDL regarding how quickly particulate forms of phosphorus convert to DIP and whether or not the detention time of the system is sufficient to allow this to occur to any meaningful level. Nonetheless, the TMDL only establishes limits for TP as if it was demonstrated that both dissolved and particulate forms of phosphorus are equally capable of stimulating plant growth. This oversight is particularly important for the stormwater contribution of phosphorus under higher rainfall events, which may be expected to reflect predominantly particulate P in runoff.

To the extent that certain discharges (e.g., MS4s) are primarily composed of particulate phosphorus, there is no way to assess how much of these discharges become bio-available and contribute to benthic algal growth as opposed to passing through the system without exerting any effect. If this information is not made available for public review and comment, the TMDL reduction requirements for MS4s should be withdrawn from the Draft TMDL.

5. No Reasonable Assurance that TMDL Will Be Achieved

The Draft TMDL establishes annual aggregate TP wasteload allocations for MS4s that require 94.1% reduction from baseline conditions (See, Draft TMDL Table 5-3 at 66) and non-point source load reductions of 88% from baseline (See, Draft TMDL at 73-86). The Draft TMDL further notes that reasonable assurance for the achievement of the MS4 WLA reductions comes from a variety of state and local watershed implementation plans already in place (See, Draft TMDL at 88). These implementation plans include stormwater management with green infrastructure, stormwater control measures, stormwater runoff reduction, public education and outreach, and volunteer maintenance activities for MS4s and incentive-based programs for non-point sources. In other TMDL actions EPA has indicated that possibly up to a 30-40 percent reduction in TP is achievable from stormwater best management practices (BMPs). This TMDL provides no assessment of TP reductions achieved through implementation of BMPs.

It is commonly understood that it is impossible for any of the MS4 permittees to achieve the TMDL target load reductions. It would essentially require the depopulation of the area and a return to pre-European conditions. Who could actually pay for such a foolish option is not known, since no one would be living in the area anymore. Nonetheless, as part of its TMDL analysis, EPA must identify specific actions and justify the load reductions associated with those actions to provide reasonable assurance that this TMDL could ever be achieved, which it has not done. In addition, if such load reductions can be achieved, EPA must show that aquatic life use attainment is due to TP reduction and not the associated sediment reduction is the controlling pollutant. As none of these demonstrations have been made in the TMDL record, the proposal must be withdrawn.

6. No Demonstrated Basis for Regulating Discharges Associated with Storm Flows

EPA claims that it modified the modeling approach used in the 2003 Nutrient TMDL to better simulate the nutrient loadings to the stream and the responses by nutrient in-stream processes and biological systems for this TP TMDL. EPA claims to have upgraded the Environmental Fluid Dynamics Code (EFDC) application to incorporate more than 160 stream cross-sections and allow for simulation of individual interactions with nutrients and substrate (e.g., flood scour effects). (See, Draft TMDL at 4). As a consequence, EPA claims that the EFDC model is reasonably well calibrated as illustrated below in Figure 4-15 from the Draft TMDL (at 56).

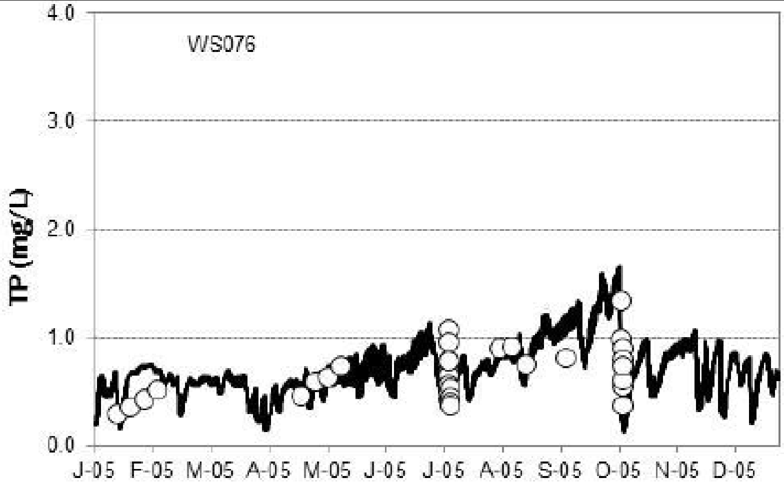


Figure 4-15. EFDC Phosphorus calibration at WS076, near the mouth of Wissahickon Creek.

The Draft TMDL further notes, regarding Figure 4-15, that the EFDC model follows seasonal trends and storm effects_as evidenced by acute drops in phosphorus in July and October 2005. These storm flows and others are illustrated in Figure F-8 from Appendix C of the Draft TMDL (illustrated below). Figure F-8 illustrates numerous storm events where ambient flows increase by an order of magnitude or more in comparison with the prior base flow.

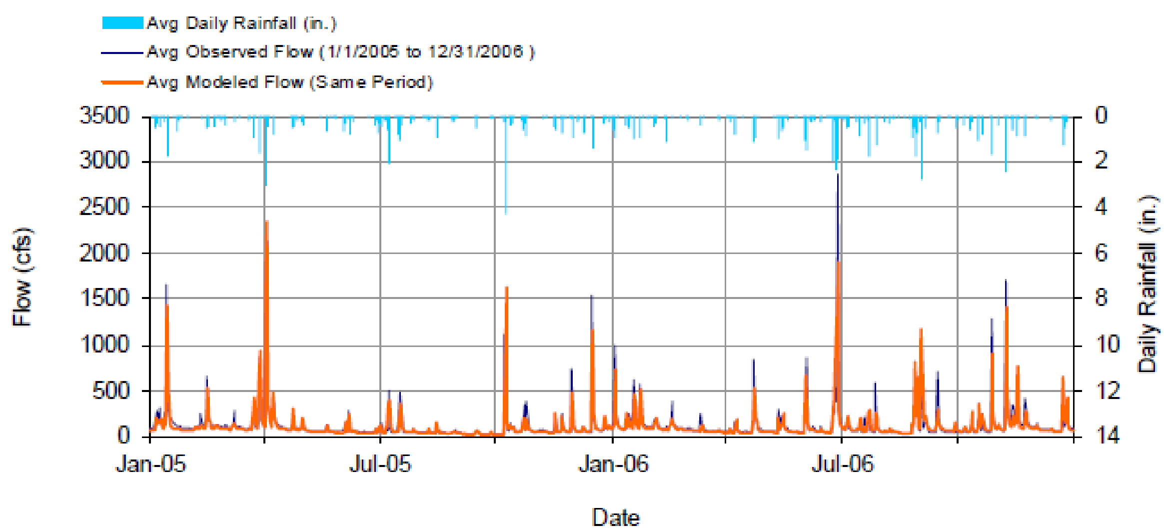


Figure F-8. Mean daily flow: Model Outlet 1 vs. USGS 01474000 Wissahickon Creek at Mouth, Philadelphia, PA

When EPA evaluated the load reduction requirements necessary to restore aquatic life uses, loading contributions were reduced from baseline conditions at all applicable sources until the TMDL water quality endpoints for TP were attained at the outlet of each subwatershed. (Draft TMDL at 61). This approach does not properly account for the effect of the loads entering the watershed during storm events when travel time through the watershed is greatly reduced such that any phosphorus loads do not have time to stimulate excessive algal growth. Moreover, as confirmed by numerous studies, the storm-related flows are sufficiently high in the watershed to scour periphyton, further reducing algal growth in the watershed. Thus, it is physically impossible for the TP associated with such flows to be creating higher algal growth in the system.

Thus, the load associated with the storm flows does not require reduction because it does not, in any material way, contribute to excessive algal growth in Wissahickon Creek. Moreover, EPA Region 3 has already acknowledged that periphyton scouring is an appropriate mechanism for meeting benthic algae targets to restore aquatic life uses. (See, Att. 7 - Decision Rationale – Jackson River TMDL, July 21, 2010). During scour events, excessive algae does not accrue and any loads associated with scour flows do not contribute to algal growth. Consequently, all of these non-point and MS4 related loads and associated flow conditions should have been excluded from the reductions identified in the Draft TMDL, assuming some level of TP reduction is even justified.

7. No Basis for Regulating Non-growing Season Discharges

EPA claims "The TMDLs are presented as annual loads, despite having a seasonal endpoint. This is because total phosphorus that enters the Wissahickon Creek and its tributaries during the non-growing season gets deposited into the sediment and can get reintroduced during the growing season." (Draft TMDL at 72). This statement is preposterous in that it is contrary to the observed data for the watershed, physically impossible (a large percentage of TP is dissolved and cannot settle), contrary to scientific understanding on in-stream processes, and unsupported by any data for the watershed.

On its face, this statement suggests that the discharge of TP exiting Wissahickon Creek at the mouth is zero during the non-growing season because all of the load entering the watershed at this time goes into the sediment. This claim is pure fiction and bears no rational relationship to the actual conditions in this system and is therefore arbitrary and capricious. *See Columbia Falls Aluminum Co. v. EPA*, 139 F.3d 914 (D.C. Cir. 1998). The data presented in Figure 4-15 from the Draft TMDL show TP concentrations at the mouth of Wissahickon Creek during the non-growing season are well above zero and projected to account for almost all of the TP load entering the system. This concentration is conveyed out of the watershed with the stream flow and cannot contribute to algal growth in subsequent growing seasons (once the flow exits the mouth, the TP present in that flow does not return to stimulate plant growth at a later date).

With regard to in-stream processes, the only way for phosphorus to be deposited into the sediment during the non-growing season is for particulate forms of phosphorus to settle out of the water column. Dissolved forms of phosphorus, such as the primary form (~90%) of phosphorus discharged by WWTPs, would need to be transformed into particulate forms before settling could occur. This can only occur if it is converted into plant matter, which does not happen to any significant extent during the non-growing season. However, EPA has presented no data showing that 100% of all dissolved phosphorus is converted to particulate forms during the non-growing season or that there is a mechanism by which this occurs. In fact, one would expect that virtually all of the dissolved forms of phosphorus entering the watershed during the non-growing season will simply pass through the system and have no effect on the next growing season.

With regard to particulate phosphorus entering the system during the non-growing season, EPA presents no information indicating how much of this load settles out and how much passes through the system. We would expect that most of this load will also pass through the watershed and exert no influence on algal growth when the growing season returns because the flow chart illustrated in Figure F-8 shows scouring flows occurring throughout the non-growing season. These flows scour the sediment and transport it out of the system, as confirmed by EPA's 2003 Sediment TMDL. This is how estuarine areas "fill in" over time – a natural process (note the existence of the Mississippi Delta). Consequently, there is no need to regulate any phosphorus loads entering the watershed during the non-growing season and the Draft TMDL should be revised to eliminate any requirements for TP reduction during the non-growing season.

8. Claim that TP Control Will Restore Aquatic Life Use Not Supported by Any Scientific Literature or Rational Data Analysis

The Draft TMDL merely presents a mass balance calculation for loads to meet a growing season average TP concentration of 40 µg/L throughout the watershed and presumes attaining this concentration will restore impaired invertebrate populations. Supposedly, this endpoint is supported in three documents: a 2007 nutrient endpoint identification study (Draft TMDL at v), a 2012 update to the 2007 study (Draft TMDL at 8) [21], and a 2012 stressor verification analysis (Draft TMDL at 8). These are grossly incompetent and deficient documents that are highly biased (i.e., exclude all studies confirming the approach is not scientifically defensible) and fail to reflect even a modicum of objective scientific assessments. A detailed review of these documents confirms that they provide no rational basis to conclude a 40 µg/l TP level is either necessary or appropriate to ensure use attainment, as follows.

[21] The Draft TMDL cites this Follow-Up Analysis as a 2011 report. However, the date on the cover page of the report indicates it was prepared on July 18, 2012.

a. ***Development of Nutrient Endpoints for the Northern Piedmont Ecoregion of Pennsylvania: TMDL Application* (November 20, 2007)**

i. **SAB Explained Conditional Probability and Change Point Analyses Do Not Identify Cause or Impairment Threshold and Do Not Necessarily Indicate Biological Significance.**

In this report (hereafter "2007 Endpoint Report"), Tetra Tech used statistical analyses, namely conditional probability and change point analysis, to identify a TP endpoint (2007 Endpoint Report at 12; Fig. 6):

> We used condition probability analysis (Paul and MacDonald, 2005) to examine changes in the biological community along stressor gradients. […]
>
> We also used nonparametric deviance reduction (change point analysis) to identify thresholds in biological responses to nutrients (Qian et al. 2003). (at 10).

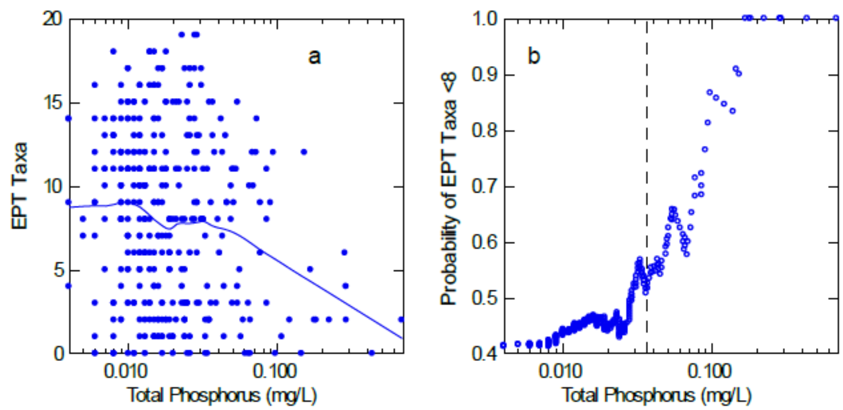


Figure 6 - Response of EPT taxa metric to the phosphorus gradient in the Northern Piedmont Ecoregion. Figure on the right shows the conditional probability of having fewer than 8 EPT taxa as TP concentrations increase.

The EPA 2010 SAB (SAB Report, 2010) commented that conditional probability does not identify cause or impairment threshold (2010 SAB Report at 15 et seq.). The SAB further issued caution regarding the use of change point analyses:

> However, although these methods may be able to identify and characterize breakpoints, such breakpoints may not necessarily have any biological significance, nor will they necessarily be related to designated uses that are to be protected by numeric nutrient criteria. Use of these methods must be associated with designated uses. (at 24).

All of the conditional probability analyses used changepoint analysis to calculate TP endpoints without showing that the identified breakpoints were biologically significant. Without such a demonstration, the calculated endpoints are meaningless and should be discarded, as EPA was informed by the Science Advisory Board five years ago.

ii. No Confounding Factors Analysis or Consideration

In addition, the statistical evaluations in the report include no analyses of confounding factors (*e.g.*, canopy and light availability, scour). Regarding confounding factors in nutrient criteria development, the SAB asserted:

> The statistical methods [including non-parametric changepoint analysis] in the Guidance require careful consideration of confounding variables before being used as predictive tools […] Without such information, nutrient criteria developed using bivariate methods may be highly inaccurate […] In order to be scientifically defensible, empirical methods must take into consideration the influence of other variables. (2010 SAB Report at 24).

The analysis must account for confounding factors for the analysis to be meaningful. This is also reiterated by EPA's revised 2010 Stressor-Response Nutrient Criteria Development document. The conditional probability evaluations presented in the 2007 Endpoint Report did not address confounding factors. No other analysis contained in this report addresses a single, well known, non-nutrient factor that can control invertebrate population dynamics (e.g., sedimentation, flows, habitat, canopy, temperature, etc.) Consequently, these lines of evidence must be discarded as not scientifically defensible and simply speculative.

iii. Selected Endpoint Does Not Affect Excessive/nuisance Algal Growth

Incredibly, the report provides an analysis that refutes the basis for the proposed TMDL but fails to acknowledge that reality in seeking to support the chosen endpoint:

> Not surprisingly, a strong algal biomass-nutrient relationship was not present in our examination of the datasets […] The wedge shaped relationship also indicated that elevated levels of algal biomass can exist at relatively low nutrient concentrations (<100 µg/L) […] Surprisingly, the highest algal biomass occurred at sites where TP concentrations were relatively low (14-35 µg/L). (2007 Endpoint Report at 15-16).

In accordance with the conceptual model, with an admitted and demonstrated lack of relationship between nutrients and algal growth and no analysis of microbial growth or confounding factors, there can be no expectation that reducing TP will result in reduced periphyton or aquatic life use attainment. There is also no demonstration that the decreased level of invertebrates found periodically in the creek is, in any way, caused by excessive plant growth. Given that the "primary response variable of interest for stream trophic state characterization is algal biomass," these facts render the Draft TMDL and its TP endpoints unnecessary, ineffective, and arbitrary (2007 Endpoint Report at 9). Moreover, the selected "impairment thresholds" (8 EPT Taxa, 31.5% Intolerant Urban, 52.5% Clingers, 4.5 TSI) are never explained or justified. It seems as if EPA simply chose the median measurement used as scoring criteria by the State of Maryland. This is clearly insufficient and some proper biological/ecological explanation for choosing this threshold must be presented in the record, but is not.

b. ***Development of Nutrient Endpoints for the Northern Piedmont Ecoregion of Pennsylvania: TMDL Application Follow-up Analysis* (July 18, 2012)**

i. Analysis Fails to Adhere to the Conceptual Models; Urban Gradient Not an Appropriate Factor for Classifying Streams

Realizing that the 2007 report was deficient as a result of the SAB review and EPA's subsequent issuance of the Stressor-Response Guidance Document, a supplemental report was prepared by Tetra Tech in 2012. The 2012 Follow-up Report presents the conceptual model from the 2007 Endpoint Report and an updated and more detailed conceptual model (2012 Follow-up Analysis at 3-4).

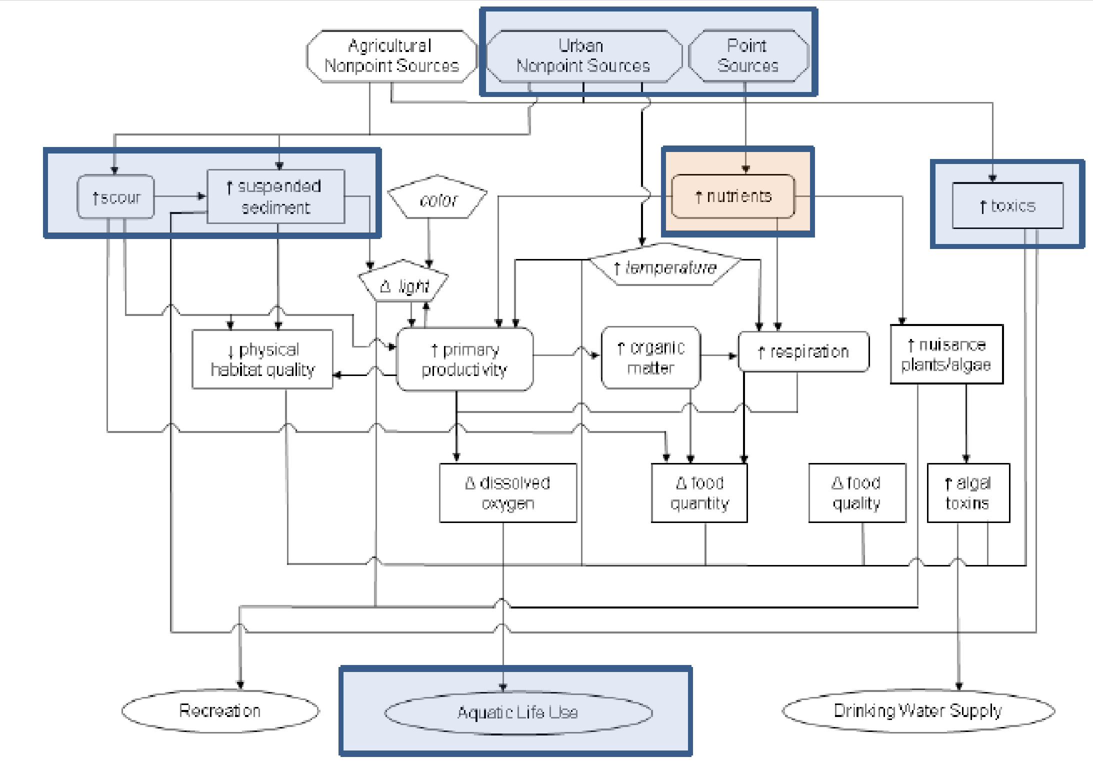


Figure 3 - More detailed conceptual model of the causal relationship between nutrients and responses in streams (after USEPA 2010)

Although the TMDL is based upon a causal link between TP – excessive algal growth and excessive algal growth – aquatic life uses, the conceptual model presented in the 2012 Follow-up Report does not show any linkage between nuisance algae and aquatic life uses. Even if we assume this is an oversight, there is no analysis linking algal biomass to aquatic life use or any of the macroinvertebrate metrics rendering the connection pure speculation and thus arbitrary and capricious. *See*, *Leather Industries*, 40 F. 3d. 392 (D.C. Cir 1994).

ii. Attempt to Exclude Confounding Factors Fatally Flawed

In an effort to exclude confounding factors from the stressor-response evaluations in the 2007 Endpoint Report and confirm TP was the likely cause of "impairment", this new analysis lumps the actual confounding factors identified in the conceptual model (conductivity, development, impervious surface, flashiness, and substrate - all non-nutrient habitat factors) into an aggregate urban gradient (excluding substrate), but the actual gradient values are never provided. One does not know precisely what is being evaluated in this assessment. Rather, the values are grouped into thirds, with Group 1 representing the least urban and Group 3 representing the most urban. Figure 6 from the 2012 Follow-up Analysis (at 12) is illustrated below. This figure shows that the TP concentrations for the various groups are nearly identical. Moreover, it only presents TP concentrations that are considered to lie within the non-outlier range. For Group 1, the non-outlier range extends to 0.042 mg/L TP (-1.38 on the log scale). For Group 2, the non-outlier range extends to 0.050 mg/L (-1.30 on the log scale). Two of the groups have TP levels ENTIRELY BELOW EPA's chosen endpoint – thus, one would not expect nutrients to even be a factor – if EPA's TP theory is correct. Therefore, it is not apparent how these datasets could possibly be used to justify that a 0.040 mg/l endpoint is necessary – there are no exposures above the impairment threshold which is required to be able to demonstrate that a lower exposure is necessary to protect aquatic life uses. *See, Leather Industries*, 40 F. 3d. 392 (D.C. Cir 1994).

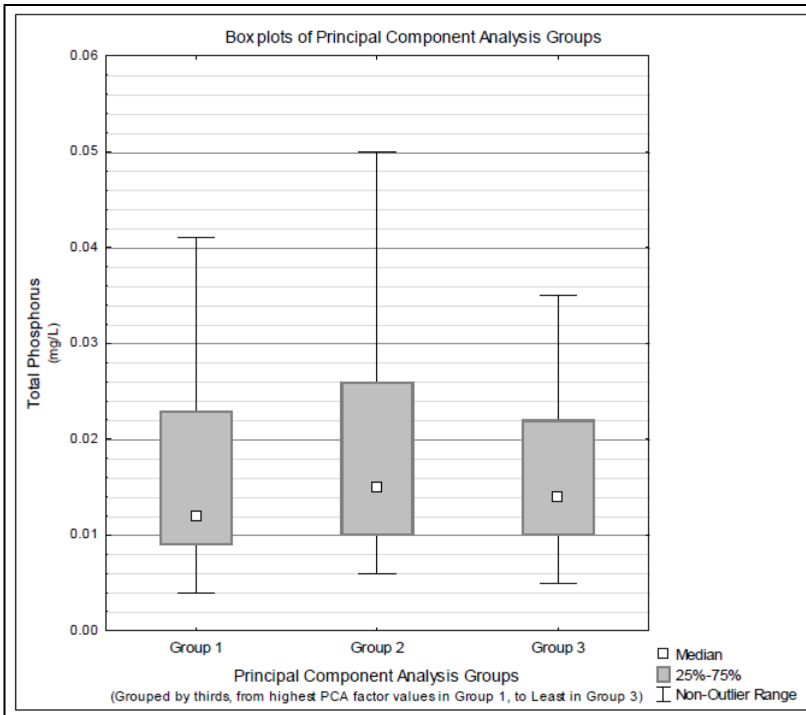


Figure 6 – Box and whisker plot of TP concentrations (mg/L) across the three principal component groups.

A regression evaluation is next presented for EPT Taxa (Figure 8), using data corresponding with Group 1 and Group 2 with a maximum non-outlier concentration of 0.05 mg/L TP. First, the regression shows a preposterously poor relationship between TP and EPT with an $R^2 \approx 0.08$. From a statistical perspective, this basically means that there is no relationship between the two parameters being plotted. However, there are other problems also. The regression includes much higher concentration data (i.e., log scale greater than -1.30) ranging up to 0.63 mg/L.

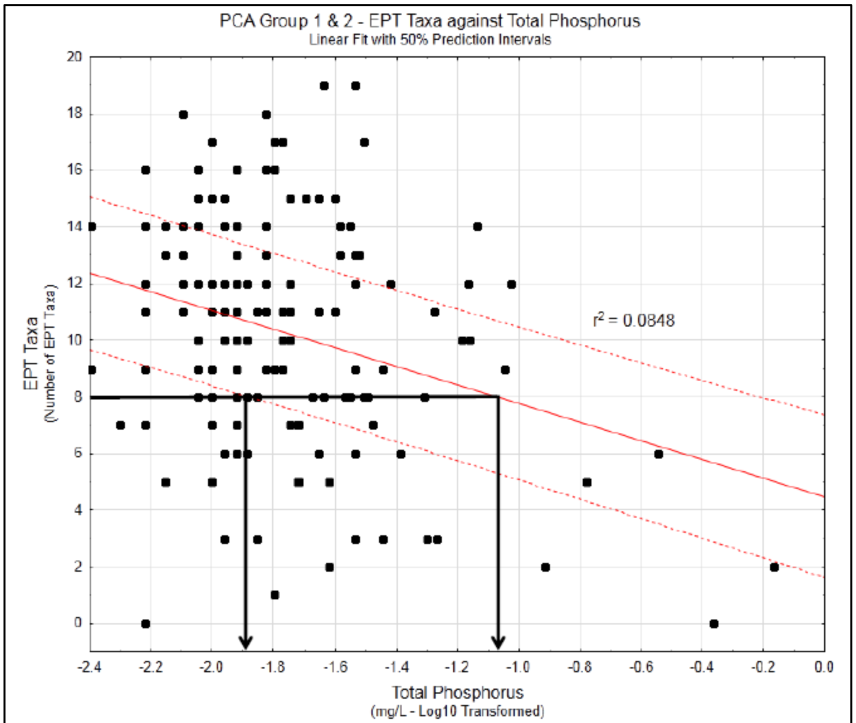


Figure 8 – Scatterplot of standardized TP concentration versus EPT taxa for Group 1,Group 2, and Groups 1 and 2 combined. Lines indicate TP lower quartile and average TP concentrations associated with the EPT richness endpoint (8). Hatched lines are the 50% prediction interval.

These data are outliers and should not have been included in the regression for the same reason that they were excluded from Figure 6. Without these outlier data, it is likely that the assessment would show an even poorer relationship or no relationship between TP and EPT Taxa. No rational, unbiased scientist or statistician would ever conclude that this data set could produce a meaningful relationship between the two parameters or that the data sets demonstrate that a 0.040 mg/l target is "necessary" to ensure an EPT taxa level of 8. The same observations are made for Figure 11 (Urban Intolerant versus TP) and Figure 12 (Clinger % versus TP).

Table 7 from the 2012 Follow-up Analysis shows that most of the evaluations were based on datasets with acknowledged confounding influences. The purpose of data classification is to "eliminate" confounding factors so that the effect of nutrient enrichment can be assessed without interference from other factors. [22] However, EPA's analysis incorporates the Group 2 data,

[22] For example, the appropriate use of bivariate regression methods requires additional efforts through classification or other means to minimize the influence of other potential causal variables so that an acceptable level of confidence in the predictive power of the relationship can be achieved. Without such information, nutrient criteria developed using bivariate methods may be highly inaccurate. (2010 SAB Report at 24).

which adds confounding factors, contrary to the recommendations of the SAB. This entire analysis is worthless for assessing the relationship between TP and the biological metric because confounding factors were purposefully included in four of the five evaluations and the consultants performing the assessment should have known that. Obviously, it was completed to create the illusion of a confounding factors analysis when none was actually done.

Table 7 – Summary of interpolated TP concentrations (µg/L) associated with target response metric thresholds for different groups (bins) of sites based on urban intensity.

		Interpolated TP (ug/L)	
Metric	Groups	lower quartile	average
EPT Taxa	Group 2	10	60
	Groups 1 and 2	10	85
Percent Intolerant Urban	Group 1	16	78
	Group 2	8	82
Percent Clingers	Group 2	8	52

The only evaluation that did not contaminate the evaluation with Group 2 data, the Group 1 evaluation of percent urban intolerant, deserves comment. This evaluation is illustrated in Figure 11 from the Follow-up Report. It shows that the highest TP concentrations (considered outlier points in Figure 6, actually exceed the urban intolerant target (31.5%) used in the evaluation. (See, log-10 TP values > -1.2 (>0.063 mg/L)). At a minimum, these observations provide evidence that the proposed TP endpoint has nothing to do with macroinvertebrate use attainment. Any competent analyst would not have missed this point. As we presume the consultant is "competent' the failure to make this observation must have been purposeful, as it would have undercut the claim that extreme TP reductions are necessary.

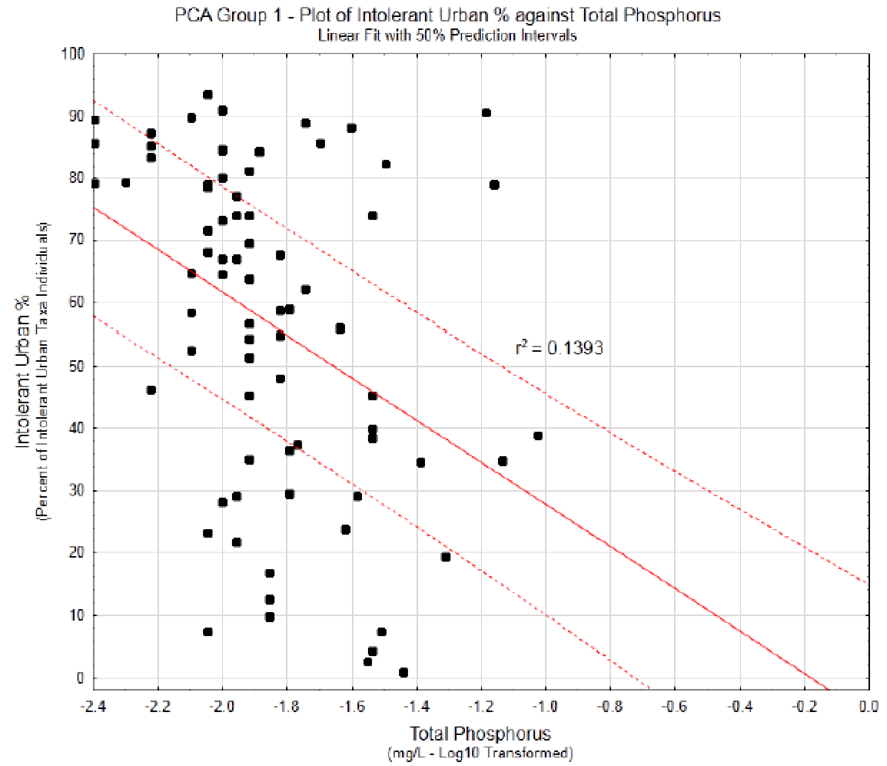


Figure 11 – Scatterplot of standardized TP concentration versus percent intolerant urban metric for Groups 1. Hatched lines are the 50% prediction interval.

iii. Analyses Confirmed TP Effect Is Non-existent

The regression evaluations presented in Figure 8 (EPT Taxa versus TP), Figure 11 (Urban Intolerant versus TP), and Figure 12 (Clinger % versus TP) result in R^2 values of 0.0848, 0.1393 and 0.1489, respectively (2012 Follow-up Analysis at 14, 17-18). These low coefficients of determination confirm that there is no reliable predictive ability for the regression lines shown in the figures, as commented on by the SAB when it reviewed EPA's draft guidance on stressor response methods.

> Also, the fact that the relationship in Figure 13 is both statistically significant (i.e., some trend is evident) and has a low $R^2 = 0.19$ (much scatter also exists) presents an opportunity to discuss strength-of-relationship concerns and how such results should be interpreted in the context of criteria development. (2010 SAB Report at 25).

The R^2 values in Figures 8, 11, and 12 are even lower than the R^2 that the SAB considered questionable, but there is no discussion regarding the strength of the relationships or how these relationships could possibly support a conclusion that the endpoints are necessary to ensure use attainment, when plainly they confirm the TP "effect" is negligible (i.e., less than 10% of EPT variation is "explained" by the TP concentration).

Such low coefficients of determination indicate no reliable predictive ability – that is a scientific and mathematical fact. The justification for including and excluding specific urban gradient groups is not explicitly clear. Furthermore, without a more detailed analysis of confounding and co-varying factors, it cannot be determined whether the effect on the response variable is due to another variable which is correlated with TP (such as increased sediment loading or the habitat occurring at the particular location). Again, as we presume the consultant is "competent' the failure to make this observation must have been purposeful, as it would have undercut the claim that extreme TP reductions are necessary

iv. Wedge Analysis Is Not an Accepted Statistical Methods and, in Any Event, It Is Plainly Improper to Compare Two Statistically Different Datasets

The consultant seeks to reach ecologically relevant conclusions based on a "wedge" analysis (at 20). First, it should be understood that there is no such thing as a "wedge" concept in the established statistical or biological data assessment or "dose-response" (stressor-response) exposure assessment methodologies. This entire line of analysis is pure fabrication and is meaningless; it is included to present the "impression" that some type of competent scientific analysis showing TP is "causing" the change in invertebrate populations has been conducted. But it gets worse. The "wedge" analysis (at 20; Fig. 13) of EPT Taxa Richness vs. TP seeks to make its points by combining two distinct data sets: Maryland Biological Stream Survey (MBSS) and USGS Chester County survey. The two datasets are plotted together with the intention of illustrating how streams in the same geographic region respond similarly.

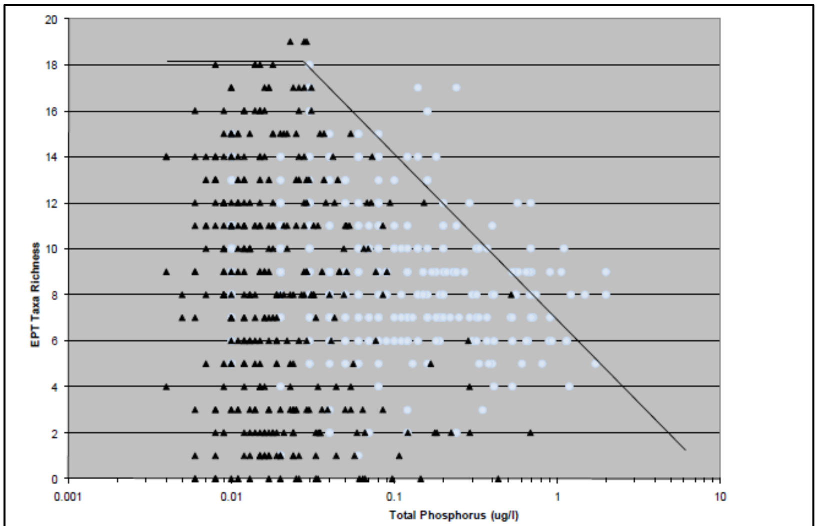
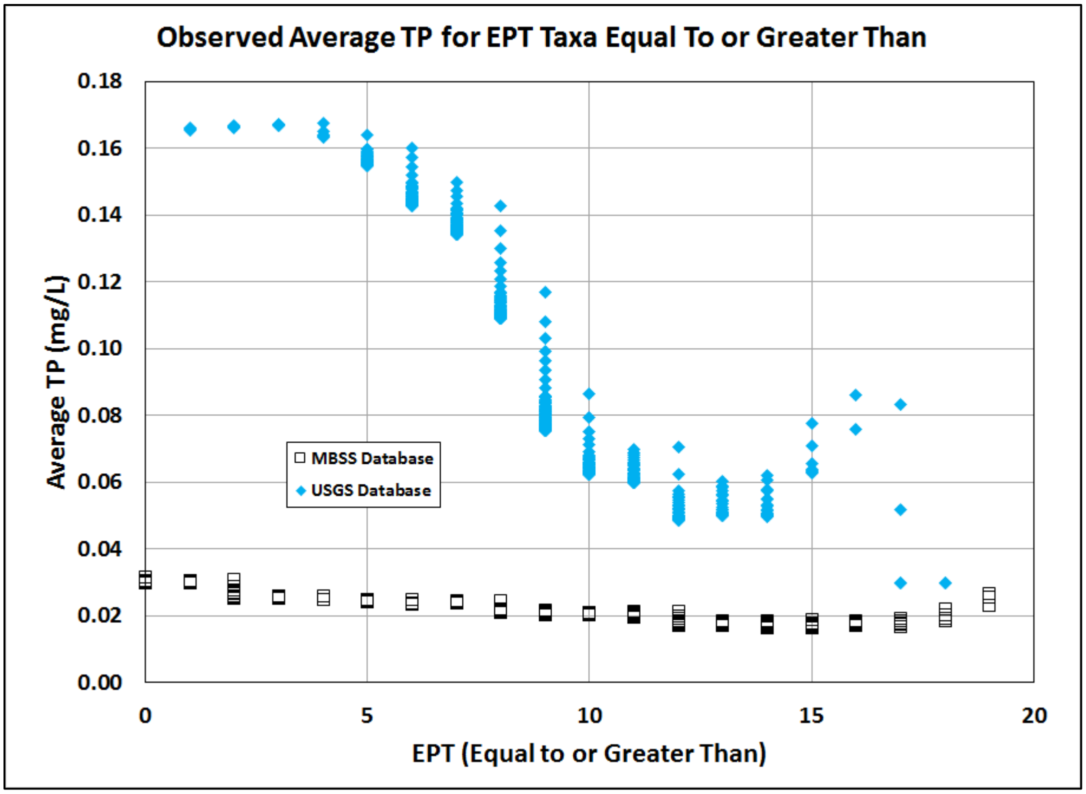


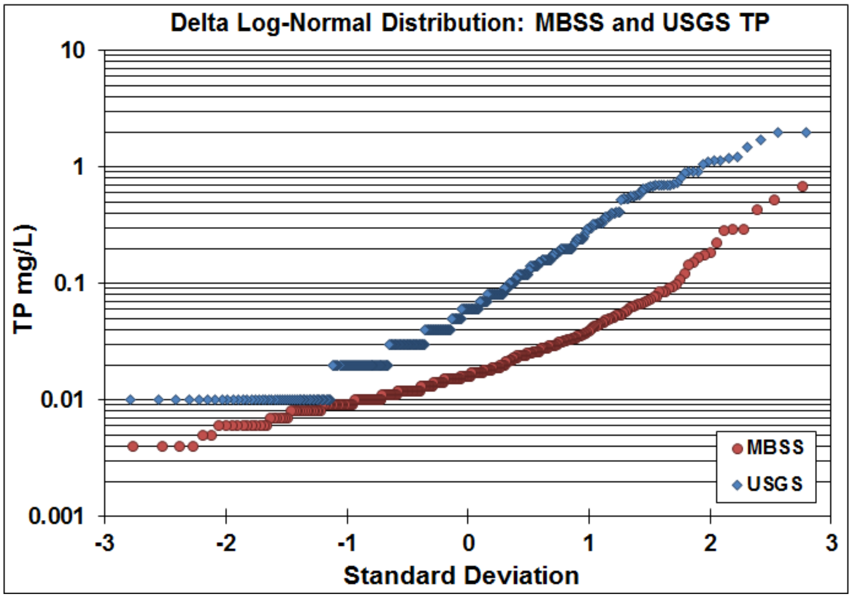
Figure 13 – Plot of TP versus EPT taxa richness for the MBSS (black triangle) and USGS Chester County datasets. The black lines indicate the locations of the approximate wedge shaped relationship between invertebrate response and TP concentration. The outer decline in EPT richness begins at a concentration of approximately 30-40 ug/L TP.

However, it is clear that the datasets illustrate differing relationships; the Chester County dataset is generally shifted well to the right of the MBSS data (i.e., EPT Taxa Richness corresponding to dramatically higher TP concentrations) as illustrated in the fugure below that separates the two data sets:

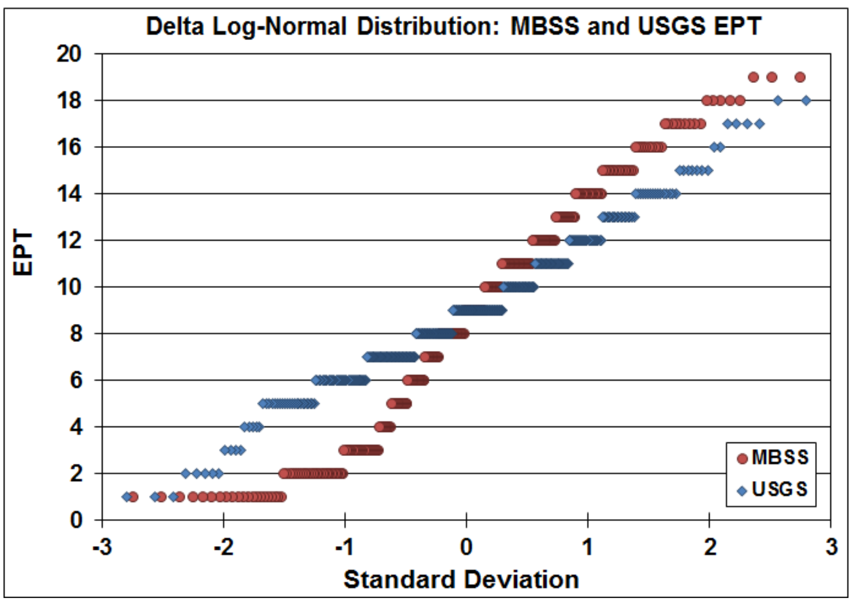


If the consultant's ecological theory was correct (higher TP impaired EPT), then the higher exposure datasets would have much poorer EPT levels. When the data are plotted separately (above) to illustrate average TP concentration corresponding with increasing numbers of EPT Taxa present, it is clear that the EPT Taxa present in Chester County, PA are present where TP concentrations are significantly elevated. That is, TP is having no apparent effect at concentrations well above the TP endpoint of 0.040 mg/L.

A log-normal statistical comparison (below) of the MBSS vs. USGS TP data indicates that the datasets are markedly different, especially above a standard deviation of -1.0. At the median, the MBSS and USGS datasets exhibit a threefold difference of 20 ug/L and 60 ug/L, respectively. At the upper end of the data (SD = 2.0), this divergence in increasingly pronounced with a sixfold difference (18 ug/L vs. 113 ug/L, MBSS and USGS, respectively).

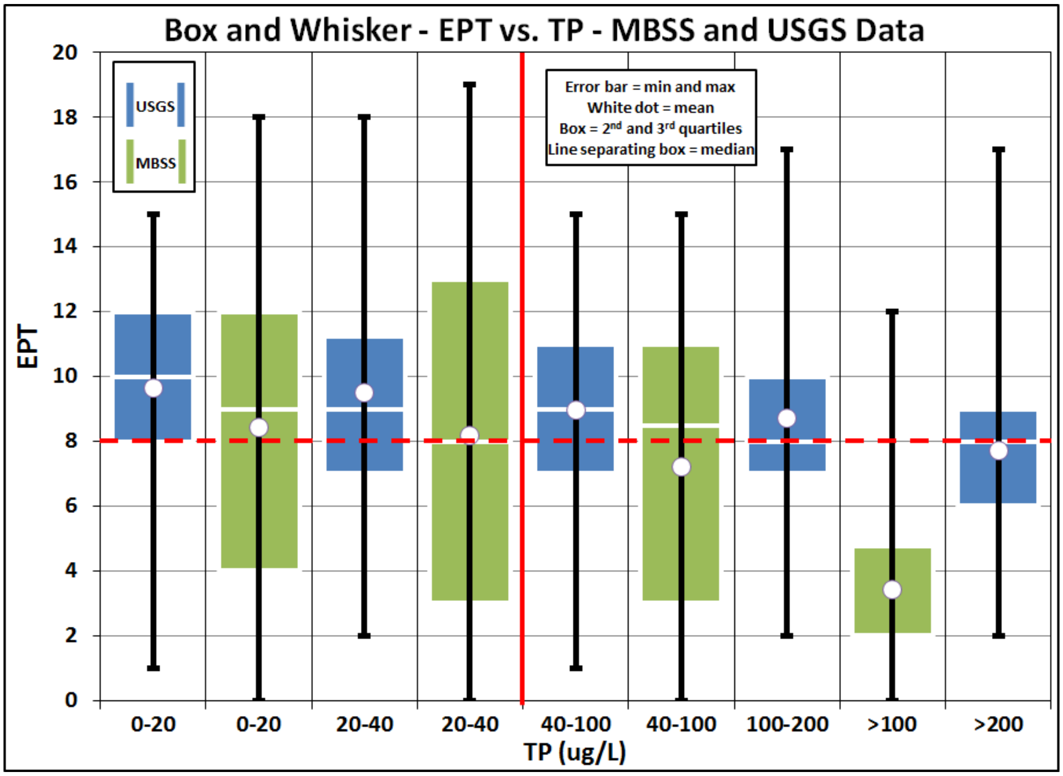


However, a statistical comparison (below) of the MBSS vs. USGS EPT Taxa data indicates that the EPT data distributions are very similar, especially when EPT ≥ 7. The values at and around the mean (SD = 0) are nearly identical. That is, the higher TP exposure has no apparent effect.



When considered in concert with the EPT distribution, it is clear that a similar EPT vs. TP relationship in the datasets cannot exist. While the MBSS TP concentrations are generally lower than those in the USGS dataset, the MBSS EPT below the mean are also lower. Accordingly, it is statistically and scientifically improper to illustrate both datasets on the same plot with the intention of suggesting similar EPT responses to changes in TP as in Figure 13.

An additional box-and-whiskers statistical analysis of the datasets provides further explanation of the inappropriate analyses and gross incompetence of the conclusions based on the wedge analysis in Figure 13.



The vertical red line represent the 40 µg/L TP endpoint and the horizontal dashed red line the 8 EPT adverse condition threshold identified by Tetra Tech. In general, a more detailed assessment of the data confirms that at any TP concentration (very low or very high), it is possible to deviate above or below the 8 EPT endpoint and that it is not possible to conclude that a particular TP endpoint is "necessary" to attain an 8 EPT level. When comparing EPT values above and below the 40 µg/L TP endpoint, there is no obvious difference in "response", excluding the TP > 100 µg/L MBSS data. For example, the EPT values in the TP ranges 20-40 µg/L and 40-100 µg/L are nearly identical in the USGS dataset. Similarly, the EPT values in the TP ranges 0-20 µg/L and 40-100 µg/L are nearly identical in the MBSS dataset. This indicates that the 40 µg/L TP endpoint is not a biologically meaningful threshold with respect to EPT. Moreover, for eastern PA streams, even TP > 200 ug/l allows for an EPT of 8 to be attained on average. Clearly, attaining a 40 ug/l TP level is not a prerequisite for meeting the EPT threshold of impairment value used in this TMDL.

Thus, the "scientific" analyses of these data sets is a pure artifact of the different exposure levels occurring, not the effect of those exposures. EPA's evaluation of the Maryland Piedmont data yields a low TP changepoint because the overall data base is exposed to lower levels of TP. That is, it was purely an artifact of the dataset that was chosen. The lack of significance is evident once the two sets are separately analyzed. The response data from Chester County, PA show no adverse "effect" at significantly higher concentration than the MBSS data set.

c. *Evaluation of Nutrients as a Stressor of Aquatic Life in Wissahickon Creek, PA* (February 23, 2012)

As discussed in the Draft TMDL (at 1, 3), the impaired use is aquatic life, the cause of this use impairment is excessive/nuisance algal, and the occurrence of nuisance algae is related to TP. We would therefore expect that the stressor verification analysis would present data relating benthic algae biomass to aquatic life impairment. In order to relate aquatic life use impairment to TP, a rational stressor verification analysis would need to present data showing the relationship between TP and benthic algal biomass. It would also need to explain precisely why the alleged "evidence" is actually applicable in this situation. No such analyses appear in the "verification study." [23]

Rather, the study presents eight predictions of varying relevance without showing that algal biomass causes impairment to the benthic macroinvertebrate community or that TP concentration is related to algal biomass. Without such demonstrations, it is not apparent how any of this is even remotely relevant to verifying the "cause" of aquatic life impairment in the Wissahickon Creek Watershed.

i. Prediction 1 (Evidence of Increased Nutrient Concentration) – No Evidence Showing Increased Nutrient Concentrations Following Implementation of 2003 Nutrient TMDL

It is widely understood that the mere presence of an elevated TP concentration provides no direct evidence that TP is causing impairment for a stream. (See USEPA Gold Book regarding "phosphate phosphorus".) Moreover, EPA Region 3 prepared a nutrient and sediment TMDL in 2003 to address aquatic life use impairment. The data presented to evaluate nutrient concentrations in the Wissahickon Creek Watershed were obtained in 2005.

> Data from 2005 were the most consistent across the majority of sites, so these data were used to calculate arithmetic annual and growing season (July-September) average nutrient concentrations. (Stressor Verification Study at 11).

The nutrient component of the TMDL was implemented in 2009 as discussed by PADEP in a March 5, 2015 meeting with stakeholders. The data upon which this Stressor Verification Study was based do not reflect implementation of the 2003 TMDL or current water quality in the Creek, as required by 40 CFR 130.7. The relevance of the older data to current conditions is unknown, but in any case, plainly inapplicable.

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[23] This is not surprising as Tetra Tech itself published a paper in 2006 confirming that there would be no such relationship in this watershed above 10 ug/l TP. *Supra* at 23, Att. 4.

The Stressor Verification Study presents further information concerning reference conditions for Piedmont streams from USEPA's technical guidance, with TP concentrations of 0.036 mg/L up to 0.060 mg/L. As noted above, these reference concentrations do not limit plant growth and suggest that nuisance algal growth would naturally occur wherever physical conditions do not otherwise limit such growth, as Tetra Tech's own peer-reviewed publication for this watershed confirmed.

ii. Prediction 2 (Evidence of Altered N:P Ratio) – Relationship to Nuisance Algal Growth Uncertain

Notwithstanding the fact that this evaluation is based on 2005 data that are irrelevant to current conditions, the mere existence of an altered N:P ratio has no demonstrable adverse impact on streams ecology and no published literature or EPA Guidance document confirms that this constitutes "impairment". Thus, this prediction bears no relationship to the stated cause of aquatic life impairment in the watershed.

> The conceptual model also posits that enrichment in nutrients will likely also alter N:P ratios, which can alter competitive relationships among taxa that vary in their preferences for N and P concentrations and ratios. (Stressor Verification Study at 14).

Even if N:P ratios have been altered, the analysis must show that this alteration has some relevance to nuisance algal growth or to aquatic life use impairment. No such evaluation is presented. Rather the Study informs us that competitive relationships may be altered. Even if this is the case, it must be related to nuisance algal growth to have any relevance as a basis for evaluating stressors in the watershed.

iii. Prediction 3 (Evidence of Increased Algal/plant Biomass at Locations Pursuant or Coincident with Elevated Nutrients) – No Evidence Showing Relationship between TP and Benthic Algal Growth

Prediction 3 was evaluated by presenting information on periphyton biomass from 2005 (before implementation of the 2003 Nutrient TMDL) as the basis for claiming that elevated nutrient concentrations in Wissahickon Creek cause increased algal biomass. (Stressor Verification Study at 17). The relevance of these data to current conditions in the watershed, following implementation of the 2003 TMDL is not known.

The presented data, from Carrick and Godwin (2006), are summarized in Figure 6 (presented below) from the Stressor Verification Study (at 18). In discussing these data, the study identifies several chlorophyll-a biomass values that may represent excessive algal growth. These concentrations are 150 – 200 mg/m^2 and 50 – 100 mg/m^2. It then compares the results from 27 samples to these endpoints.

> For context, nuisance or excessive periphyton biomass is considered to occur when maximum chlorophyll exceeds 150 to 200 mg m^{-2} (Dodds et al., 1998, Suplee et al., 2009), although concentrations from 50 to 100 mg m^{-2} have also been suggested as indicative of nuisance concentrations (Horner et al. 1983, Nordin 1985, Welch et al., 1988). In addition, trophic boundaries have been estimated for streams and mean benthic chlorophyll a of 70 mg m^{-2} and maximum concentrations of 200 mg m^{-2} are considered the boundary between meso- and eutrophic streams. In the Wissahickon, 3 of the 4 site maximum values were greater than 200 mg m^{-2} indicating eutrophic nuisance conditions. A study by Carrick and Godwin (2006) characterized periphyton at nine sites in the Wissahickon. Chlorophyll a averaged 201 mg m^{-2} across the sites and ranged from 44 to 444 mg m^{-2} (Figure 6). Every site had average values greater than 50 mg m^{-2} and 6 of the 9 had average values greater than 200 mg m^{-2}, again consistent with eutrophic nuisance conditions based on the literature cited above. (Stressor Verification Study at 17).

Figure 6 is misleading because it presents the results of periphyton biomass for individual rocks rather than the average results for the three rocks collected at each of nine stations.

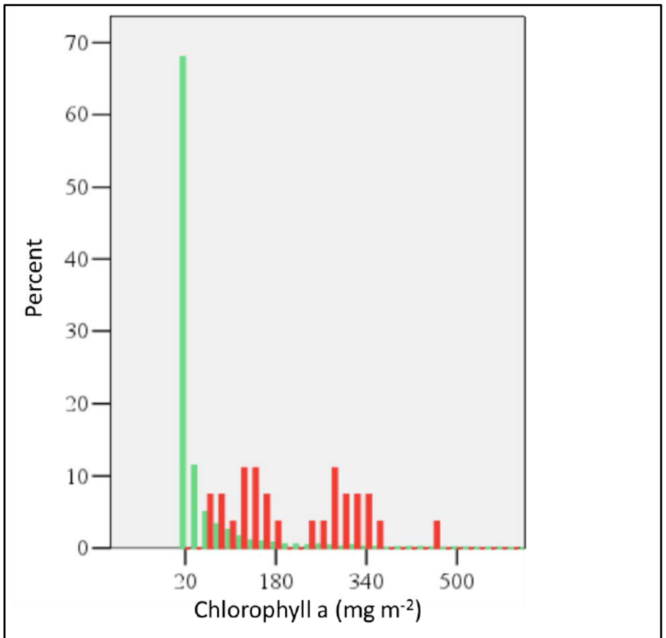
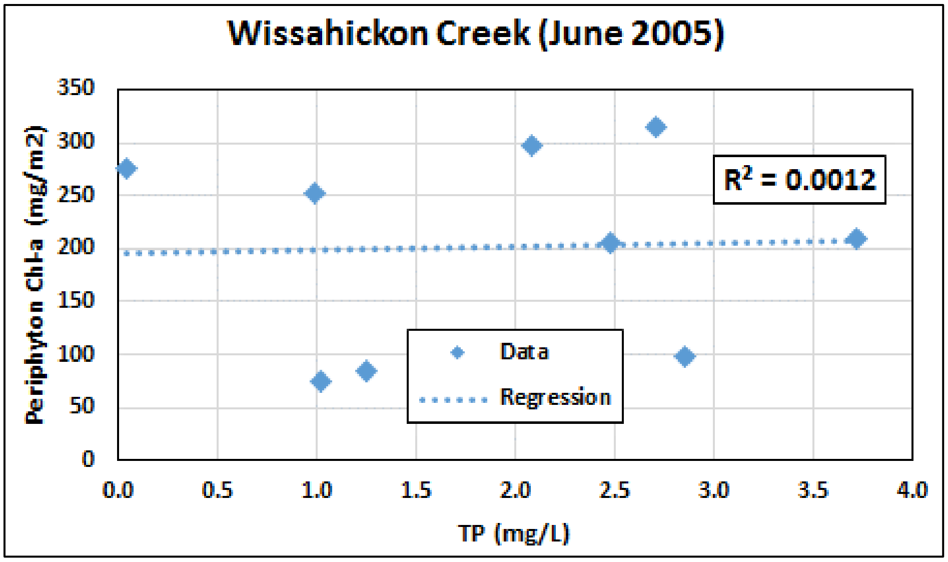


Figure 6 - Percent distribution of algal periphyton chlorophyll (mg/m2) measured from 410 streams throughout the world including North America and compared with measurements made in Wissahickon Creek. From Carrick and Godwin (2006). Green bars are worldwide data and red bars are Wissahickon observations.

The actual results reported in Carrick and Godwin (2006) are illustrated below relative to the measured TP concentration at each station. These results demonstrate that periphyton biomass is unrelated to TP concentration. Moreover, the lowest TP concentration (0.039 mg/L) is nearly identical to the endpoint used in the TMDL and the associated periphyton concentration was among the three HIGHEST periphyton growth levels measured. The properly graphed data show that this endpoint does not affect periphyton biomass.



The document also references a study conducted by PADEP in 1998 which sampled algae at 10 sites on Wissahickon Creek. (PADEP, 2002; Stressor Verification Study at 18). That study concluded that canopy cover, not phosphorus concentration, was the primary determinant concerning periphyton biomass.

This Draft TMDL is predicated on a conceptual model that links excessive nutrients to nuisance algal growth to aquatic life use impairment. The selection of a level of periphyton biomass that is excessive, in accordance with the narrative criterion, must be a threshold biomass above which aquatic life use impairment occurs. This relationship is not shown anywhere in the Stressor Verification document, and without it there is no basis for claiming that any level of periphyton biomass is excessive or that TP is causing aquatic life use impairment. Consequently, this evidence is irrelevant with regard to a determination that TP is the stressor requiring control in this TMDL. Moreover, the only data evaluated to assess this prediction show that TP concentrations as low as 0.039 mg/L have no effect on algal biomass. The prior 2002 study by PADEP also confirmed that algal biomass was controlled by canopy cover.

iv. No Evidence that Altered Algal Assemblages (Prediction 4) Cause Aquatic Life Use Impairment

Prediction 4, concerning altered algal assemblages coincident with elevated nutrients, implies that there is a preferred algal assemblage against which the existing assemblage is to be compared. The assessment is based on diatom data collected in 1998 (West 2000) and in 2005 (Carrick and Godwin 2006). (Stressor Verification Study at 19). These data do not reflect conditions after implementation of the 2003 TMDL and their relevance to existing conditions cannot be assessed. The relevance of altered diatom assemblages to “excessive algal growth” causing “aquatic life use impairment” is not addressed. Consequently, the relevance of this prediction to demonstrating that TP is the stressor causing aquatic life use impairment is not demonstrated. Moreover, PADEP does not have any published "preferred" algal assemblage that must be found in streams and there is no such "algal assemblage data" developed for this stream or any analysis showing how macroinvertebrate aquatic life uses are impaired by the algal assemblage. Therefore, this "evidence" also does not comport with the narrative criteria implementation methodology that the state has published.

v. No Evidence that Altered N:P Content of Periphyton Causes Aquatic Life Use Impairment (Prediction 5)

Prediction 5 concerns "Evidence of altered suspended organic matter composition and altered periphyton nutrient ratios pursuant or coincident with elevated nutrients." With regard to the suspended organic matter prediction, the Study states that there were insufficient data to test this prediction (Stressor Verification Study at 20). With regard to altered periphyton nutrient ratios, the Study cites the 2005 data in the Carrick and Godwin (2006) report and notes:

> This observation supported the prediction that nutrient enrichment alters the nutrient composition of algal and plant tissue, consistent with the causal model predictions. (Stressor Verification Study at 20).

These data do not reflect conditions after implementation of the 2003 TMDL and their relevance to existing conditions cannot be assessed. The relevance of altered periphyton nutrient ratios to "excessive algal growth" causing "aquatic life use impairment" is not addressed. Consequently, the relevance of this prediction to demonstrating that TP is the stressor causing aquatic life use impairment is not demonstrated. Moreover, there is no analysis showing how such "altered cell composition" affects the endpoint of concern, aquatic life use attainment. These are just conclusory statements made without any meaningful corroboration to significant ecological effects that would constitute a narrative criteria violation under PA law.

vi. No Evidence Showing that Altered Dissolved Oxygen Dynamics, Absent Dissolved Oxygen Water Quality Standard Exceedances, Cause Aquatic Life Use Impairment. (Prediction 6)

Prediction 6 concerns "Evidence of altered dissolved oxygen dynamics (greater diel flux, lower minima, and higher maxima) pursuant or coincident with elevated alga/plant biomass." In discussing this prediction, the study notes:

> It was fortunate in that the data available for this watershed included a number of long-term continuous dissolved oxygen (DO) deployments using recording sondes at several sites that allow insight into diel DO dynamics in the stream. For example, continuous DO was measured at two sites in 2005, one that exhibited relatively lower nutrients (WISS210_DO) and one that exhibited much higher nutrients (WISS500_DO). (Stressor Verification Study at 20).

The Draft TMDL indicated that watershed DO levels have improved since implementation of the 2003 Nutrient TMDL. (Draft TMDL at 1). The data evaluated in the Stressor Verification Study do not reflect conditions after implementation of the 2003 TMDL and their relevance to existing conditions cannot be assessed.

The assessment goes on to present data relating minimum DO (seasonal 10th percentile) to seasonal average TP concentration.

> Of particular interest is the extent of DO response relative to water quality standards. We analyzed the response of the 10th percentile seasonal DO observation to DO and, it too, was significantly negatively related to both TN and TP (Figure 8). Note that several values below 4 mg/L were observed. (Stressor Verification Study at 22).

Figure 8 (illustrated below) is presented as though there is a cause and effect relationship between TP and DO. This is plainly incorrect. The conceptual model cited in the study (Figure 1, illustrated above) shows that the diel DO range is a function of algal biomass. Diel DO range is not the same as 10th percentile minimum DO. The diel DO range can be large in response to elevated periphyton biomass, but if the overall average DO is high, the 10th percentile DO would also be high. Alternatively, if the overall average DO is low, the 10th percentile DO would be low, regardless of diel range.

The prediction is based on elevated algal biomass, not TP. The analysis presented in the figure swaps TP for algal biomass, but as shown previously there is no relationship between TP and algal biomass. Moreover, DO response is mediated by numerous confounding factors, none of which are addressed in this evaluation.

> Combined with increased dissolved oxygen inputs from the increased primary productivity, one prediction is an increase in diel flux with concomitant reduced oxygen minima and increased dissolved oxygen maxima. <u>These changes are influenced by reaeration rates in the channel, the magnitude of which will either exacerbate or mitigate oxygen responses</u>. (Stressor Verification Study at 9).

This assessment is simply bad science and should be ignored.

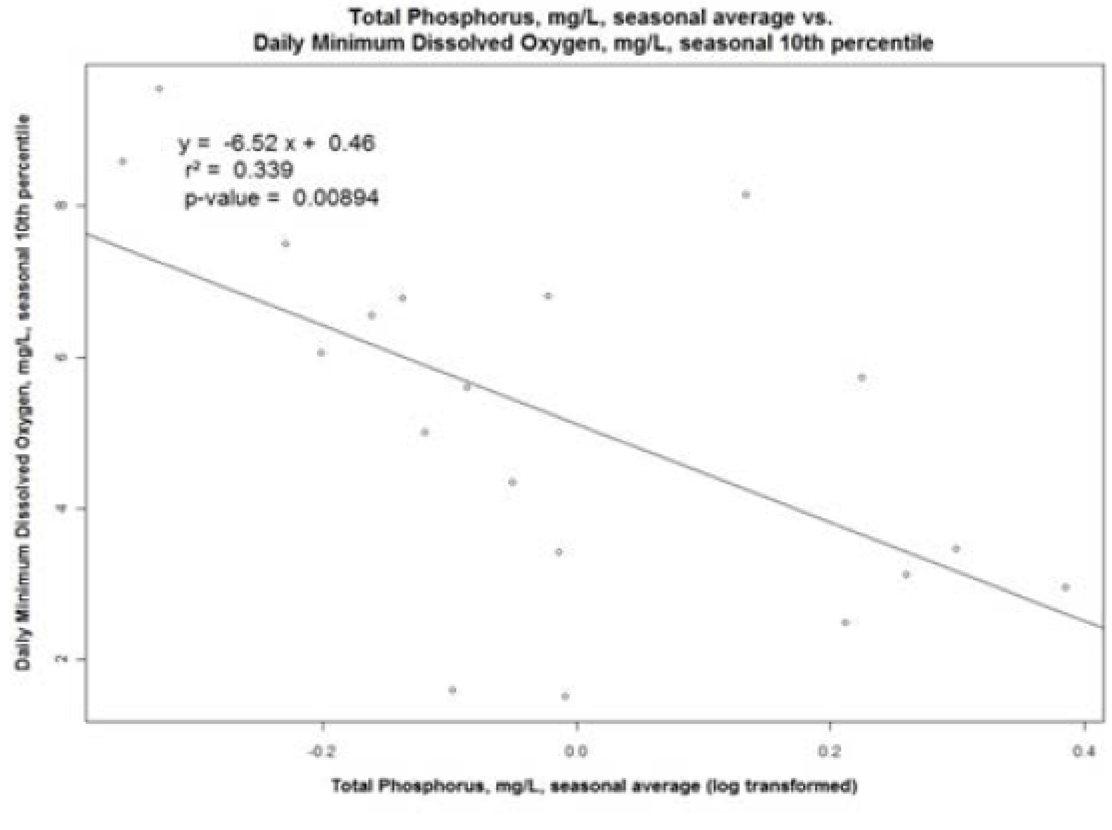


Figure 8 – Relationship of seasonal average TP (mg/L) do the 10th percentile observed diel DO concentration (mg/L) in the Wissahickon.

Finally, as noted in the attached EPA Headquarters FOIA response, diurnal DO variation, per se, is not demonstrated to cause use impairment. (See, Attachment 8 - FOIA EPA-HQ-009040 Request, Response and Email Chain). Thus, this condition is not a basis for claiming that a narrative criteria violation exists.

vii. pH Relationship Contrary to Conceptual Model and Adopted WQS

Prediction 7 (Evidence of altered pH pursuant or coincident with elevated algal/plant biomass) intends to relate increasing algal biomass to increasing pH as illustrated in the conceptual model presented in Figure 1 of the Stressor Verification Study (at 7). Apparently, the data do not bear out this prediction, so the prediction was reversed to claim that a decrease in pH is expected due to nutrient enrichment of heterotrophic respiration.

> Annual and seasonal average, maximum, and daily minimum pH declined with nutrient concentrations, especially TP, consistent with increased respiration decreasing DO and increasing dissolved inorganic carbon concentrations that reduce pH overall. (Stressor Verification Study at 24).

No data are provided to support this revised prediction. Moreover, mere pH variation or decrease cannot be used to claim a narrative criteria violation exists where an actual numeric criteria exists for pH, which it does in this instance. See, e.g., 40 CFR 122.44(d). The present pH condition meets aquatic life protection goals based on the adopted and applicable numeric water quality criteria. The claim that this decrease constitutes "impairment" is specious and contrary to the applicable, EPA-approved, water quality standard.

viii. No Relationship between Algal Biomass and Aquatic Life Use

Prediction 8 (Evidence of altered invertebrate assemblage composition pursuant or coincident with elevated alga/plant biomass, altered dissolved oxygen, altered pH, altered assemblage composition) attempts to relate excessive algal biomass or other factors to aquatic life use impairment (e.g., altered invertebrate assemblage).

> The last prediction relates to the biological condition and evidence of its relationship to the proximate stressors of algal biomass, DO, pH, and altered assemblage composition. Given the range of stressors and the nearly uniform presence of impacts across the watershed and cumulatively downstream, there was little expectation that a clear signal with these specific endpoints would manifest itself in the invertebrate assemblage. Indeed, the nearly uniform severely impacted biological conditions across the watershed meant the response signal was limited (PWD 2007). However, consistent with predictions, there was a significant decline in Total Richness and an increase in Hilsenhoff Biotic Index (HBI) scores (higher values indicate fewer sensitive species) with chlorophyll a (Figure 9). Response to DO metrics were weak, however HBI scores also showed a significant decline with average daily pH, suggesting a loss in sensitive species as pH declined (Figure 10). (Stressor Verification Study at 24).

This prediction is the critical assessment in EPA's attempt to relate TP to aquatic life use impairment. However, the prediction is without merit because the aquatic life metrics used in the analyses are not specific indicators of use impairment, the selected stressors are inappropriate to show that TP stimulates excessive algal growth that causes aquatic life use impairment, the purported relationship is unsubstantiated, and, as confirmed in prior graphs of the applicable data for this and other systems, the linkage to TP concentration does not exist.

Figure 9 (Taxa Richness versus phytoplankton chlorophyll-a, Hilsenhoff Biotic Index (HBI) versus phytoplankton chlorophyll-a) and Figure 10 (HBI versus pH) use macroinvertebrate indices that do not equate with use impairment. While the two macroinvertebrate metrics (Taxa Richness, HBI) are related to use attainment, the values presented in the figures do not, in any way, demonstrate or confirm that TP is causing use impairment.

The stressor in Figure 9 is phytoplankton chlorophyll-a concentration. This is the wrong form of algal growth to assess excessive plant growth and is irrelevant in small streams such as Wissahickon Creek. The documents claiming excessive algal growth all evaluate periphyton chlorophyll-a. Moreover, the y-axis scale in Figure 9b (HBI vs. chlorophyll-a) is exaggerated to give the regression line the appearance of a steep slope. The resulting regression line yields ludicrous results, requiring phytoplankton chlorophyll-a concentrations well below 0.1 µg/L (extreme oligotrophic conditions) for HBI = 5 (which still indicates a stressed waterbody). *The person that prepared this assessment is clearly incompetent as such a low level of algal growth is indicative of the most pristine waters on the plant (which would then support very limited aquatic life because insufficient food source is present).*

The stressor in Figure 10 is pH. The figure implies that insignificant changes in the seasonal average pH (i.e., 0.2 s.u.) cause degradation in the HBI for pH values well within the State's water quality standard for pH. This is another ludicrous result or prediction. Moreover, the regression equation shown on the chart is obviously wrong. The line on the figure shows HBI = 6.0 at a pH ≈ 7.3. The equation yields a negative value at pH = 7.3.

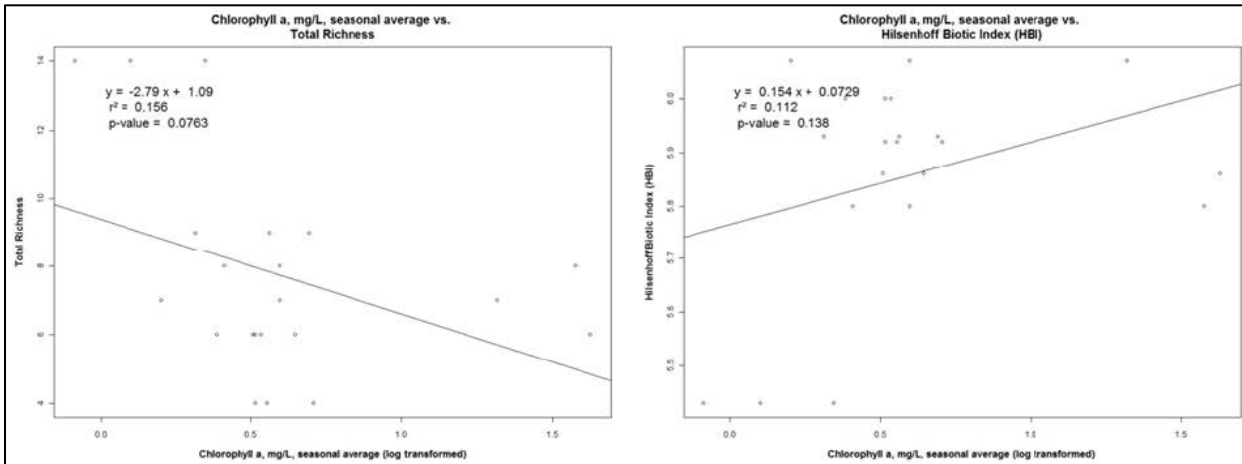


Figure 9 – Response of total invertebrate richness and Hilsenhoff Biotic Index to chlorophyll a in the Wissahickon.

In summary, none of the alleged "lines of evidence" are proof that TP is the cause of any alleged ongoing impairment of Wissahickon Creek. Several of the analyses are so grossly incorrect as to call into question the competence of the analysts that prepared this "junk science".

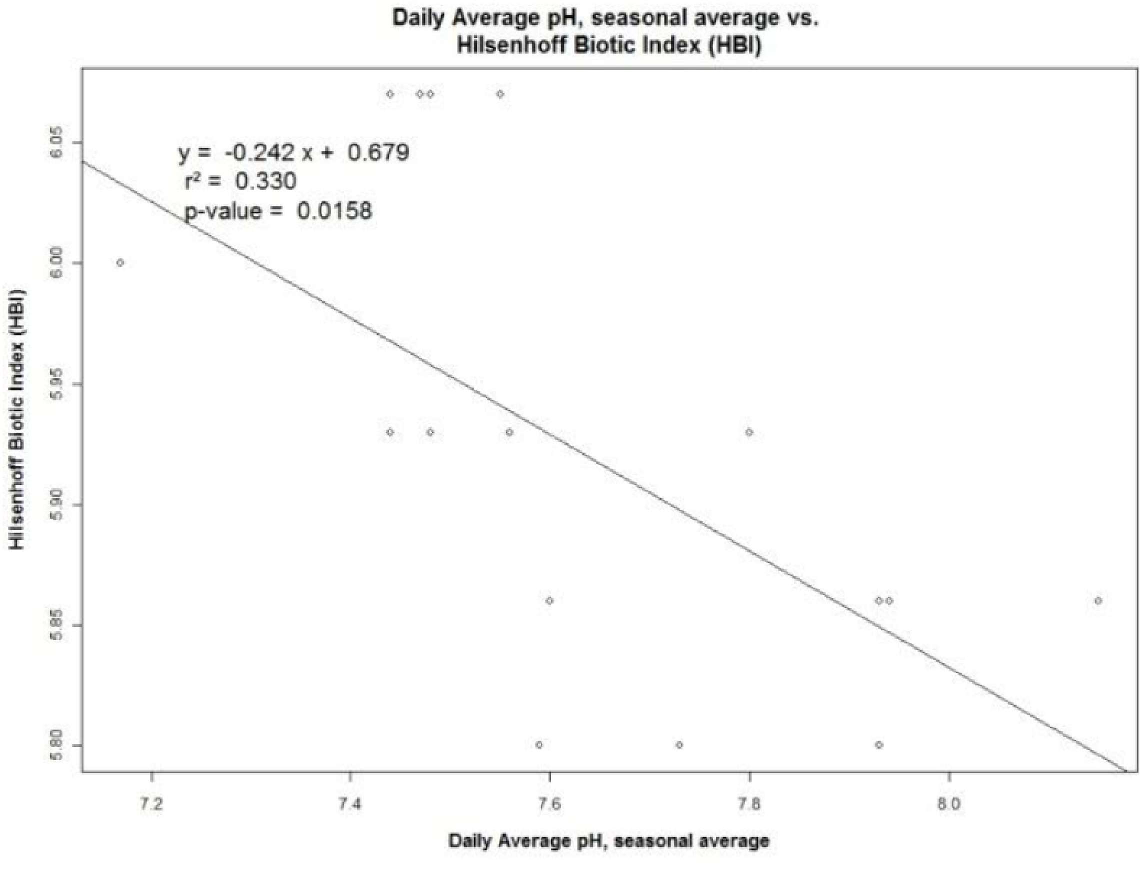


Figure 10– Response of Hilsenhoff Biotic Index to seasonal average pH in the Wissahickon.

The regression lines in Figure 9 and Figure 10 imply a cause-and-effect relationship between the aquatic life metric and the stressor. These relationships are confounded by other stressors that must be considered to separate out the influence of nutrients. The Stressor Verification Study recognizes this.

> Note that primary producer response can be limited by light, flow, and substrate (Allan 1995, Dodds 2002). Where the stream is shaded from riparian canopy, primary production may be light limited and therefore show limited response to nutrient enrichment. Similarly, during periods of high flow which are more frequent in urban watersheds, shear on the bed can remove plant and algal biomass. Lastly, unstable substrates can limit the accumulation of primary producer biomass. These modifying factors are important in interpreting causal-response data (USEPA 2000a). (Stressor Verification Study at 9).

However, none of these confounding factors were considered. Consequently, these relationships are not credible.

d. Public Denied Due Process Because the Wissahickon Creek Watershed TMDL Does Not Have an Associated Modeling Report

As discussed in the Draft TMDL, a new model was developed for evaluating the Wissahickon Creek Watershed TMDL. This model is complex, with multiple assumptions that require data to justify application in the model. However, the assumptions and the necessary justification cannot be evaluated because there is no modeling report accompanying this TMDL. Whereas the 2003 Nutrient and Sediment TMDL and the 2008 Nutrient TMDLs for Chester Creek/Goose Creek, Indian Creek, and Southampton Creek all included modeling reports to support the TMDLs, the administrative record for this TMDL is devoid of a modeling report.

Public review of a modeling report is necessary to allow for informed commenting. We have already commented that the selected half saturation constant for phosphorus is suspect and it is incomprehensible that nutrient loads entering the watershed during high flow conditions or during the non-growing season have any impact on benthic algal growth. There may be other issues with this TMDL, but the public has been denied its due process rights because a detailed model has been developed and its basis is shrouded in secrecy by the lack of any report giving the model substance. Consequently, this TMDL should be withdrawn until such time as a modeling report is prepared and made available to the public for review.

ATTACHMENTS

1. **List of FOIA Requests for Wissahickon TMDL Records**

2. **PADEP PowerPoint, Modeling for the Wissahickon Watershed TMDL**

3. **Email Exchange between EPA Region 3 and H&A (July 6-13, 2015 - RE: Wissahickon Creek TMDL)**

4. **Zou, R., Carter, S., Shoemaker, L., Parker, A., Henery T. 2006. Integrated Hydrodynamic and Water Quality Modeling System to Support Nutrient Total Maximum Daily Load Development for Wissahickon Creek, Pennsylvania. Journal of Environmental Engineering. ASCE.**

5. **PADEP Wissahickon Watershed Stakeholder Meeting, March 5, 2015**

6. **Brent, R., R. Morland, D. Berberick, S. Davis, B. Foltz, and K. Drummond. 2014. Mercury falling. How a facility upgrade intended to reduce algae growth resulted in unintended (yet favorable) consequences. Water Environment and Technology. August 2014. 62 – 65.**

7. **Decision Rationale - Total Maximum Daily Load - Dissolved Oxygen and Aquatic Life Use (Benthic) Impairments in the Jackson River Alleghany, Bath, Craig and Highland Counties, Virginia, July 21, 2010**

8. **FOIA EPA-HQ-009040 Request, Response and Email Chain**

ATTACHMENT 1 -

List of FOIA Requests for Wissahickon TMDL Records

- EPA-HQ-2015-008836
- EPA-HQ-2015-008857
- EPA-R3-2015-008290
- EPA-R3-2015-008605
- EPA-R3-2015-008815
- EPA-R3-2015-008817
- EPA-R3-2015-008819
- EPA-R3-2015-008831
- EPA-R3-2015-008843
- EPA-R3-2015-008848
- EPA-R3-2015-008851
- EPA-R3-2015-008853
- EPA-R3-2015-008855
- EPA-R3-2015-008860
- EPA-R3-2015-008861

ATTACHMENT 2 –

Excerpts from PADEP PowerPoint, Modeling for the Wissahickon Watershed TMDL

MODELING FOR THE WISSAHICKON WATERSHED TMDL

ALLOCATION METHODOLOGY

- 2005-2006 chosen as modeling period
- 2005 chosen as calibration period due to rich data monitoring data availability
  - Monitoring data used to calibrate model
  - Good calibration suggests good representation of Wissahickon system in 2005
- 2005-2006 Conditions used to derive allocations
  - Meteorological conditions
  - Land use
  - Discharge volumes and concentrations

ALLOCATION METHODOLOGY

- Allocation Scenario meets the average TP target of 0.04mg/L for the growing season, which is based on 2012 Nutrient Endpoint Guidance for the Northern Piedmont Ecoregion of PA.
- Only TP was reduced to meet the TP target (i.e ammonia, BOD were represented for nutrient dynamics, but were not reduced).
- DO and algal growth were simulated, but not used explicitly as allocation targets.
- Permitted point source discharges, land surface contributions, and septic contributions were reduced to meet the target.

Development of Nutrient Endpoints for the Northern Piedmont Ecoregion of Pennsylvania: TMDL Application

Follow-up Analysis

Prepared for

United States Environmental Protection Agency

Region 3

Philadelphia, PA

Prepared by

Michael J. Paul, James Robbiani, Lei Zheng, Teresa Rafi, Sen Bai, and Peter Von Loewe

Tetra Tech, Inc.

400 Red Brook Boulevard, Suite 200

Owings Mills, MD 21117

18 July 2012

ATTACHMENT 3 –

Email Exchange between EPA Region 3 and H&A (July 6-13, 2015 - RE: Wissahickon Creek TMDL)

From:	Toy, Ashley
To:	Bill Hall
Cc:	John Hall; Benjamin Kirby; MacKnight, Evelyn; Richardson, William; Schepel, Kristen; Day, Christopher
Subject:	RE: Wissahickon Creek TMDL
Date:	Monday, July 13, 2015 1:40:45 PM
Attachments:	Validation of Nutrient Impacts in Wissahickon Creek 07132015 Final.pdf

Bill,

I apologize for the delay in response. I was trying to get information on all outstanding issues to be more comprehensive.

Regarding your question about Figure 9 in the 2012 Stressor Verification report, the graph should have been labeled ug/L (analyzed water column chlorophyll data). A corrected version is attached. I will broadly distribute to the stakeholders asap.

An administrative record is "*the set of non-deliberative documents that the decision-maker considered, directly or indirectly (e.g., through staff), in making the final decision.*" Please see our guidance document at http://www.epa.gov/ogc/adminrecordsguidance09-00-11.pdf. There is an open comment period for the proposed Total Phosphorus TMDL for the Wissahickon Creek Watershed which closes July 30th. With that in mind, I tried to be helpful to point you to documents that were directly used in development of the draft document which is what I thought you were asking. There is no administrative record for you to view and there is no requirement for EPA to prepare an administrative record at this time. As stated in my earlier message EPA has not made a final decision in this matter. If there are certain documents you want to be made available for viewing in our office, please provide a list of the specific documents via a FOIA request.

Sincerely,
Ashley

From: Bill Hall [mailto:bhall@hall-associates.com]
Sent: Wednesday, July 08, 2015 11:39 AM
To: Toy, Ashley
Cc: John Hall; Benjamin Kirby; MacKnight, Evelyn; Richardson, William; Schepel, Kristen; Day, Christopher
Subject: RE: Wissahickon Creek TMDL

Thanks Ashley.

I would like to review the Administrative Record next week. Do I need to make an appointment and, if so, whom should I contact?

Bill

William T. Hall
Associate
Hall & Associates **– Note New Address:**
1620 I Street NW, Suite 701
Washington, DC 20006
Phone: 202-463-1166
Fax: 202-463-4207
Cell: 610-247-4651
E-Mail: bhall@hall-associates.com

From: Toy, Ashley [mailto:toy.ashley@epa.gov]
Sent: Wednesday, July 08, 2015 11:22 AM
To: Bill Hall
Cc: John Hall; Benjamin Kirby; MacKnight, Evelyn; Richardson, William; Schepel, Kristen; Day, Christopher
Subject: RE: Wissahickon Creek TMDL

Hi Bill,

In response to our July 6 message, I do not have a final list of documents in the administrative record to share at this time. For now, please refer to the "Reference" section of the TMDL. EPA may consider additional information as a result of the public participation process, which will help inform our decision making process. Until the final decision is made, the documents considered as part of the administrative record will evolve.

There is not a separate modeling report. EPA considers the modelling information made available in the draft TMDL to be representative of a "modelling report." Additionally, modelling files were made available on EPA's website at http://www.epa.gov/reg3wapd/tmdl/ on July 1st.

Regarding your request about Figure 9 in the 2012 Stressor Verification report, we will look into whether or not it was a mislabeling and will have to get back to you on that.

Sincerely,
Ashley

Ashley K. Toy
Office of Standards, Assessments & TMDLs
Water Protection Division
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From: Bill Hall [mailto:bhall@hall-associates.com]
Sent: Monday, July 06, 2015 12:50 PM
To: Toy, Ashley
Cc: John Hall; Benjamin Kirby
Subject: Wissahickon Creek TMDL

Ashley:

Please provide the list of documents in the administrative record for the Wissahickon Creek TMDL. Is there a separate modeling report that was prepared for this TMDL. If so, can you provide me with that report?

Also, the "Evaluation of Nutrients as a Stressor of Aquatic Life in Wissashickon Creek, PA" (February 23, 2012) includes a figure to support Prediction 8 (Evidence of Altered Invertebrate Assemblage Composition with Elevated Algal Biomass). Figure 9 includes two graphs with the x-axis titled "Chlorophyll-a mg/L, seasonal average (log transformed)". The data on the chart have chlorophyll-a values ranging from approximately 0.2 to 1.5. Assuming this is a base-10 transform, the corresponding chlorophyll-a concentrations are 1.5 mg/L – 31.6 mg/L. Is this supposed to be "ug/L". Is the chart plotting phytoplankton chlorophyll-a or periphyton chlorophyll-a?

Thanks for your help.

Bill

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Associate
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PRIVILEGED AND CONFIDENTIAL – ATTORNEY-CLIENT WORK PRODUCT

ATTACHMENT 4 -

Zou, R., Carter, S., Shoemaker, L., Parker, A., Henery T. 2006. Integrated Hydrodynamic and Water Quality Modeling System to Support Nutrient Total Maximum Daily Load Development for Wissahickon Creek, Pennsylvania. *Journal of Environmental Engineering*. ASCE.

Integrated Hydrodynamic and Water Quality Modeling System to Support Nutrient Total Maximum Daily Load Development for Wissahickon Creek, Pennsylvania

Rui Zou[1]; Stephen Carter[2]; Leslie Shoemaker[3]; Andrew Parker[4]; and Thomas Henry[5]

Abstract: This paper presents a hydrodynamic and water quality modeling system for Wissahickon Creek, Pa. Past data show that high nutrient levels in Wissahickon Creek were linked to large diurnal fluctuations in oxygen concentration, which combining with the deoxygenation effect of carbonaceous biological oxygen demand (CBOD) causes violations of dissolved oxygen (DO) standards. To obtain quantitative knowledge about the cause of the DO impairment, an integrated modeling system was developed based on a linked environmental fluid dynamics code (EFDC) and water quality simulation program for eutrophication (*WASP/EUTRO5*) modeling framework. The EFDC was used to simulate hydrodynamic and temperature in the stream, and the resulting flow information were incorporated into the *WASP/EUTRO5* to simulate the fate and transport of nutrients, CBOD, algae, and DO. The standard *WASP/EUTRO5* model was enhanced to include a periphyton dynamics module and a diurnal DO simulation module to better represent the prototype. The integrated modeling framework was applied to simulate the creek for a low flow period when monitoring data are available, and the results indicate that the model is a reasonable numerical representation of the prototype.

DOI: 10.1061/(ASCE)0733-9372(2006)132:4(555)

CE Database subject headings: Hydrodynamics; Water quality; Numerical models; Nutrient loads; Dissolved oxygen; Pennsylvania; Streams.

Introduction

The Wissahickon Creek drains approximately 164 km^2 and extends 38.6 mil in a southeasterly direction through lower Montgomery and northwestern Philadelphia Counties of Pennsylvania (Fig. 1). Major tributaries in the basin include Sandy Run and Pine Run, draining a heavily urbanized area east of the midsection of the watershed. Other major tributaries draining less urbanized area include Trewellyn Creek and Lorraine Run.

Biological investigations of the Wissahickon Creek basin over the past 20 years have repeatedly documented a continuous problem regarding eutrophic conditions in the mainstem and tributaries. Results of a 1998 survey of the periphyton conducted by the Pennsylvania Department of Environmental Protection (PADEP) indicate that excess nutrient levels may be contributing to the dissolved oxygen impairment found in the creeks due to the intensive biological activities from excessive periphyton growth. The diurnal dissolved oxygen sampling performed by PADEP in 1999 and 2002 showed repeated violations of state water quality criteria (Tetra Tech Inc., 2002). All tributaries of Wissahickon Creek basin as mentioned above are included with the main stem of the Wissahickon Creek on Pennsylvania's 303(d) list of impaired waters, thus necessitating the development of total maximum daily load (TMDLs) for the basin.

A scientifically justifiable TMDL for a waterbody can only be developed based on a quantitative understanding of the system. In practice, water quality modeling offers a feasible tool to establish this quantitative understanding. A water quality model that is customized for a specific waterbody can simulate the major physical, chemical, and biological process that occur in the system, and thus establishing quantitative relationships between the water quality response and external forcing functions (Lung 2001).

This paper presents the development and application of an integrated hydrodynamic and water quality model for supporting the determination of TMDLs for Wissahickon Creek and its tributaries (USEPA 2003). The modeling framework employed in this study consists of three major components. The first is a hydrodynamic model developed based on the computational framework of the environmental fluid dynamics Code (EFDC), and the second is a nutrient and dissolved oxygen (DO) interaction simulation model developed based on an enhanced version of the water quality simulation program for eutrophication (WASP/EUTRO). These two components are integrated through the third component, a linking interface developed to allow smooth communication of information between the hydrodynamic and water quality models. To enable a reasonable representation of the interactive mechanism of periphyton dynamics and diurnal DO fluctuation as observed in the basin, a new module was developed and incorpo-

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[2]Environmental Engineer, Tetra Tech Inc., 10306 Eaton Pl., Fairfax, VA 22030.

[3]Vice President, Tetra Tech Inc., 10306 Eaton Pl., Fairfax, VA 22030.

[4]Director, Tetra Tech Inc., 10306 Eaton Pl., Fairfax, VA 22030.

[5]TMDL Program Manager, Water Protection Division, USEPA, Region 3, 1650 Arch St., Philadelphia, PA 19103-2029.

Note. Discussion open until September 1, 2006. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on October 4, 2004; approved on June 15, 2005. This paper is part of the ***Journal of Environmental Engineering***, Vol. 132, No. 4, April 1, 2006. ©ASCE, ISSN 0733-9372/2006/4-555–566/$25.00.

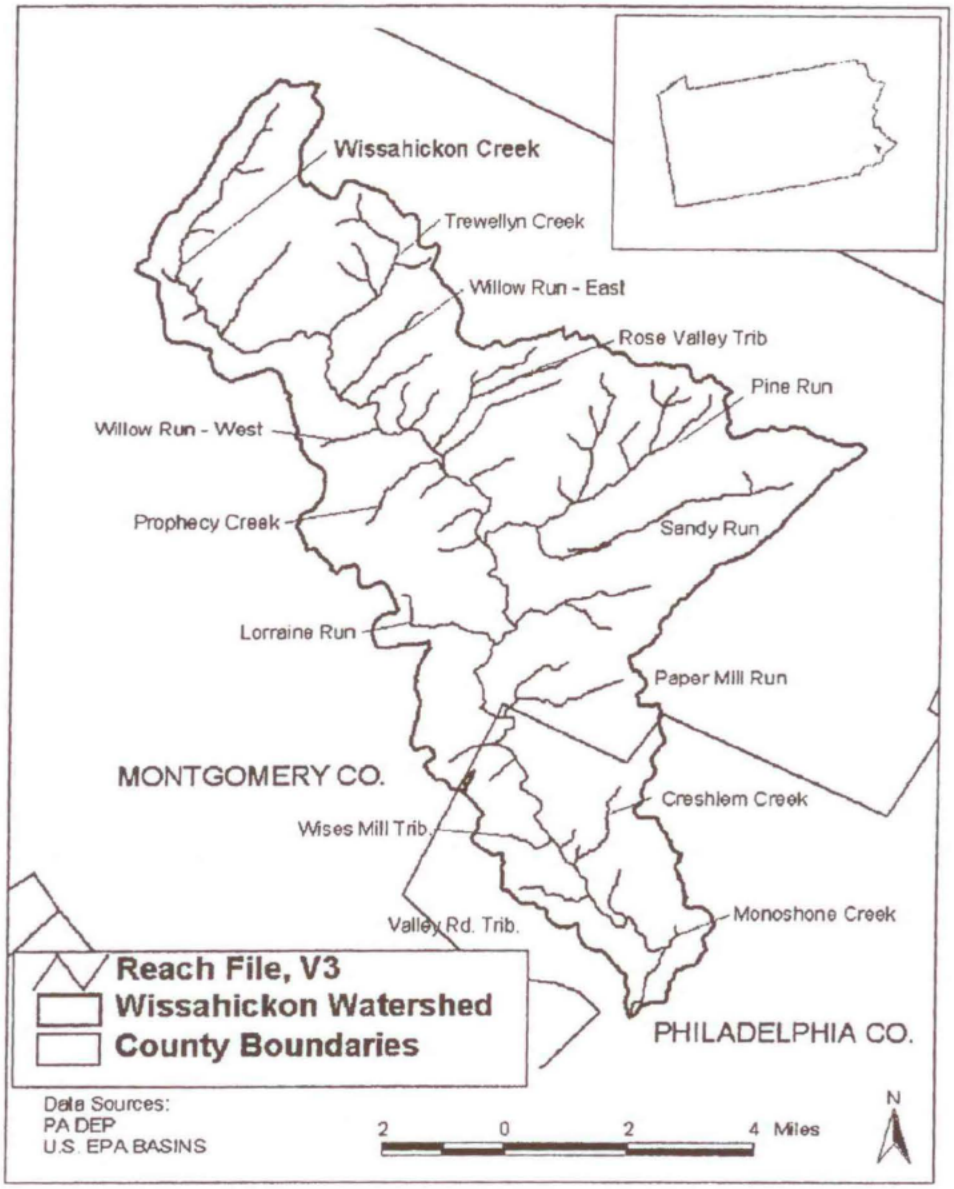

Fig. 1. Wissahickon Creek Watershed

rated into the water quality model facilitating a more realistic representation of the processes contributing to water quality impairments within Wissahickon Creek and tributaries.

The modeling system simulates the main channel of Wissahickon Creek as well as other 303(d) listed tributaries including Pine Run, Sandy Run, Trewellyn Creek, and Lorraine Run using a total of 115 computational grid cells with nonuniform dimensions. The hydrodynamic component of the model was calibrated using time-of-travel data obtained from a dye study provided by PA DEP, and supplemented with temperature calibration, while the water quality model component was calibrated using water quality data collected during a 2002 PA DEP survey, and was then validated using the data collected by Natural Institute of Environmental Research (NIER) in 1999.

Modeling Framework and Governing Equations

Standard WASP/EUTRO Model

The modeling framework for this study includes a hydrodynamic submodel and a water quality submodel. The USEPA's Water Quality Simulation Program (WASP), a generalized modeling framework for the fate and transport of contaminants in surface water, was employed as the computational framework to develop the water quality submodel. WASP is based on the concept of a "box" model and can be configured into one, two, or three dimensions depending on the characteristics required for proper representation of the system (Ambrose et al. 1993). The governing equation can be written as

$$\frac{\partial c}{\partial t} = -\frac{\partial(uc)}{\partial x} - \frac{\partial(vc)}{\partial y} - \frac{\partial(wc)}{\partial z} + \frac{\partial\left(D_x \frac{\partial c}{\partial x}\right)}{\partial x} + \frac{\partial\left(D_y \frac{\partial c}{\partial y}\right)}{\partial y} \frac{\partial\left(D_z \frac{\partial c}{\partial z}\right)}{\partial z} \pm S(x,y,z,t) \tag{1}$$

where (x,y,z)=longitudinal, lateral, and vertical coordinates, respectively [L]; c=constituent concentrations $[(\text{mass})L^{-3}]$; t=time; (u,v,w)=flow velocity at x, y, and z directions, respectively $[L\,t^{-1}]$; (D_x, D_y, D_z)=horizontal and vertical diffusion/dispersion coefficients $[L^2\,t^{-1}]$; and S=temporal and spatially dependent source and sink terms $[[\text{mass}]L^{-3}\,t^{-1}]$

WASP implements the finite segment method to solve for constituent concentrations through discretizing the integral rather than the differential form of the governing equation (Ditoro et al. 1983; Lung 2001). Based on this method, the model automatically accounts for the mass balance of each individual computational segment, ensuring conservation of mass. The right-hand side of Eq. (1) is addressed using a "splitting" mode in the model, which decomposes the last term, $S(x,y,z,t)$, into two parts: the first part accounts for all external sources and sinks; the second part accounts for internal kinetics. The first part is then combined with the first six terms and solved in the transport module of the model, while the second part of the last term is solved in the kinetic module *EUTRO*. The standard *WASP/EUTRO5* model is capable of simulating the fate and transport of eight constituents, including ammonium (NH4), nitrite/nitrate (NO2/NO3), DO, carbonaceous biological oxygen demand (CBOD), algae (chlorophyll-a), organic nitrogen (organic-N), organic phosphorus (organic-P), and ortho-phosphate (ortho-PO_4). Details regarding the formulation of kinetic equations in the standard *WASP/EUTRO* model are reported fully in Ambrose et al. (1993).

Model Enhancement

The standard *WASP/EUTRO* framework required modification to provide capability for simulating the observed periphyton and DO interaction in Wissahickon Creek. In general, the dynamics of periphyton are conceptually modeled as a mass balance in which growth, depending on the availability of limiting factors such as nutrients, light, and temperature, is offset by death and respiration. Although this conceptual model establishes the foundation for virtually all models for periphyton dynamics, significant differences exist between the detailed formulations (Shanaha and Alam 2001). In *QUAL-TX* (TDNR 1985) and *LA-QUAL* (Wiland and LeBlanc 2000), the dynamics of periphyton are interpreted to be identical to those of the phytoplankton. This approach suffers the limitation of oversimplification, and is incapable of accounting for several important features of periphyton dynamics such as substrate availability, limited advective transport, and depth of light attenuation. In contrast, other modeling studies elaborate the conceptual model using different compartments for different parts of macrophyte/periphyton, and differentiate benthic algae from epiphyton (Kemp et al. 1995; Cerco and Meyers 2000). Although appealing, this complicated formulation of periphyton/macrophyte dynamics is often not applicable to most real world cases where supporting data are limited. Other conceptual models provide a more reasonable representation of the processes with a compromise between the two extremes (Rutherford et al. 2000; Shanaha and Alam 2001). Their formulations follow the equation

$$\frac{\partial B}{\partial t} = (G - R - P - M)B \tag{2}$$

where B=periphyton biomass per unit area $[(\text{mass})/L^2]$; G=growth rate $[t^{-1}]$; R=respiration rate $[t^{-1}]$; P=predation rate $[t^{-1}]$; and M=nonpredatory mortality rate.

These models share the following common features: representation of periphyton in terms of mass per unit area; incorporation of limitations that not only include light and nutrient considerations, but also substrate, zero advective transport, no differentiation between different species, and parts of periphyton. With these features included, the formulation offers a moderately complex tool for simulating periphyton dynamics in natural waters. For this study, the model developed by Shanaha and Alam (2001) was incorporated into the general modeling framework for the Wissahickon Creek.

Several limitations have been identified in the Shanaha and Alam (2001) model: omission of the self-competing feature of periphyton population; the inability to properly distribute the organic matter generated from periphyton death; exclusion of the spatial variability of substrate distribution, preventing it from realistically representing the real world condition; and light penetration and attenuation was not correctly evaluated. In this study, the Shanaha and Alam's *WASP/EUTRO* was modified to overcome these limitations. The final formulation of the periphyton dynamics in Eq. (2) and the interaction with other water quality constituents are mathematically represented with the following equations.

The growth rate is represented as

$$G = G2_{\max}\theta_2^{T-20}F_A L_{\text{im2}}(\text{light})L_{\text{im2}}(\text{nutrient})L_{\text{im2}}(\text{Carry\_}CA) \tag{3}$$

where $G2_{\max}$=maximum specific growth rate of periphyton at 20°C (day^{-1}); L_{im2}(light)=light limitation function for periphyton; L_{im2}(nutrient)=nutrient limitation function for periphyton; L_{im2}(Carry_CA)=carrying capacity limitation function for periphyton; θ_2=temperature coefficient for periphyton growth; T=temperature (°C); and F_A=fraction of base area available for periphyton growth. The carrying capacity limitation function is introduced into this equation to address the growth limitation caused by the self-competing effect. In addition, F_A is location dependent to address spatial variability.

The respiration rate is represented as

$$R = K_{2R}\theta_{2R}^{T-20} \tag{4}$$

where K_{2R}=periphyton respiration rate at 20°C and (day^{-1}); and θ_{2R}=temperature coefficient for periphyton respiration.

The nonpredatory mortality rate is represented as

$$M = D_{2D}\theta_{2D}^{T-20} \tag{5}$$

where D_{2D}=periphyton death rate at 20°C (day^{-1}); and θ_{2D}=temperature coefficient for periphyton respiration. The predation effect is omitted since simulation would require an additional capacity to represent the dynamics of the population of predators. Therefore, the predation loss rate is lumped with the term M to form a gross loss of periphyton mass.

The periphyton dynamics can impact water quality through the following processes: nutrient uptake, thus reducing the concentration of orthophosphate, ammonia, and nitrate; metabolism activities that impact diurnal DO fluctuation; death of periphyton can result in accumulation of phosphorus, nitrogen, and oxygen-consuming matters such as CBOD. The differential equations describing the interactions between periphyton and DO-CBOD can be expressed in the following equation:

$$\frac{\partial(\mathrm{DO})}{\partial t} = L_1 + G\frac{B}{D}\left(\frac{32}{12} + \frac{48}{14}\frac{14}{12}(1 - P_{2nh3})\right) - \frac{32}{12}R\frac{B}{D} - K_d\mathrm{CBOD}_{\mathrm{peri}} \quad (6)$$

where L_1=total time rate of variation of DO concentration due to all processes other than the periphyton dynamics; P_{2nh3}=ammonia preference coefficient of periphyton; K_d=decay rate of CBOD; $\mathrm{CBOD}_{\mathrm{peri}}$=CBOD originated from periphyton; and D=water depth.

The interaction between periphyton dynamics and CBOD can be described as

$$\frac{\partial(\mathrm{CBOD})}{\partial t} = L_2 + a_{2oc}M\frac{B}{D}F_w(1 - K_d) \quad (7)$$

where L_2=total time rate of variation of CBOD due to all processes other than the periphyton dynamics; a_{2oc}=oxygen to carbon ratio for periphyton; and F_w=fraction of CBOD originating from dead periphyton and distributed to the water column.

The equations describing the interactions between periphyton and other system variables such as NH4, OPO4, and NO3/NO2 are the same as in Shanaha and Alam (2001), thus will not be listed here.

The diurnal simulation was implemented through introducing a step function of light conditions into the model. The value of the step function assumes the average solar radiation during the daytime and zero during nighttime. With this function, the growth of periphyton is halted during nighttime model simulation, and hence the suspension of oxygen production. In the meantime, the respiration process would continue to consume as much oxygen as it does during the daytime, resulting in a net loss of DO until daylight resumes. During the daytime, the periphyton resumes growth under the condition of daylight average solar radiation, and therefore oxygen is produced through photosynthesis. Consequently, the DO concentration would recover during the daytime from the DO deficit developed during the night.

Special care is needed to address the light formulation in the model. In the *EUTRO* module, the algal growth rate, as a function of light, is evaluated on a daily average and depth average basis. This must be modified for instantaneous simulations of algal growth. Thus the following light prediction equation is used:

$$\mathrm{Lim2(light)} = \frac{I_{\mathrm{bott}}}{I_s}\exp\left(-\frac{I_{\mathrm{bott}}}{I_s} + 1\right) \quad (8)$$

where I_{bott}=instantaneous light intensity at the bottom of water (Langley/day), and can be calculated using the Beer–Lambert law; and I_s=saturated light intensity for optimum algal growth (Langley/day).

EFDC and Model Linking

Eq. (1) shows that to solve the mass transport equation requires knowledge about the velocity field (i.e., u, v, and w), which can be obtained from a hydrodynamic model. This study used the EFDC as the computational framework for the hydrodynamic model due to its ability to route flow through a stream network and provide ready-to-use linkage to the *WASP/EUTRO* water quality model.

EFDC is a general modeling package for simulating one- or multidimensional flow, transport, and biogeochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and coastal regions (Hamrick 1992). Although EFDC is capable of simulating the complicated eutrophication process, this study only utilizes it as a hydrodynamic component in the externally linked modeling framework because the external linkage can improve the computational efficiency significantly by decoupling the solution of hydrodynamic and water quality governing equations.

The governing equations for hydrodynamics in EFDC consist of momentum equations, a continuity equation, and temperature/constituent transport equations. For details of the equations, interested readers can refer to the theoretical manual for EFDC (Hamrick 1992)

The differences in temporal and spatial scale between hydrodynamic and water quality models are always major concerns for coupling hydrodynamic and water quality models (Atkinson et al. 1998). Many previous studies employ the collapsing approach, which uses very fine resolution for the hydrodynamic model and very coarse for the water quality model (Lung and Hwang 1989). However, it has been widely acknowledged that the collapsing approach is subjected to the limitations of excessive numerical dispersion and information loss from lower resolution (Wang 2001). In view of the limitation of the collapsing approach, this study adopts a direct mapping scheme to link the hydrodynamic and water quality models using consistent spatial resolution for both models.

Hydrodynamic Model Configuration and Calibration

Segmentation

Wissahickon Creek and its tributaries were represented using a one-dimensional (1D) grid with a total of 115 segments. The segmentation was derived based on the distribution of point sources throughout the watershed, the variable geometric properties of the stream network, the level of resolution needed to address regulatory requirements, and computational requirements. Geometric data collected by PA DEP during a low flow survey in summer 2002 were used to define the cell dimensions. The geometric data included width and depth values at sampling locations along the main channel and its tributaries. Dimensions of the model cells varied from 1.1 to 16.8 m widths and from 126 to 967 m lengths. The width and depth of the segments between any two surveyed cross sections were obtained using linear interpolation.

Boundary and Initial Conditions

A flow balance calculation was performed using available data to derive the flow boundary conditions. The available data include the stream flow data collected by PA DEP during the period from July 11, 2002 to August 11, 2002, time variable discharge data provided by major dischargers for the same period, and flow data for two USGS stations located in the Wissahickon Creek basin: one at the mouth of the Wissahickon Creek main stem, and the other on Wissahickon Creek at Fort Washington. Fig. 2 shows the resulting flow distribution for the low flow season of the 2002 survey, and the locations of the major point source dischargers along the creek.

In addition to the flow boundary conditions, the hydrodynamic model requires atmospheric boundary forcing data including solar

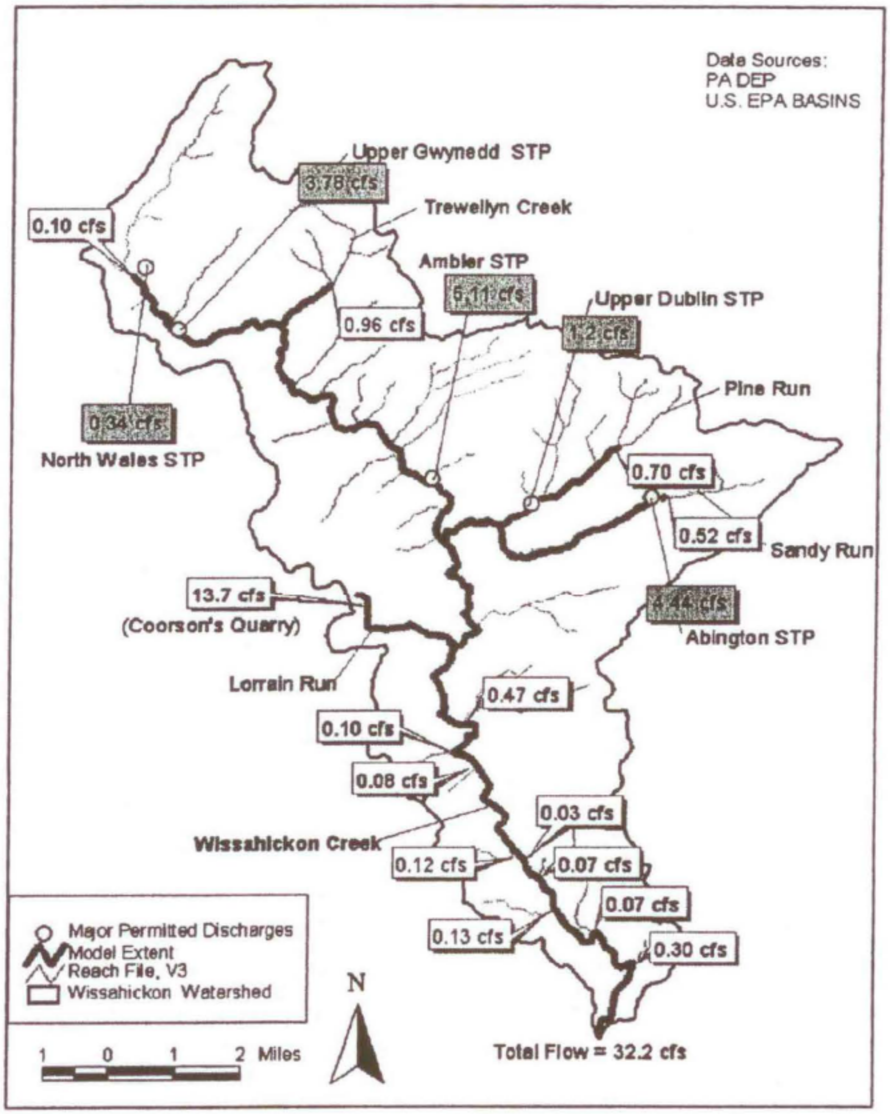

Fig. 2. Flow distribution for Wissahickon Creek model calibration

radiation, wind shear stress, and air temperature. Meteorological data from Allentown, Pa., were accessed from NOAA and used for atmospheric boundary conditions in the model. Data from the June 1, 2002 to September 30, 2002 time frame were used to represent typical conditions during the summer low-flow period.

The initial conditions for the hydrodynamic model include initial water depth, flow velocity, and temperature. The initial water depth was obtained through an iterative process until the model achieves stable simulation, and the initial velocity was set to 0.0 m/s for all segments. The initial temperature was set to be 20°C. The model was run through an extended period of 120 days to achieve steady state for both the hydrodynamic and water quality model. It was found through a series of sensitivity runs using different combinations of initial condition values that the impacts of initial conditions dampen off very quickly, suggesting that the initial conditions for water depth, temperature, and flow velocity can be set to any arbitrary values that ensure model stability.

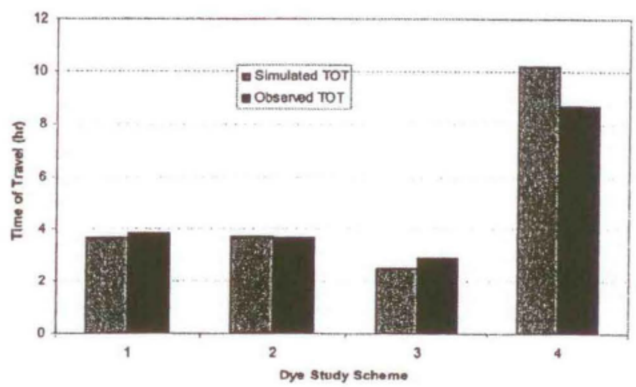

Fig. 3. Simulated versus observed time of travel (TOT)

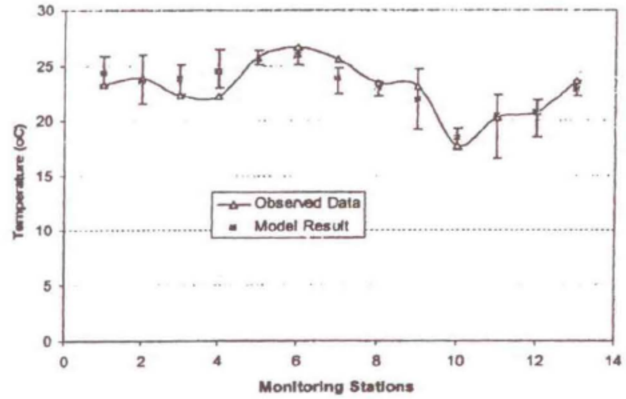

Fig. 4. Simulated versus observed water temperature

Model Calibration

The hydrodynamic model was calibrated using the time of travel (TOT) and temperature data collected in the 2002 low flow survey. During the survey period, PA DEP conducted a dye study to analyze the TOT in Wissahickon Creek, Pine Run, and Sandy Run. In addition, PA DEP measured water temperature at 13 locations along the creeks. Fig. 3 shows the simulated TOT compared to observed data. In addition, the simulated temperatures are compared with the observed data in Fig. 4. Note that the temperatures were measured on different dates for different locations. For the sake of consistency, the simulated temperatures were extracted from the model output files for each individual location on the specific days when temperatures were measured, and then plotted against the measured temperatures on the corresponding dates. The error bars in Fig. 4 indicate the diurnal temperature variation simulated by the model.

As shown in Figs. 3 and 4, the model reproduced the observed spatial distribution of temperature very well. In the meantime, the simulated TOT matches the observed data with reasonable accuracy. The flow condition during the survey period was relatively steady, with a coefficient of variation (standard deviation divided by mean) of 0.27 and 0.22 for the flows measured at USGS Stations 01473900 and 01474000, respectively. Therefore, the average flow condition during the low-flow survey period can be assumed representative of the flow condition of that period, suggesting a valid approach for hydrodynamic model setup using the average flow as a steady-state condition. The good agreement between the model results and observed data indicates that the hydrodynamic model can be considered a reasonable numerical representation of the system.

Due to the absence of an independent data set representative of low-flow conditions (e.g., TOT, temperature, etc.), a separate validation for the hydrodynamic model was not performed. This was not a cause of concern due to the fact that the model was applied to a low-flow condition similar to the calibration condition when the streams were dominated by major discharge flows, making the water quality in the streams insensitive to the minor change in background stream flows. In the event that the model is applied to a significantly different hydrological condition such as peak storm flow simulation, a model validation will be necessary.

Water Quality Model Calibration and Validation

General Configuration

This study employed a direct mapping scheme to link the hydrodynamic and water quality model, resulting in 115 1D *WASP* segments with the same dimensions as the hydrodynamic model grids. The major information needed to configure the water quality model includes boundary conditions, external loadings, initial conditions, circulation patterns, and internal sources and sinks. The locations of boundary conditions were the same as those in the hydrodynamic model.

Nine constituents were included as state variables in the water quality model, and boundary conditions were defined for each. Since periphyton is not transportable, the concentration was specified as 0.0 for all 20 boundary conditions. For chlorophyll-a, the concentration was specified as 0.0 for the five major point sources, while a background concentration of 0.5 $\mu g/L$ was specified for the other fifteen boundary conditions. However, the model was found to be insensitive to the chlorophyll-a boundary conditions from the headwaters due to the fact that the system is effluent dominant during the modeling period.

The concentrations boundary conditions for the main point sources were specified based on discharger monitoring data and PA DEP data grab samples at the effluent. The nutrient loads from ten minor point sources were configured as "dry" point source loads. Dry loads were specified instead of full boundary conditions (complete with flow) because flows from these dischargers were too low (ranging from 0.00007 to 0.08300 cfs) to significantly affect hydrodynamics since the total flow from these minor dischargers only amount to 0.35% of the total flow.

Table 1. Calibrated Parameter Values

Parameter	Description	Values
K12C	Nitrification coefficient (per day)	0.12
KNIT	Nitrification half-saturation coefficient (mg/L)	1.00
K20C	Denitrification coefficient (per day)	0.10
K1C	Phytoplankton growth rate (per day)	1.20
K1T	Temperature coefficient for phytoplankton growth	1.06
K1RC	Phytoplankton respiration rate (per day)	0.10
K2C	Periphyton growth rate (per day)	1.00
K2T	Temperature coefficient of periphyton growth rate	1.06
K2RC	Respiration rate of periphyton (per day)	0.12
Carry CA	Carrying capacity of periphyton (g/m^2)	30.00

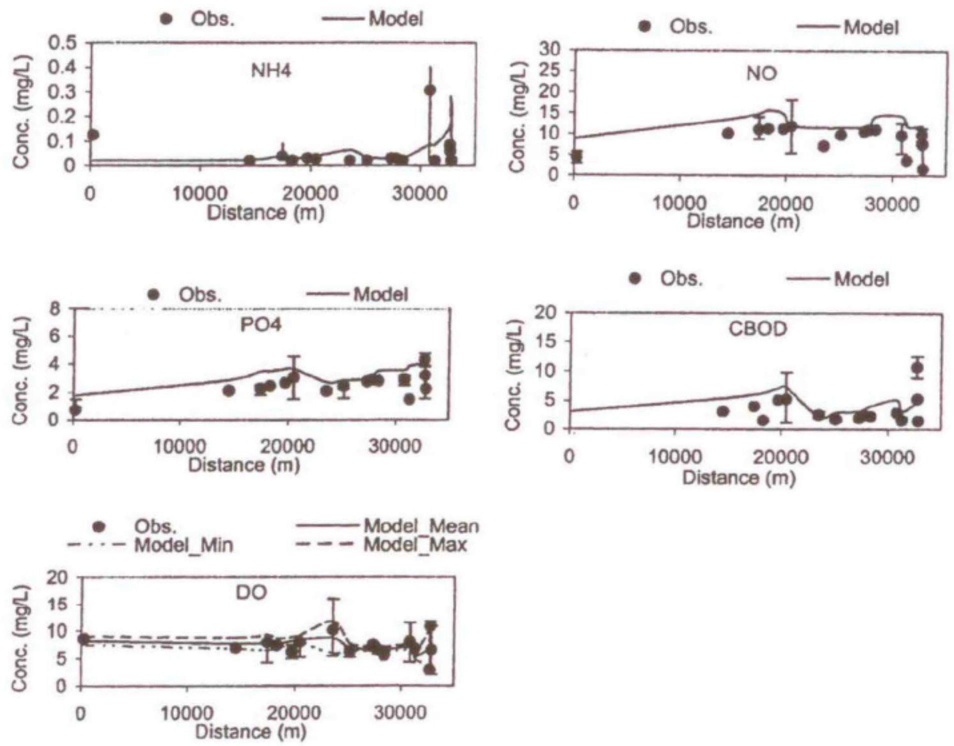

Fig. 5. Model calibration for Wissahickon Creek (distances represent meters from mouth)

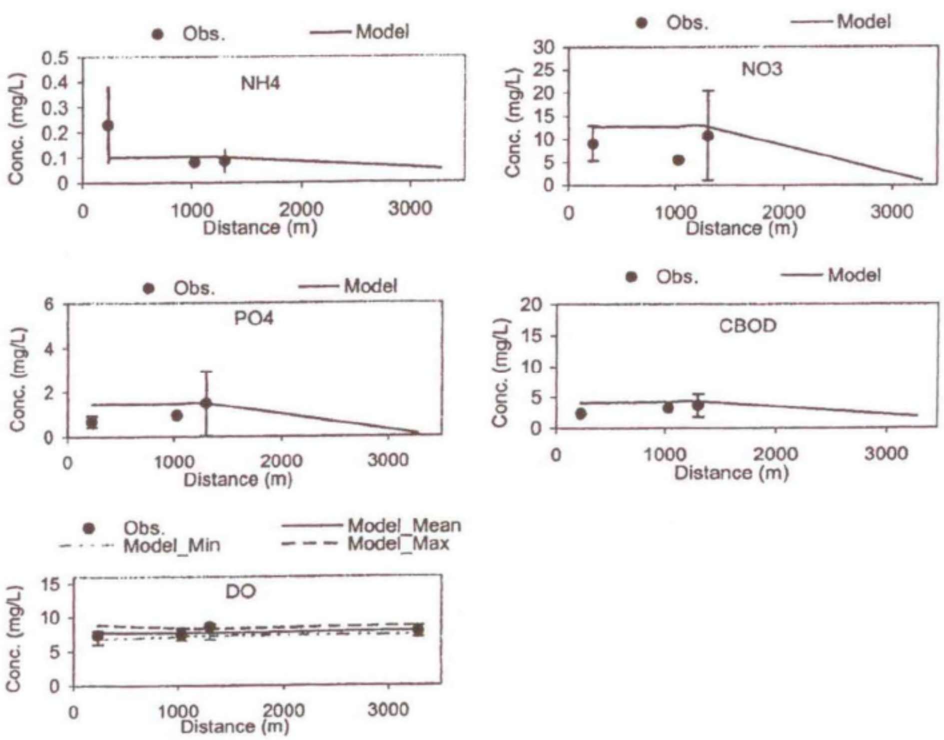

Fig. 6. Model calibration for Pine Run of Wissahickon Creek system (distances represent meters from confluence with Wissahickon Creek)

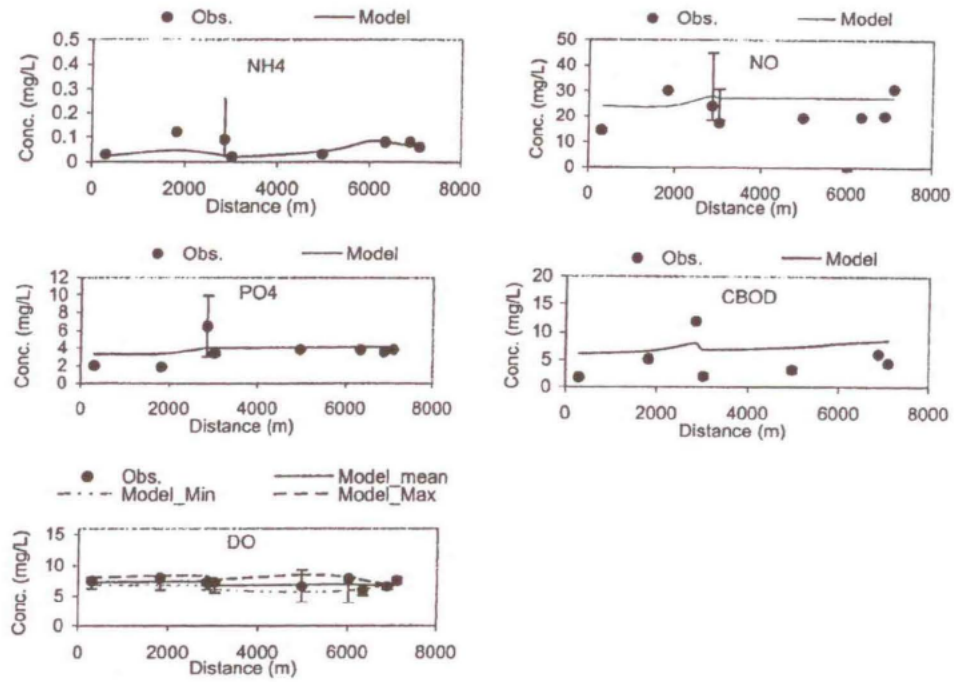

Fig. 7. Model calibration for Sandy Run of Wissahickon Creek system (distances represent meters from confluence with Wissahickon Creek)

Model Calibration

Following model configuration, the model was calibrated for individual parameters through a comparison of model results to observed data gathered during the 2002 low-flow survey period. The main parameters subjected to calibration included chlorophyll-a and periphyton growth rates, respiration rates, and death rates; CBOD decay rate, carrying capacity of periphyton, sediment oxygen demand (SOD), nitrification, and denitrification rates. The calibration process involved a stepwise adjustment of these parameters, within reasonable and acceptable ranges, until the model adequately reproduced the observed data. Table 1 shows the calibrated values of the major parameters.

In general, the model reproduced the spatial distribution of water quality very well, particularly in the vicinity of point source discharge locations. In addition, the DO fluctuation, as simulated with the diurnal module, matched the observed data reasonably well. The calibration results are shown in Figs. 5–7. Note the range of the simulated and observed DO represent the magnitude of diurnal fluctuation. To analyze the effect of periphyton on DO diurnal fluctuation, a sensitivity simulation which turns off the periphyton compartment was implemented. The resulting DO shows no diurnal fluctuation since the phytoplankton activities were minimal in the stream. Another interesting phenomenon demonstrated by the model sensitivity analysis is that, while periphyton tends to aggravate the daily minimum DO problem, it does improve the daily average DO through the photosynthesis in the daytime.

Although there were no data indicating the distribution of periphyton in 2002, the model-simulated periphyton was compared with data collected in 1998 summer low flow period to

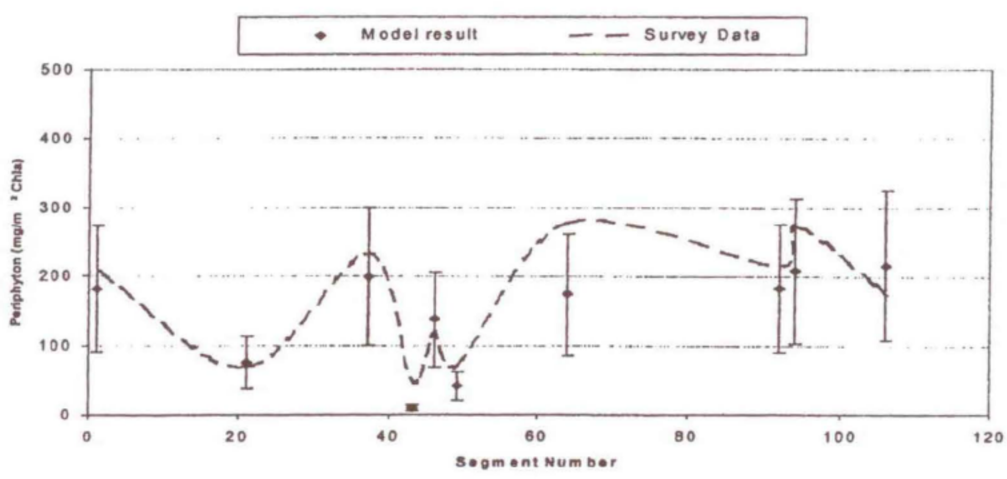

Fig. 8. Calibration of periphyton for Wissahickon Creek system

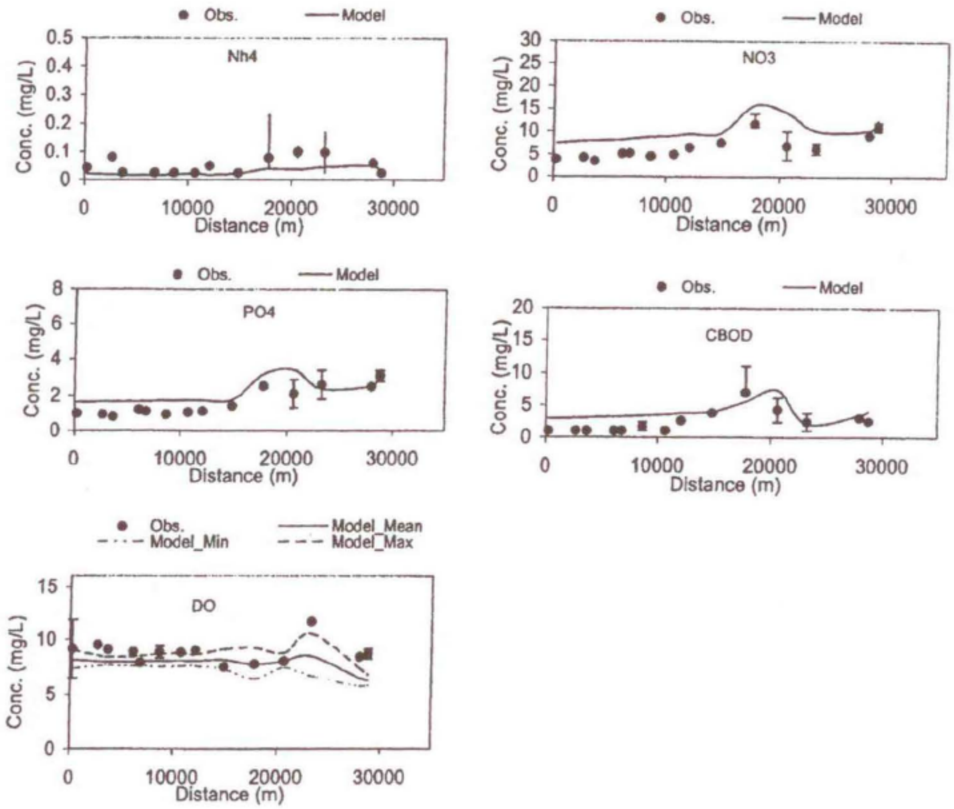

Fig. 9. Model validation for Wissahickon Creek (distances represent meters from confluence with Wissahickon Creek)

check the capability of the model in simulating the general magnitude and spatial pattern of periphyton. Since the periphyton state variable in the model is defined as mass of carbon, and the collected periphyton data were in terms of chlorophyll-a, a mass conversion operation was necessary before comparisons could be made. Assuming a carbon-to-chlorophyll-a ratio of 30:1, which is similar to the default value for algae (Shanaha and Alam 2001), and assuming a ±50% range of variation, the simulated periphyton mass was converted to chlorophyll-a (micrograms/Liter) and plotted with the surveyed data (Fig. 8). The disparity between the model results and the data can be explained in several aspects such as the model was configured using data collected in a different year than the periphyton survey year, and the model might not have represented all the localized features in the stream. As a whole, the model captured the general distribution of the periphyton with reasonable accuracy.

Model Validation

The calibrated water quality model was validated using data collected by NIER in its 1998 low flow survey. The validation involved application of the calibrated model (and parameters) to this separate time period and comparison of model predictions with monitoring data. The only flow data available for the period was at the USGS gage flow at the Wissahickon mouth (01474000). No reliable flow data were available for the point source dischargers or the quarry, therefore a detailed calculation of the flow distribution was not possible for this time period. The average flow rate for this period was 42.8 cfs, and this was assumed to represent a relatively low flow condition since it is comparable to the 2002 low flow rate. Based on this consistency in flow values, it was also assumed that the point source dischargers and the quarry were discharging similarly to the 2002 low flow condition. Thus, the hydrodynamic and water quality models were configured in the same manner as they were for the calibration case. The predicted water quality profiles for the validation are compared with the NIER data in Figs. 9–11. The plots show that the model simulation matches the observed water quality trends and magnitudes for Wissahickon Creek, Sandy Run, and Pine Run reasonably well. The capability of the model to reproduce the water quality in both 1998 and 2002 using the same set of parameter values indicates that the model reasonably represents the dynamic processes observed in Wissahickon Creek and its tributaries under low flow conditions.

Application for TMDL Development

Once calibrated and validated, the model was reconfigured for simulation of critical conditions for TMDL development. The critical condition for DO impairment in Wissahickon Creek is summer low flow. A standard flow often utilized for low-flow, steady-state analysis is the *7Q10* flow, defined as the streamflow that occurs over 7 consecutive days and has a 10 years recurrence interval. As for the point sources, the critical condition was defined to be when all the dischargers discharge at the designed flow and load conditions.

The model for developing the TMDL was configured through

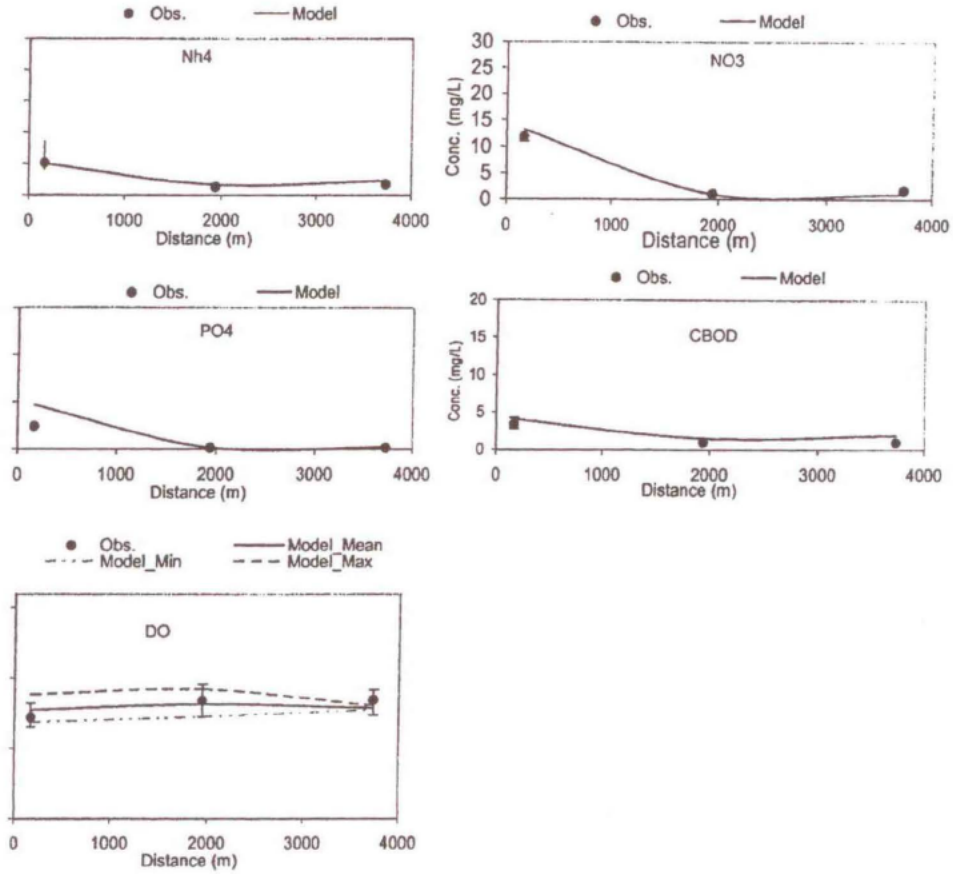

Fig. 10. Model validation for Pine Run of Wissahickon Creek system (distances represent meters from confluence with Wissahickon Creek)

incorporating the critical conditions into the calibrated and validated model. First, the *7Q10* flows and designed discharger flows were incorporated into the hydrodynamic model. Second, the designed point source loading capacity was incorporated into the water quality model. Third, an adjusted SOD rate was incorporated into the reconfigured water quality model based on the varied loading to the system. A linear relationship between SOD reduction and pollutant load reduction was assumed, and this is one of the most common approaches for addressing SOD variation following load change (Chapra 1997). Although a detailed sediment diagenesis model can provide better description of the relationship between SOD variation following load change, sufficient data are unavailable for configuring and testing such a model.

For TMDL development, model-predicted instream water quality data compared to targets set to provide assurance that designated uses of Wissahickon Creek and tributaries are met or restored. Based on that data and analysis, USEPA determined that only DO has applicable numeric criteria based on PA DEP water quality standards. The standards for DO are based on levels required to support fish populations, with the critical period (period of higher required concentrations) based on supporting the more stringent aquatic life use for trout stocking. This period requires a minimum DO level of 5.0 mg/L and a minimum daily average of 6.0 mg/L to support the aquatic life use for trout stocking (TS) from February 15 through July 31. For the remainder of the year, a minimum DO level of 4.0 mg/L and a minimum daily average of 5.0 mg/L are required to support warm water fish (WWF).

The nutrient TMDL endpoints are based on both the minimum daily average and daily minimum DO for the critical periods associated with TS and WWF. However, in analyses of the streams ability to meet these standards, it was necessary to consider all biological processes that are factors in the impairment of the water bodies. These factors included the link between nutrient levels and biological activity, including effects of periphyton/algae growth and the resulting diurnal variability of DO resulting from biological processes. Through modeling analyses of the Wissahickon Creek and tributaries, instream DO concentration was predicted to be highly sensitive to those parameters directly related to periphyton growth and respiration. The details of the TMDL calculation as well as sensitivity analysis are not included here due to the limitation of space. However, it is worth mentioning that while periphyton activities were identified as one of the major causes of the DO violation, it was finally determined to be infeasible to control the periphyton through reducing nutrient load from the point sources. Several model sensitivity runs show that the phosphorus concentrations from the dischargers need to be reduced by almost 99% before we can impose a significant limiting effect on periphyton growth. This is because under critical low flow conditions, the discharge flows account for more than 98% of the total flow in the channel, resulting in no dilution condition in the stream. At the same time, periphyton only needs very low concentration of phophorus to support its growth. Consequently, the TMDL has to be focused on reducing loading rates of BOD and other oxygen consuming constituents such as organic nitrogen and NH4.

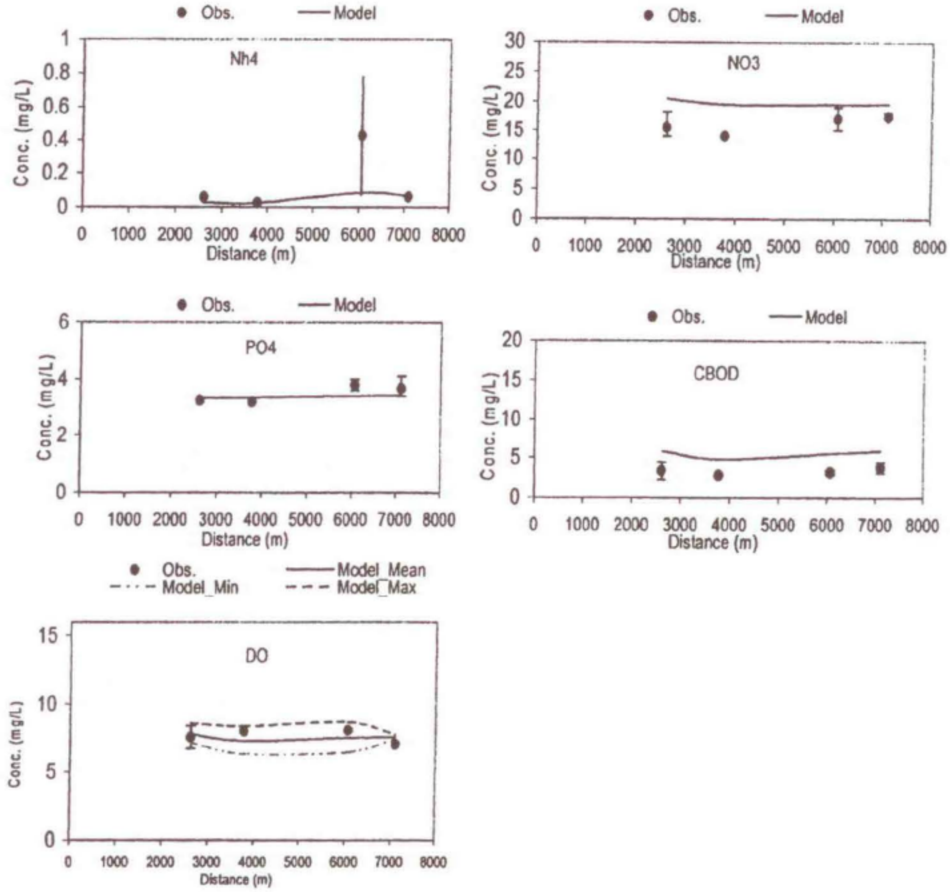

Fig. 11. Model validation for Sandy Run of Wissahickon Creek system (distances represent meters from confluence with Wissahickon Creek)

Summary and Conclusions

This paper presents an integrated hydrodynamic and water quality modeling for Wissahickon Creek and its tributaries in Pennsylvania. The modeling framework included a hydrodynamic submodel, a water quality submodel, and a linking interface between these two submodels. To enable a reasonable representation of the interactive mechanism of periphyton dynamics and diurnal DO fluctuation as observed in the basin, the existing modeling framework was enhanced with modules facilitating a more realistic representation of the processes contributing to water quality impairments within Wissahickon Creek and tributaries.

The modeling system was first configured and calibrated for low-flow conditions observed in the summer of 2002 using data collected by USGS, PA DEP, and then validated using the data collected by the NIER in 1999. Once calibrated and validated, the modeling system was configured for critical conditions to represent baseline conditions. To achieve water quality endpoints in the stream segments, multiple scenarios were modeled to account for varying discharge concentrations and conditions.

The modeling study has indicated that periphyton dynamics play an important role in impacting the DO conditions in the Wissahickon Creek system. Without the incorporated periphyton and DO diurnal simulation module, the model would not be able to reproduce the observed range of daily DO fluctuation, which is a major cause of the DO impairment. On the other hand, although periphyton resulting from the excessive nutrient in Wissahickon was identified to be an important factor responsible for the DO impairment, it was found infeasible to control the periphyton through reducing nutrient load from the point sources since under the critical condition the required reduction of phosphorus load was unreasonably high. This phenomenon has significant implication in eutrophication control for relatively small river systems where summer low flow conditions minimize the dilution effect. Thus an extremely high percentage of nutrients reduction are needed to limit any excessive primary production as well as the associated water quality impairment.

Acknowledgments

This study was sponsored by the U.S. Environmental Protection Agency, Region 3. The writers would like to thank Mark Sievers, and Katherine Labuhn at Tetra Tech, Inc. for their valuable assistance in data process and figure production.

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ATTACHMENT 5 -

PADEP Wissahickon Watershed Stakeholder Meeting, March 5, 2015

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Office of Water Management

TMDL Alternative for the Wissahickon

Wissahickon watershed stakeholder meeting

Southeast Regional Office, Norristown

March 5, 2015

Tom Wolf, Governor

John Quigley, Acting Secretary

Wissahickon TMDL alternative

[Comments]

Framing the issue:

- *We all share in the responsibility to find a way to address the Wissahickon's WQ problems.*
- *Our water quality problems are difficult because: 1) They push our science, our engineering, and our public policy to the limits of what can be done; and 2) ecology, engineering, and public policy are three disciplines that don't integrate neatly or easily with one another.*
- *Around the country, there is no single conventional way in which ecology, engineering, and public policy are woven together to make solutions to water quality problems in rivers and streams. It's done differently in different places.*
- *Federal and State law provide room for stakeholder-led processes.*

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Wissahickon TMDL alternative

- Water quality impairments documented - 1990s
- TMDL for nutrients and siltation – 2003
- Pollutant controls are being implemented, but the stream ecology has not improved.

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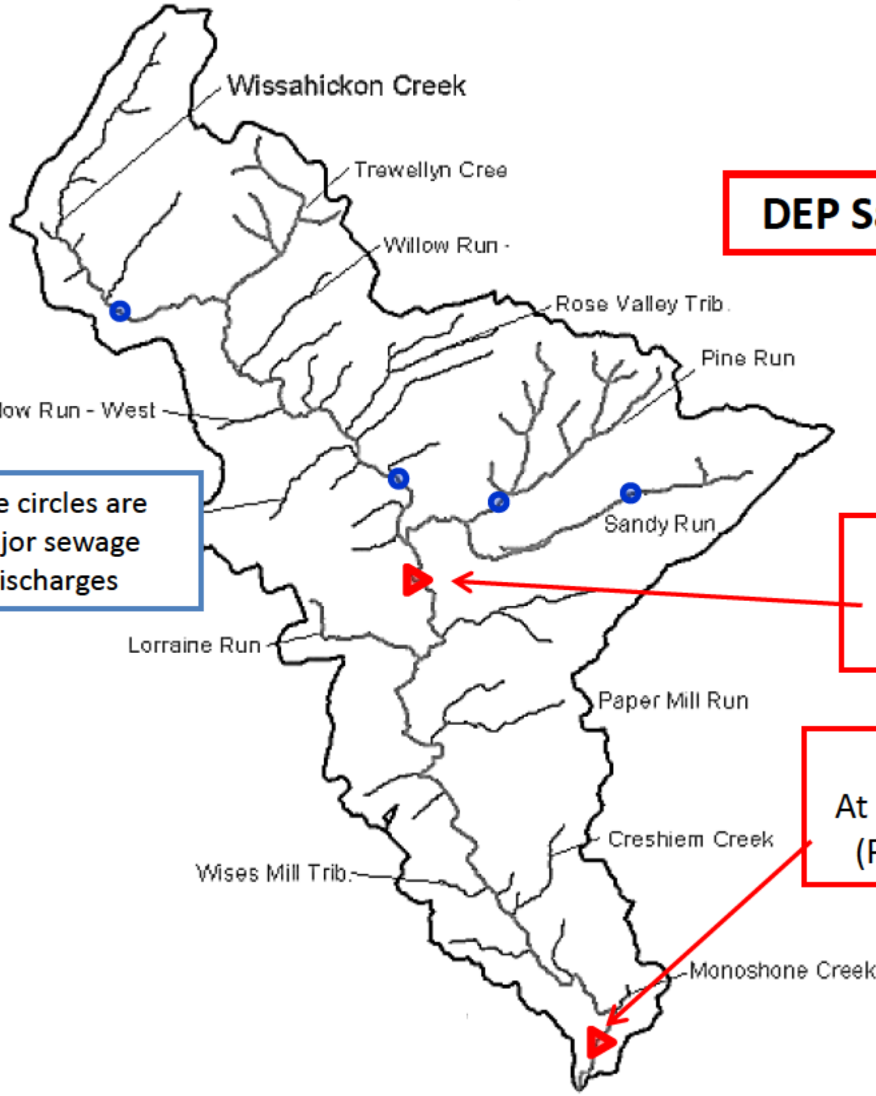
Wissahickon TMDL alternative



DEP Sampling Sites

Blue circles are major sewage discharges

WQN 193
At Route 73
(Fort Washington)

WQN 115
At Ridge Avenue
(Philadelphia)

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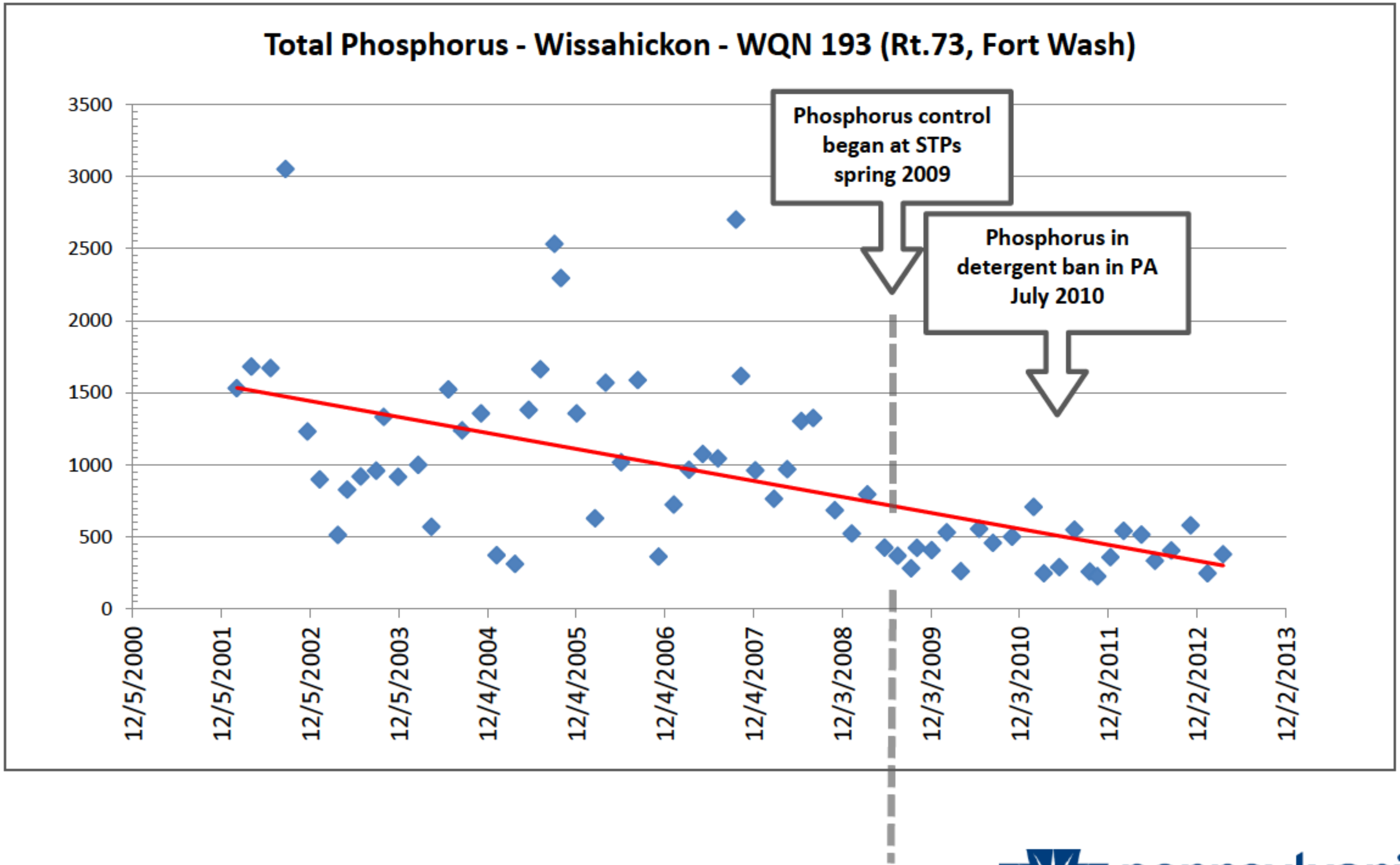
Wissahickon TMDL alternative



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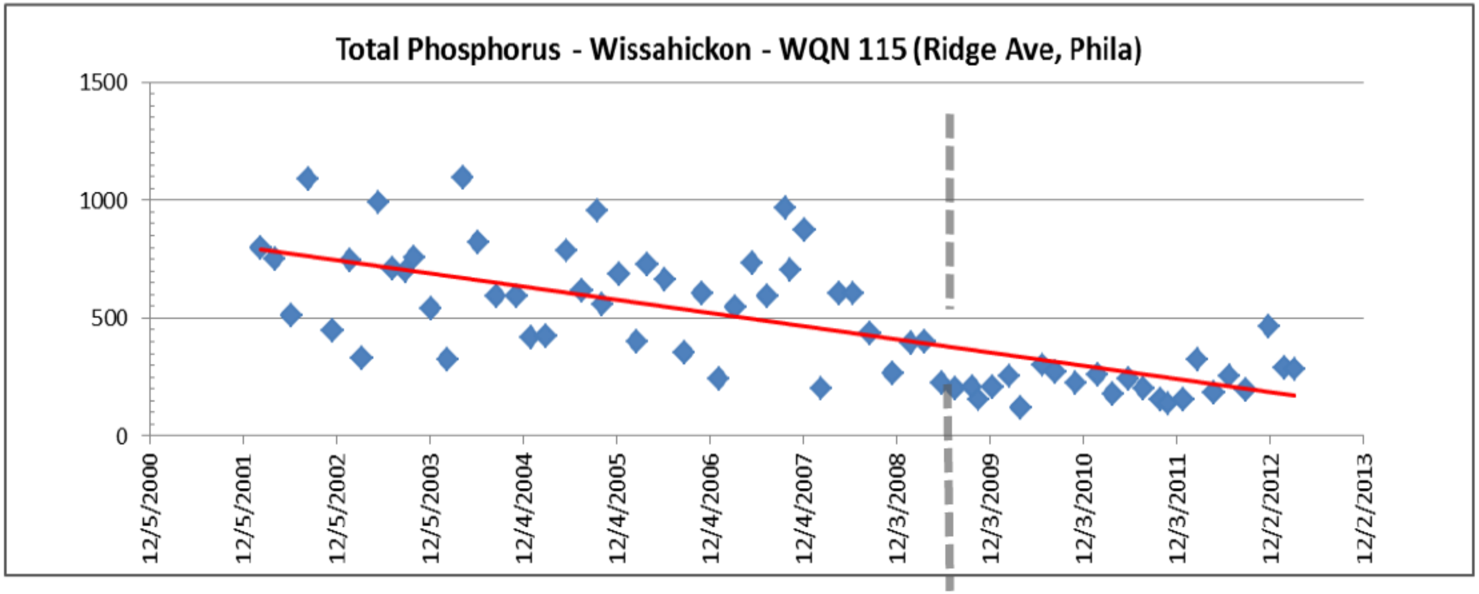
Wissahickon TMDL alternative



- Phosphorus loadings in the stream are approximately 30%-40% of what they were before 2009.

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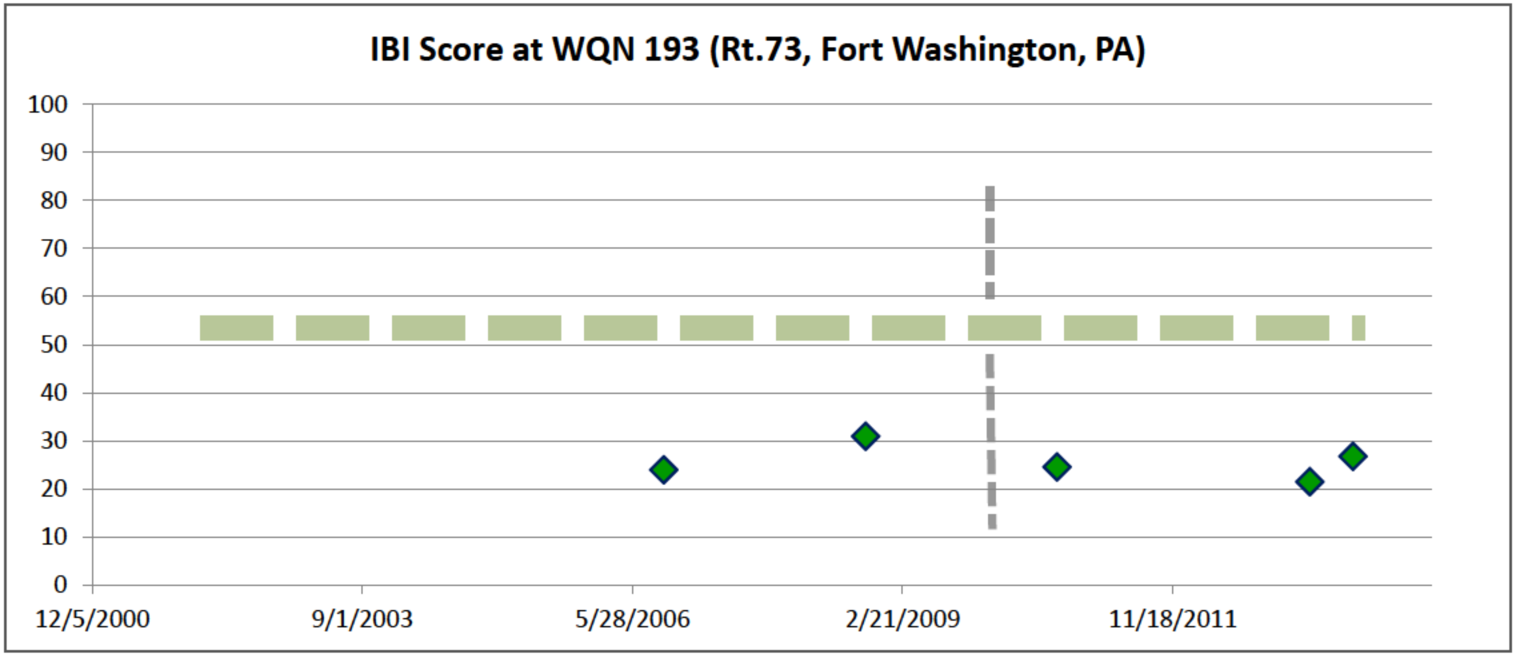
Wissahickon TMDL alternative



Bio-assessments performed since 2009 show that the stream's ecology has not improved.

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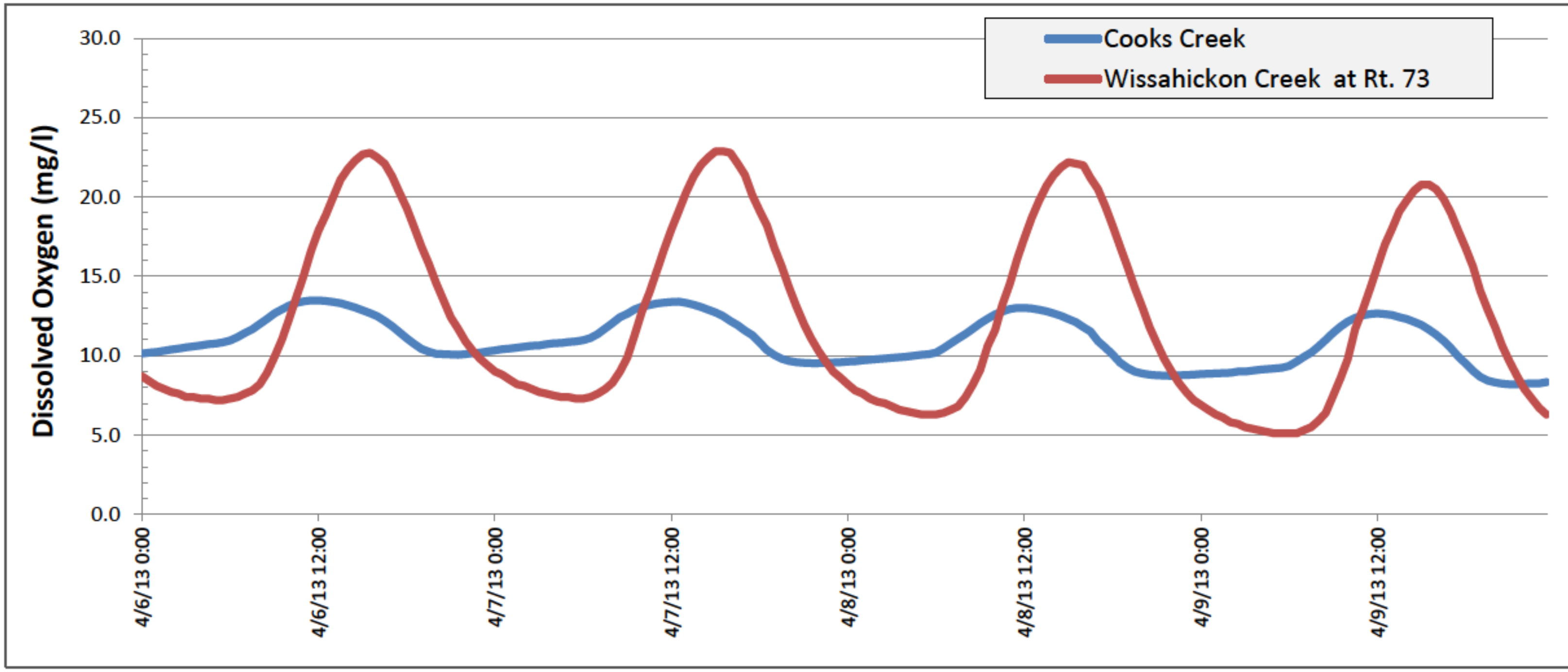
Wissahickon TMDL alternative

[Comments about previous slide]

- *Index of Biological Integrity (IBI) is a way of quantifying ecological condition. It may be the single most significant datum representing the water quality status of a stream.*
- *Each of the five data points on this graph represents an event when DEP biologists collected a macroinvertebrate sample from the stream. Stream animals were identified and counted, and various ecological metrics applied to the list of species collected. Several metrics are normalized and combined to give "IBI."*
- *IBI score of zero is a dead stream; IBI score of 80 to 100 would indicate a very healthy stream.*
- *Sites that score above 50 or 60 (depending on circumstances) would generally be determined to "attain" PA water quality standards for aquatic life use. Lower numbers would be "not attaining", or "impaired."*
- *The Wissahickon's scores indicate 1) that the stream is impaired, and 2) there is no noticeable improvement after 2009, to coincide with the observed reductions in phosphorus concentration.*

Wissahickon TMDL alternative



- Dissolved oxygen diel is amplified in the Wissahickon, compared to an unimpaired stream.

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Wissahickon TMDL alternative

[Comments about previous slide]

- *The graph presents data from continuous in-stream monitoring for Dissolved Oxygen (DO) in two different streams, for four days in April 2013.*
- *It is typical for DO to cycle up and down between nighttime and daytime. DO cycling is driven by biological and physical processes, dominated by photosynthesis and respiration of plants.*
- *The difference between these two streams is in the amplitude of the DO swings. The Wissahickon shows much greater difference between the daily maximum and the daily minimum.*
- *The Cooks Creek is a stream that is "attaining" water quality standards. It's diurnal DO pattern is normal.*
- *The Wissahickon's amplified DO swing is evidence of an oversupply of nutrients, a conditions known as "eutrophy."*

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Wissahickon TMDL alternative

- A revised nutrient TMDL is being prepared.
- Phosphorus concentrations in the stream need to be reduced further. Reductions are probably needed from all categories of sources (treated sewage, MS4s, others).
- Revised TMDL would specify the phosphorus reductions that are required.

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Wissahickon TMDL alternative

The Wissahickon Creek's water quality problems are complex. **It's not simply a phosphorus loading problem.**

- Too much benthic algae growth
- Poor macroinvertebrate community
- Altered hydrology – low base flow and flashy floods
- Altered sediment regime
- Pollutants in runoff

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Wissahickon TMDL alternative

- Factors that influence the Wissahickon's water quality impairments include
  - physical hydrology
  - sediment dynamics
  - riparian landscape conditions
  - nutrient loading (N and P)
- TMDL may not provide for all the management actions that are needed

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Wissahickon TMDL alternative

- A watershed solution would involve coordinated actions of various kinds
- Other actions will complement nutrient load reductions.
  - Stormwater improvements
  - Sediment load reductions
  - Riparian condition – buffer the streams, shade the streams

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Wissahickon TMDL alternative

The Wissahickon Watershed has some advantages:

- Stormwater management recommendations in the Act 167 Plan
- Restoration planning under way funded by private foundation
- Detailed water quality model developed for EPA

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Wissahickon TMDL alternative

Act 167 Stormwater Management Plan

- Just completed (2014)
- Contains a special section (Section 6) with specific recommendations for implementation
- Hundreds of sites identified and prioritized

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Wissahickon TMDL alternative

<u>Restoration planning</u> funded by private foundation (Wm Penn Fndtn.)

- "Upstream Suburban Philadelphia Cluster"
- Ongoing collaborative project
  - CSC (Temple U.)
  - Pennsylvania Environmental Council
  - Natural Lands Trust
  - Villanova U.
  - Wissahickon Valley Watershed Association

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Wissahickon TMDL alternative

Restoration planning funded by private foundation (Wm Penn Fndtn.)

"Upstream Suburban Philadelphia Cluster"

- Implementation Plan recommends several kinds of action
- Includes a consideration of water quality monitoring

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Wissahickon TMDL alternative

Water quality model developed for EPA

- Could be useful for planning action, and demonstrating the expected benefits of action

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Wissahickon TMDL alternative

Many of the actions recommended in the recent and ongoing restoration planning are <u>not specifically required</u> by law or regulation.

- A watershed solution could provide the **framework**, and the **system**;
- … and eventually the water quality **benefits**

Wissahickon TMDL alternative

DEP proposes …

…that the stakeholder group that was invited to this meeting today could represent a partnership …

…whose collective powers, authorities, and resources could solve the water quality problems of the Wissahickon watershed.

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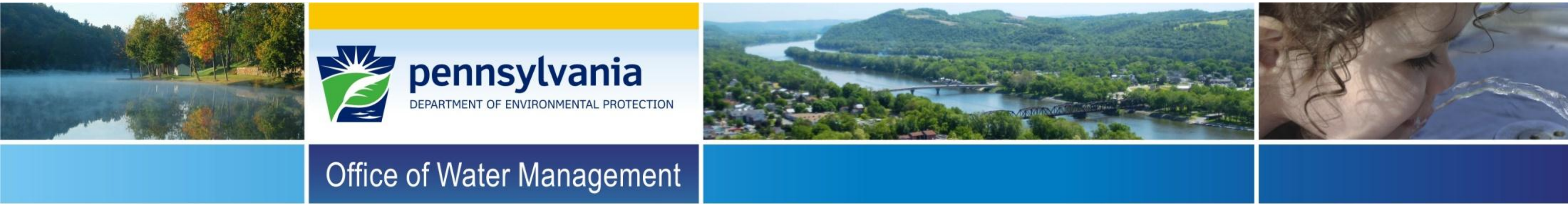


PA DEP
Southeast Regional Office
Clean Water Program
email: daburke@pa.gov

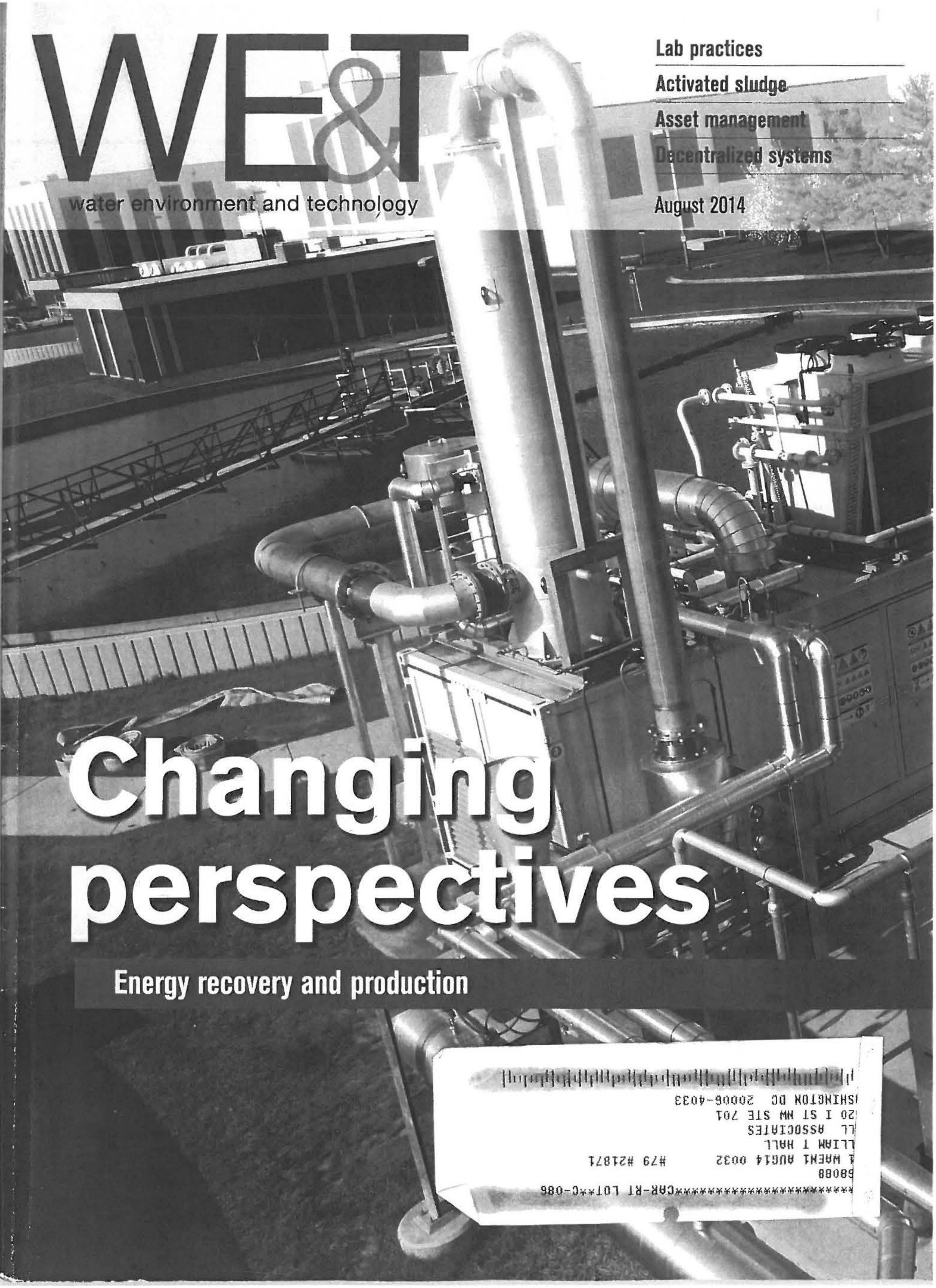
ATTACHMENT 6 –

Brent, R., R. Morland, D. Berberick, S. Davis, B. Foltz, and K. Drummond. 2014. Mercury falling. How a facility upgrade intended to reduce algae growth resulted in unintended (yet favorable) consequences. Water Environment and Technology. August 2014. 62 – 65.

WE&T

water environment and technology

August 2014



Changing perspectives

Energy recovery and production

Mercury falling

How a facility upgrade intended to reduce algae growth resulted in unintended (yet favorable) consequences

Robert Brent, Ross Morland, David Berberich, Spencer Davis, Brandon Foltz, and Kurt Drummond

While most residents generally are concerned about the health of local rivers, lakes, and estuaries, often it is difficult for them to see the immediate benefits of costly facility upgrades, especially for a waterbody more than 480 km (300 mi) downstream. The City of Waynesboro, Va., faced this challenge when it upgraded the Waynesboro Wastewater Treatment Plant in 2010 to meet newly promulgated Virginia nutrient regulations for dischargers within the Chesapeake Bay watershed.

Waynesboro, a small city of about 20,000 nestled in the foothills of Virginia's Blue Ridge Mountains, is located on the South River, which forms the headwaters of the Shenandoah–Potomac River system, a major tributary to the Chesapeake Ba

To demonstrate that nutrient reductions aimed at reducing eutrophication in the bay also could improve local water qualit the city partnered with researchers from James Madison University (JMU; Harrisonburg, Va.) to study water quality improvements to the South River throughout the upgrades. While the main objective – to reduce algal growth – was not necessarily achieved, a surprising side benefit was the possibl reduction in methylmercury accumulation within this mercury-impaired stream.

◄ Five monitoring stations were set up on the South River upstream and downstream of the Waynesboro Wastewater Treatment Plant discharge point. Dissolved oxygen, pH, conductivity, temperature, chloride, nitrate, sulfate, total phosphorus, filtered and unfiltered total mercury, and filtered and unfiltered methylmercury were measured.
Robert Brent

The need to reduce nutrients dramatically

Virginia nutrient regulations required that the water resource recovery facility (WRRF) reduce annual nitrogen loads to 22,103 kg (48,729 lb) and annual phosphorus loads to 1658 kg (3655 lb) by January 2011. This meant that the facility would need to reduce loads by 65% and 88%, respectively. To meet the new regulations, the city replaced trickling filters and rotating biological contactors with a five-stage Bardenpho biological nutrient removal (BNR) process and denitrification filters. In addition, the facility was expanded from 15,000 m^3/d (4 mgd) to accommodate a 23,000-m^3/d (6-mgd) design flow, new secondary clarifiers were constructed, disinfection was upgraded, and a solids dewatering facility was added.

The upgrades and BNR installation at the WRRF were effective, at least from a treatment perspective. Prior to the upgrades, total nitrogen levels in effluent averaged 17 mg/L, while total phosphorus levels averaged 4 mg/L. Within 1 year of the upgrades, nutrient levels dropped dramatically (see Figure 1, below). By 2011, average total nitrogen levels dropped to 1.17 mg/L, and phosphorus levels dropped to 0.12 mg/L – reductions of 93% and 97%, respectively. Annual loads similarly were reduced, and the city met Chesapeake Bay nutrient regulations with nitrogen and phosphorus loads of 4879 kg (10,756 lb) and 350 kg (771 lb), respectively, in 2011.

Upgrade effects on algal growth and mercury uptake

While the upgrades at the WRRF primarily were intended to meet Chesapeake Bay watershed goals, the upgrades likely also would improve local water quality in the South River. To quantify those improvements, JMU researchers began a water quality study in 2010 that intensively monitored the river prior to, during, and after the upgrades.

The researchers established five monitoring stations on the South River: 0.40 km (0.25 mi) upstream from the WRRF discharge and 0.2, 0.8, 2, and 16 km (0.1, 0.5, 1.2, and 10 mi) downstream from the discharge point (see Figure 2, p. 64). At each station, the following water quality parameters were measured: dissolved oxygen, pH, conductivity, temperature, chloride, nitrate, sulfate, total phosphorus, filtered and unfiltered total mercury, and filtered and unfiltered methylmercury.

In addition, the JMU team measured the growth of algae in the river and the uptake of mercury by the algae. Algal growth is a direct measure of nutrient enrichment, so algal growth rates would presumably decrease with reduced nutrient loads. There also was a possibility that nutrient reductions could affect the cycling of mercury, a long-term contaminant in the river. Legacy industrial sources had polluted the river with mercury decades ago, and sport fish, like smallmouth bass, continue to exceed safe mercury levels for human consumption.

The cycle of mercury accumulation in the river begins with inorganic mercury being transformed to the more bioavailable methylmercury form under low oxygen conditions. Methylmercury is then taken up by algae and transferred up the food chain to invertebrates, to small forage fish, and then to top predators such as smallmouth bass. Nutrient reductions in the river could raise dissolved oxygen levels and lower mercury methylation rates, resulting in lower mercury levels at each link in the South River food chain.

To measure algae growth and mercury uptake, the JMU team placed eight baskets of clean rocks at each monitoring location. Algae were allowed to colonize the rocks and grow for 6 weeks. At 2, 4, and 6 weeks of colonization, the rocks were removed and a defined area was scraped to remove the colonized algae. Algae samples were dried, weighed, and ashed at 500°C to determine biomass. A second batch of 6-week samples were scraped from the rocks and analyzed for mercury and methylmercury content.

Nutrient results

As stated earlier, the BNR upgrades were highly successful in reducing nutrients in the discharge. These reductions also affected nutrient levels in the South River (see Figure 3, p. 65). South River phosphorus levels decreased within a range of 85% to 94% downstream of the outfall. Reductions in nitrogen concentrations, however, were not as dramatic. Nitrate levels downstream of the outfall dropped in a range of 39% to 59%.

Nonpoint sources of nitrogen in the watershed explained the smaller reductions observed for instream nitrate levels. Prior to upgrades, the Waynesboro facility outfall contributed approximately

Figure 1. Nutrient reductions in Waynesboro facility discharge

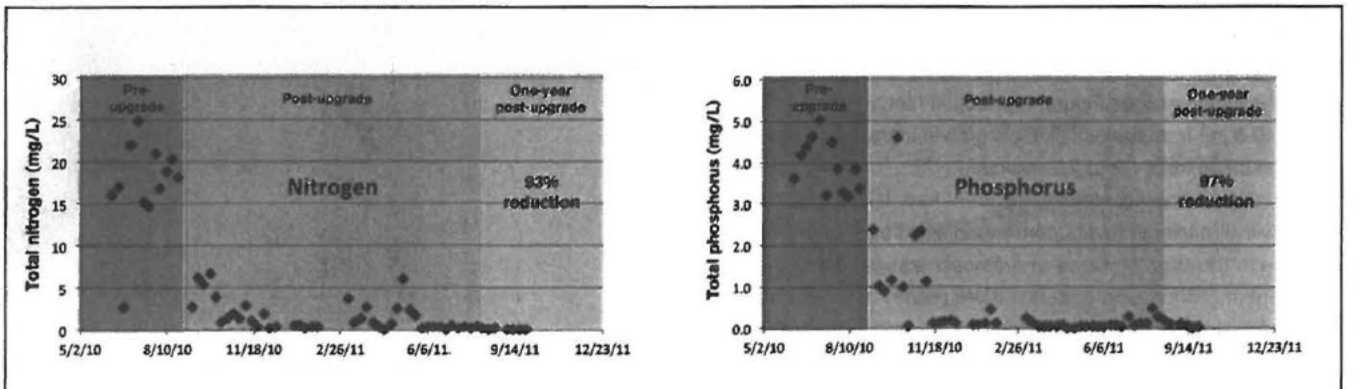
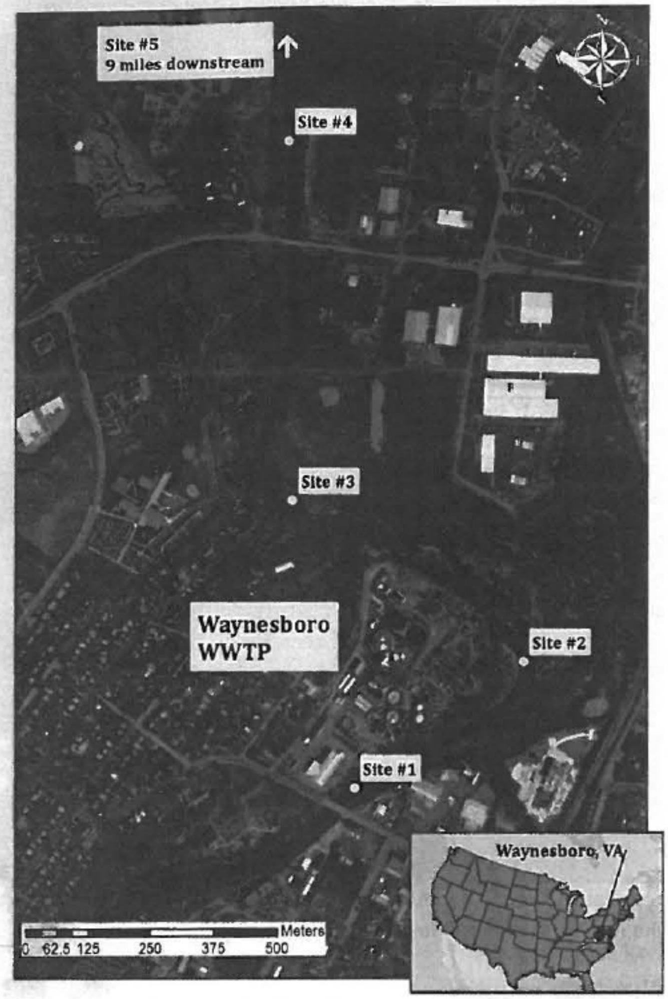


Figure 2. Location of Waynesboro monitoring sites



93% of the instream phosphorus load at that point in the South River. However, for nitrogen, the facility discharge accounted for a smaller fraction of instream loads (63%).

Other instream water quality indicators showed no consistent or significant trends resulting from the upgrades. Conductivity and temperature varied by season but were relatively unaffected by the upgrades. Chloride, sulfate, and pH were unchanged. Dissolved oxygen conditions within the river improved somewhat, but diurnal variations made it difficult to determine whether these improvements were significant and resulted from the upgrades.

Algae growth increases despite nutrient reductions

Algal growth did not decrease significantly after the upgrades at any of the locations (see Figure 4, p. 65). In fact, at one site located 0.8 km (0.5 mi) from the outfall, algal growth increased significantly, nearly doubling from 1.2 to 2.1 mg/cm^2.

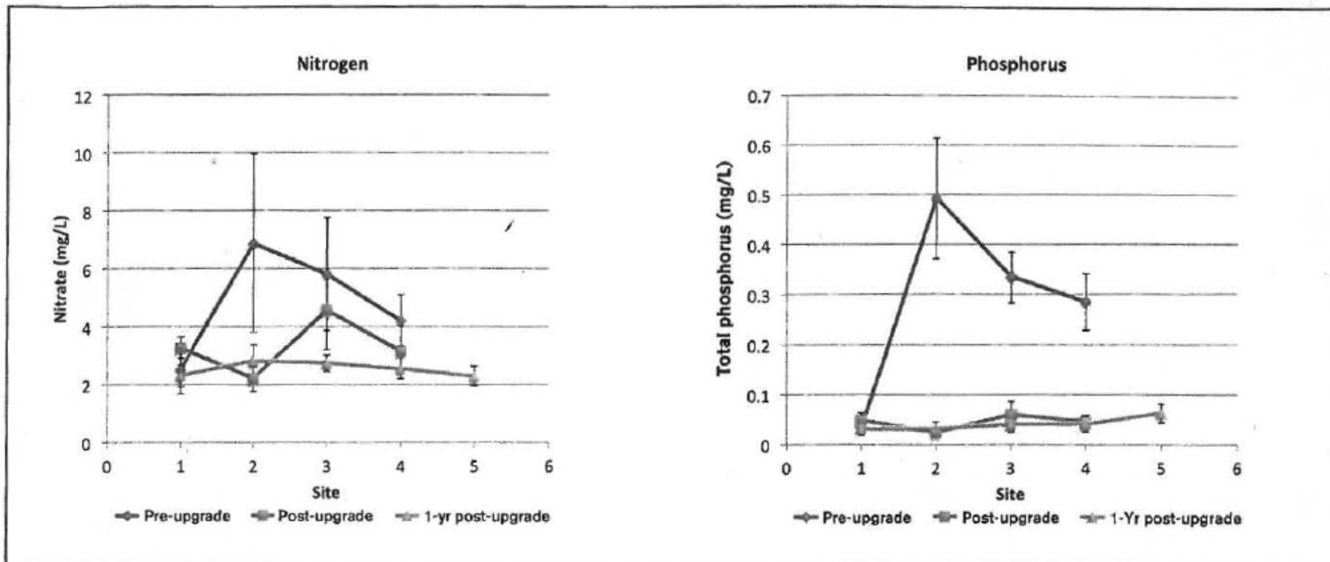
The reason was not definitively identified. It is possible that while overall nitrogen levels decreased in effluent, more reduced nitrogen in the form of nitrite or ammonia was available directly downstream. Since ammonia is a more readily available nitrogen source for algae growth than nitrate, this could have spurred algal growth for a short distance downstream until reduced forms were oxidized to nitrate.

Research assistants Brandon Foltz and Kurt Drummond sample algae on rocks from the South River. Robert Brent

The finding that algal growth had not decreased after the upgrades is interesting. The purpose of nutrient regulations in the Chesapeake Bay watershed is to reduce algae growth and improve water quality in the bay. However, even at a local scale, large nutrient reductions (greater than 90%) were not effective in limiting algae growth. Certainly, Waynesboro's lower nutrient loads will be multiplied by reductions from other point sources throughout the watershed, but the ultimate fate of the bay may rest in the hands of nonpoint nutrient sources. In the South River, even when the primary phosphorus source (Waynesboro facility) was reduced by 97% and instream levels were reduced 94%, algae growth was not reduced. This is because remaining nutrient levels in the river from point source residuals and nonpoint sources have yet to reach critical thresholds. The U.S. Environmental Protection Agency's recommended nutrient criteria for this ecoregion are 0.01 mg/L phosphorus and 0.31 mg/L nitrogen. Even after upgrades, average nitrogen levels in the South River were twice this recommendation,

Baskets of clean rocks were used to colonize algae in the South River for biomass and mercury analysis. Robert Brent

Figure 3. Nutrient reductions in the South River resulting from facility upgrades



and phosphorus levels were 3 to 4 times higher than the recommended level. To meet both local water quality goals and Chesapeake Bay watershed goals, significant help is needed from the nonpoint source community.

Mercury uptake results promising

To evaluate the effects of nutrient upgrades on mercury cycling, methylmercury concentrations in algae at each time period and location were normalized against the upstream control site (Site 1).

Normalized methylmercury concentrations in algae downstream of the Waynesboro outfall decreased significantly after the upgrades (see Figure 5, below), ranging from 44% to 81% in downstream stations. This indicates that as nutrient loads decrease, the rate of mercury methylation slows down, reducing the amount of bioavailable mercury. This added benefit, which was not intended as a part of the Waynesboro facility upgrades, may be one of the most beneficial outcomes of the upgrades.

The City of Waynesboro spent $32 million on upgrades aimed at reducing nutrients in the Chesapeake Bay. The upgrades were extremely successful in reducing nitrogen and phosphorus in the discharge and in the receiving stream, the South River. But these large nutrient reductions did not translate into reduced algal growth in the river.

Still, perhaps the most surprising finding from the study was that the nutrient reductions might help to improve mercury contamination issues in the river. Large reductions in mercury loadings from the former industrial site and the watershed will still be needed to reach safe fish consumption goals, but the effect of nutrient reductions on mercury dynamics may help to reach this goal sooner.

Robert Brent *is an associate professor at James Madison University (Harrisonburg, Va.). At the time this project was conducted,* ***David Berberich, Spencer Davis, Brandon Foltz,*** *and* ***Kurt Drummond*** *were undergraduate research assistants at James Madison University.* ***Ross Morland*** *is the coordinator at the Waynesboro Wastewater Treatment Plant for the City of Waynesboro, Va.*

Figure 4. Algae growth downstream of the Waynesboro Wastewater Treatment Plant before and after upgrades

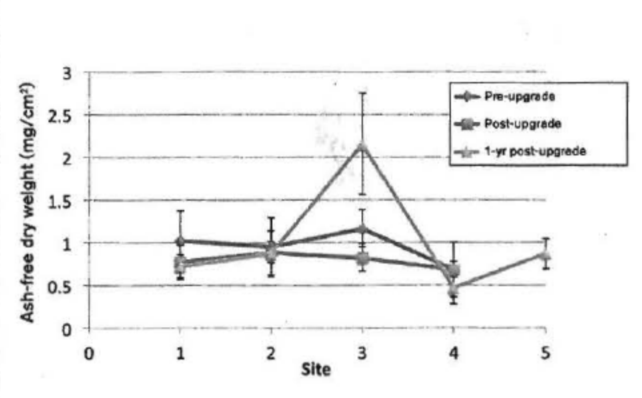
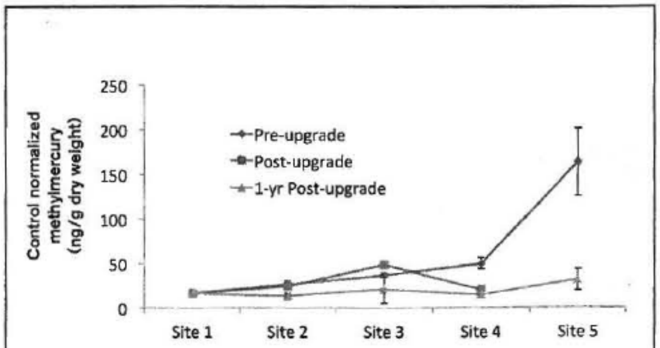


Figure 5. Mercury uptake in algae before and after upgrades



ATTACHMENT 7 –

Decision Rationale - Total Maximum Daily Load

Dissolved Oxygen and Aquatic Life Use (Benthic) Impairments in the Jackson River Alleghany, Bath, Craig and Highland Counties, Virginia, July 21, 2010

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Decision Rationale
Total Maximum Daily Load
Dissolved Oxygen and Aquatic Life Use (Benthic) Impairments in the Jackson River
Alleghany, Bath, Craig and Highland Counties, Virginia

/S/

Jon M. Capacasa, Director
Water Protection Division

Date:7/21/2010

Decision Rationale
Total Maximum Daily Load
Dissolved Oxygen and Benthic Impairments
Jackson River, Alleghany, Bath, Craig and Highland Counties, Virginia

I. Introduction

The Clean Water Act (CWA) requires that a Total Maximum Daily Load (TMDL) be developed for those waterbodies identified as impaired by a State where technology based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a Margin of Safety (MOS), which may be discharged to a water quality-limited waterbody.

This document will set forth the U.S. Environmental Protection Agency's (EPA) rationale for approving the nutrient TMDLs developed to address dissolved oxygen (DO) and benthic impairments in the Jackson River. EPA's rationale is based on the determination that the TMDLs meet the following seven regulatory conditions pursuant to 40 CFR Part 130.

1. The TMDL is designed to implement applicable water quality standards.
2. The TMDL includes a total allowable load as well as individual wasteload allocations (WLAs) and load allocations (LAs).
3. The TMDL considers the impacts of background pollutant contributions.
4. The TMDL considers critical environmental conditions.
5. The TMDL considers seasonal environmental variations.
6. The TMDL includes a MOS.
7. The TMDL has been subject to public participation.

In addition, these TMDLs provided reasonable assurance that the TMDL allocations assigned to nonpoint sources can be achieved.

II. Background

The Jackson River is part of the James River Basin, and flows through portions of Alleghany County, Bath County, Craig County and Highland County in southwestern Virginia. The watershed is 584,686 acres (916mi^2) in size, and consists primarily of forest (89.3%) and agricultural lands (8.5%). Other land uses in the watershed include water/wetlands (0.8%), developed lands (0.9%), and transitional/recreational lands (0.5%). In 1981, the Gathright Dam was installed along the Jackson River for flood control and water quality benefits. The dam is located approximately 19 miles north of the City of Covington, and regulates stream flow in the Jackson River.

An 11.21 mile segment of the Jackson River (I09R-01-DO), extending from river mile 24.21 downstream to river mile 13.00, was originally listed as impaired for DO on Virginia's

1996 Section 303(d) List. In addition, a 24.21 mile segment of the Jackson River (I09R-01-BEN), beginning at river mile 24.21 and extending to the confluence of the Jackson River and the Cowpasture River, was originally listed as impaired on Virginia's 1996 Section 303(d) List for failing to meet the aquatic life (general standard - benthic) designated use. A complete Section 305(b)/303(d) listing history for the impaired stream segments, covered under the Jackson River nutrient TMDL, is provided in Table 1.

Table 1. Section 305(b)/303(d) Listing History for Impaired Stream Segments Covered under the Jackson River Nutrient TMDL

Waterbody (Impairment)	1996-2002 303(d) ID	2004 303(d) ID	2006 303(d) ID	2008 303(d) ID	305(b) Assessment Units
Jackson River (Benthic)	*VAW-I04R	VAW-I04R-01	00458	I09R-01-BEN	VAW-I09R_JKS04A00 VAW-I09R_JKS02A00 VAW-I09R_JKS03A00 VAW-I09R_JKS01A00 VAW-I09R_JKS05A00 VAW-I09R_JKS06A00
Jackson River (DO)	*VAW-I04R	VAW-I04R-01	00280	I09R-01-DO	VAW-I04R_JKS01A00
Jackson River (Benthic)	*VAW-I04R	VAW-I04R-01	00457	I09R-01-BEN	VAW-I09R_JKS04A00 VAW-I09R_JKS02A00 VAW-I09R_JKS03A00 VAW-I09R_JKS01A00 VAW-I09R_JKS05A00 VAW-I09R_JKS06A00
Jackson River (DO)	*VAW-I04R	VAW-I04R-01	00281	I09R-01-DO	VAW-I04R_JKS01A00

*Consent Decree ID

The Jackson river is classified as a Class IV "Mountainous Zone" waterbody, as defined in Virginia's Water Quality Standards (9 VAC 25-260-50). All Class IV waters must have a minimum DO concentration of 4.0 milligrams per liter (mg/L) and a minimum daily average DO concentration of 5.0 mg/L. Data obtained from DEQ monitoring stations along the Jackson River indicate multiple violations of the minimum DO standard of 4.0 mg/L.

Additionally, all surface waters in Virginia are required to meet the Commonwealth's general water quality standard for the aquatic life designated use. VADEQ's assessment of the degree of support for the aquatic life designated use is based on the Virginia Stream Condition Index (VASCI). This index is derived from eight benthic bio-monitoring metrics, which are used to calculate a VASCI score between zero and 100. A score of 100 represents the healthiest benthic community sites. VADEQ's current Water Quality Assessment Guidance classifies "non-impaired" waters as those with a VASCI score of 60 or above, and "impaired" waters as those with a score below 60. Based upon data collected between 1994 and 2008, VASCI scores calculated at three VADEQ monitoring stations within the benthic-impaired segment of the Jackson River have been consistently below 60.

Although biological assessments are indicative of the impacts of pollution, the specific pollutant(s) and source(s) are not necessarily known based on biological assessments alone. Accordingly, a stressor analysis was performed to identify the most probable stressor(s) to the benthic community. In the Jackson River, excessive periphyton growth and accumulation was identified as the most probable stressor. The stressor analysis concluded that high nutrient concentrations in the Jackson River stimulate excessive periphyton growth, leading to eutrophic conditions, high organic loading, and decreased dissolved oxygen concentrations. Consequently, TMDLs for Total Phosphorus (TP) and Total Nitrogen (TN) were developed to limit nutrient loadings in the water. These TMDLs will address both the benthic and dissolved oxygen impairments. Tables 2 and 3 summarize the annual and daily TP and TN TMDLs for the Jackson River.

Table 2. Annual Phosphorus and Nitrogen Loads for the Jackson River Nutrient TMDLs

Pollutant	WLA (lbs/growing season*)	LA (lbs/growing season)	MOS (lbs/growing season)	TMDL (lbs/growing season)
Total Phosphorus	72,955	2,880	Implicit	75,835
Total Nitrogen	220,134	24,160	Implicit	244,294

*Growing Season = June 1st – October 31st

Table 3. Daily Phosphorus and Nitrogen Loads for the Jackson River Nutrient TMDLs

Pollutant	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
Total Phosphorus	476.8	18.8	Implicit	495.6
Total Nitrogen	1,438.8	157.9	Implicit	1596.7

The TMDL Report also recommends that the existing flow schedule for the Gathright Dam be modified to restore natural stream flow variability in the Jackson River. The flow augmentation study, insuring that the Virginia aquatic life standards will be met, is being implemented and finalized through an Army Corps of Engineers (USACE) §216 study.

This TMDL was developed by the VADEQ as part of a 1999 Consent Decree commitment between EPA, the American Canoe Association and the American Littoral Society. The U.S. Fish and Wildlife Service has been provided with a copy of the TMDL Report.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all seven of the basic requirements for establishing nutrient TMDLs for the Jackson River. Additionally, Virginia provided reasonable assurance that the TMDL allocations assigned to nonpoint sources can be achieved. EPA is therefore approving the TMDL. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Dissolved Oxygen

The Jackson river is classified as a Class IV "Mountainous Zone" waterbody, as defined in Virginia's Water Quality Standards (9 VAC 25-260-50). Virginia's water quality criterion for DO in Class IV waters is a minimum concentration of 4.0 mg/l and a minimum daily average concentration of 5.0 mg/l. Data obtained from DEQ monitoring stations along the Jackson River indicate multiple violations of the minimum DO standard of 4.0 mg/L, as indicated in Section 3.2.1.1 of the TMDL Report.

General Standard - Benthic

Virginia State law 9VAC25-260-10 (Designation of uses) indicates:

All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.

The General Standard**,** as defined in Virginia State law 9 VAC 25-260-20, states:

State waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.

The General Standard is implemented and assessed by VADEQ through application of the VASCI. Since 2008, VADEQ has used the VASCI to measure and classify the health of benthic macroinvertebrate communities. The biological assessments conducted on the Jackson River indicate that some pollutant(s) is interfering with attainment of the General Standard. Using data collected between 1994 and 2008, VASCI scores calculated at three VADEQ monitoring stations within the benthic-impaired segment of the Jackson River have been consistently below 60, as indicated in Tables 3-5 of the TMDL Report.

The process outlined in EPA's Stressor Identification Guidance was used to identify the most probable benthic stressor(s) for the Jackson River. A list of potential stressors was developed and evaluated based upon available monitoring data, field observations, and consideration of potential sources in the watershed. In the Jackson River, excessive periphyton growth and accumulation was identified as the most probable stressor to the benthic community. Periphyton are a type of algae that grow on the bottom of stream beds and represent the dominant type of algal biomass in riverine ecosystems. In addition to contributing to high organic loading, excessive periphyton can also impair benthic macroinvertebrate assemblages by covering the interstitial spaces between rocks and cobble that provides habitat for many types of macroinvertebrates. The stressor analysis therefore concluded that high nutrient concentrations in the Jackson River stimulate excessive periphyton growth, leading to eutrophic conditions, high organic loading, and decreased dissolved oxygen concentrations. Consequently, TMDLs for TN and TP were developed to limit nutrient loadings that will address both the dissolved oxygen and benthic impairments in the Jackson River.

As part of TMDL development, a numeric endpoint for nutrients was developed to represent the water quality goal that is to be achieved through implementation of the TMDL. Virginia currently does not have numeric water quality standards for nutrients, therefore an alternative approach for determining the nutrient endpoint for this TMDL was utilized.

To determine the nutrient TMDL endpoint, an appropriate level of benthic chlorophyll *a* – a photosynthetic pigment in algae that is frequently used as an indicator of algal biomass – was selected that was deemed amenable to restoring the benthic community in the Jackson River. A literature review revealed that chlorophyll *a* levels in streams that range from 100-150 milligrams per square meter (mg/m^2) are considered excessive. Consequently, a chlorophyll *a* level of 100 mg/m^2 was selected as the chlorophyll *a* TMDL endpoint for the Jackson River.

In addition, the selected chlorophyll *a* TMDL endpoint of 100 mg/m^2 was used to calculate corresponding nutrient concentrations and TMDL endpoints. Using extensive monitoring data collected between 2000 and 2002, an empirical regression analysis was performed to identify the concentrations of total dissolved nitrogen (TDN) and orthophosphorus (PO_4-P) that corresponded to a chlorophyll *a* concentration of 100 mg/m^2. The regression analysis demonstrated that orthophosphorus explains approximately 60 percent of the variation in benthic biomass in the Jackson River, therefore only PO_4-P was used to develop the nutrient TMDL endpoint. The regression analysis also indicated that an average PO_4-P concentration 0.038 milligrams per liter (mg/L) corresponds to an average chlorophyll *a* concentration of 100 mg/m^2. Accordingly, a PO_4-P concentration of 0.038 mg/L was selected as the nutrient TMDL endpoint for the Jackson River. Table 4 provides the TMDL endpoints for chlorophyll *a*, PO_4-P, and the corresponding TN:TP ratio for each endpoint. Additional details on the methodology used to calculate the TMDL endpoints is provided in section 5.0 of the TMDL report.

Table 4. TMDL Endpoints and N:P Ratios for the Jackson River Nutrient TMDLs

PO_4-P TMDL Endpoint	Chlorophyll *a* TMDL Endpoint	N:P Ratio
0.038 mg/L	100 mg/m^2	11.7

A combination of two models was used in the development of the Jackson River nutrient TMDLs. EPA's Water Quality Simulation Program Version 7.2 (WASP7.2) was used to simulate and allocate nutrient loads to point sources. WASP7.2 includes a euthrophication module that was used to represent nitrogen and phosphorus cycling, dissolved oxygen-organic matter interactions, as well as phytoplankton and periphyton kinetics in the Jackson River watershed. The model was calibrated and validated using extensive monitoring data collected from 2000 through 2001, a period during which the Jackson River experienced the most excessive periphyton growth on record.

In addition, a modified version of the Hydrological Simulation Program -- FORTRAN (HSPF), developed by EPA specifically for the Chespeake Bay watershed, was used to simulate and allocate nutrient loads to nonpoint sources in the Jackson River watershed. HSPF is a continuous, physically-based, lumped-parameter model which simulates hydrology, sediment, and chemical pollutants in soil and in streams. HSPF also includes a nutrient simulation module that was used to calculate nutrient loads from a variety of different land use types. The model was calibrated using monitoring data collected from 1985 through 1999, and was validated against data collected from 2000 through 2003.

The results of the modeling indicate that the selected PO_4-P endpoint of 0.038 mg/L and the corresponding chlorophyll *a* target of 100 mg/m^2 cannot be reached in the Jackson River with nutrient reductions alone. This is due to the fact that the Jackson River is not a free flowing river, and also due to the fact that MeadWestvaco, the main nutrient contributor to the Jackson River, has reached its limits of technology in terms of phosphorus reductions. The remaining option that will help the Jackson River achieve the TMDL endpoints and a healthy, balanced biologic community is to mimic the natural hydrology and flows that existed before the operation of the Gathright Dam.

Since it is unlikely that the pre-Gathright Dam hydrologic regime will be fully re-established, VADEQ proposed that flow be periodically released from the dam to provide periphyton scouring that will help reach the identified TMDL endpoints. Consequently, in October 2007, VADEQ, in cooperation with MeadWestvaco, the Philadelphia Academy of Natural Sciences (ANS) and the USACE implemented and developed a flow release study on the Gathright Dam. The primary objective of the study was to assess the level of periphyton biomass scouring resulting from flow augmentation. The other objective was to identify the number and level of the flow pulses that can be technically feasible. The flow pulse study indicated that the flow releases from the Gathright Dam will help the Jackson River meet the identified endpoints, and recommended that six flow pulses of 3,000 cubic feet per second (cfs) be performed during the growing season.

To demonstrate that the proposed flow releases will help restore the benthic community in the Jackson River, modeling scenarios were developed which indicated that the recommended flow pulses, combined with the nutrient reductions required by the TMDLs, will result in an average chlorophyll *a* level of 101 mg/m^2 in the main stem of the Jackson River. This is comparable to the chlorophyll *a* TMDL endpoint of 100 mg/m^2 and will allow the Jackson River meet the aquatic life use.

Before the flow releases recommended in the 2007 flow-pulse study can be permanently implemented, a USACE §216 study must be completed to assess the feasibility and evaluate the environmental impact of flow augmentation in the Jackson River during the growing season. The primary focus of the study will be directed to fine tuning the water release procedures from Gathright Dam during low flow conditions by incorporating new techniques, such as pulsing, to better mimic natural stream conditions that occurred before the dam existed. The USACE and VADEQ have signed an official agreement to fund the §216 study and insure that the flow augmentation study will be implemented and completed within the next three years. In addition**,** a Feasibility Cost Sharing Agreement between the USACE Norfolk District and the Commonwealth of Virginia, the study's local sponsor, was executed in December 21, 2009. A Project Management Plan was also approved outlining all the steps necessary to complete the §216 study, and memorandums of understanding were executed between VADEQ, MeadWestvaco and the Virginia Department of Game and Inland Fisheries for the development of a monitoring Quality Assurance Project Plan and the development of the monitoring plan itself.

2) The TMDL includes a total allowable load as well as individual wasteload allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to nonpoint and point sources. Tables 2 and 3 in this Decision Rationale provide the total allowable loads for TP and TN in the Jackson River, calculated on an annual and daily basis.

Wasteload Allocations

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR §122.44(d)(1)(vii)(B), "the permitting authority shall ensure that … effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR §130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

In the nutrient TMDLs for the Jackson River, there are a total of 31 permitted nutrient point sources, including five industrial facilities that currently hold individual Virginia Pollutant Discharge Elimination System (VPDES) permits, eight municipal facilities with individual VPDES permits, three Domestic Sewage facilities covered under a VPDES general discharge permit, and 15 facilities covered under a VPDES general stormwater permit. Annual point source WLAs were developed consistent with EPA's guidelines for future nutrient discharges to the Chesapeake Bay, as explained in Section 7.4.2 of the TMDL Report, and were calculated by multiplying the design flow or calculated runoff and the permitted concentration of TP and TN for each facility. Since the Jackson River is dominated by point source loads with relatively constant discharge flows, the daily WLAs were calculated by dividing the annual WLAs by 153 (the number of days in a growing season). WLAs for the 15 facilities covered under a VPDES general stormwater permit were expressed as an aggregate. Tables 4 and 5 provide breakdowns of the WLAs for the Jackson River TP and TN TMDLs, respectively.

Table 5. Wasteload Allocations for Permitted Point Sources in the Jackson River Total Phosphorus TMDL

NPDES ID	NPDES Name	Pollutant	Annual WLA (lbs/growing season*)	Daily WLA (lbs/day)
VA0003646	MeadWestvaco Packaging Resource Group	TP	66,991.0	437.85
VA0025542	Covington City STP	TP	1,914.0	12.51
VA0027979	Alleghany County - Low Moor STP	TP	440.0	2.88
VA0090671	Alleghany County Lower Jackson River WWTP	TP	1,659.0	10.84
VA0003450	Applied Extrusion Technologies	TP	178.4	1.17
VA0006076	Clifton Forge Water Treatment Plant	TP	8.9	0.06
VA0003344	CSX Transportation Inc - Clifton Forge	TP	4.5	0.03
VA0091324	DGIF Paint Bank Fish Cultural Station	TP	517.3	3.38
VA0088544	Boys Home Inc STP	TP	305.8	2.00
VA0032115	Morris Hill STP	TP	191.1	1.25
VA0088552	Sponaugle Subdivision	TP	203.9	1.33
VA0090646	Tanglewood Manor Home for Adults	TP	229.3	1.50
VA0075574	VDOT I-64 Rest Area - Alleghany County	TP	191.1	1.25
VAG402026	Rothe, Martin Residence	TP	13.0	0.08
VAG402094	Shirley Residence	TP	13.0	0.08
VAG402098	Rogers Residence James O and Iris L	TP	13.0	0.08
15 Stormwater General Permits (Aggregate WLA)		TP	82.0	0.54
VAR102964	Kim Stan Landfill Superfund Site			
VAR050759	Alleghany Asphalt Plant - Lowmoor			
VAR050765	Bennett Lodging and Lumber Inc			
VAR050713	Bradley Saw Mill			
VAR051383	Clifton Forge Water Treatment Plant			
VAR051361	Covington Wastewater Treatment Plant			
VAR050182	General Chemical LLC			
VAR050408	Kestersons Used Parts			
VAR050415	Lear Corp - Covington			
VAR050440	Martin Coal Corp - Coal Handling Facility Inc			
VAR051392	Peters Mountain Landfill			
VAR050393	Westvaco - Low Moor Converting Plant			
VAG840047	Boxley Materials Company - Alleghany Plant			
VAG842020	Boxley Materials Company - Alleghany Plant			
VAG110170	Cliftondale Redi Mix			
Total			**72,955**	**476.8**

*Growing Season = June 1st – October 31st

Table 6. Wasteload Allocations for Permitted Point Sources in the Jackson River Total Nitrogen TMDL

NPDES ID	NPDES Name	Pollutant	Annual WLA (lbs/growing season*)	Daily WLA (lbs/day)
VA0003646	MeadWestvaco Packaging Resource Group	TN	165,245.0	1080.03
VA0025542	Covington City STP	TN	22,968.0	150.12
VA0027979	Alleghany County - Low Moor STP	TN	5,359.0	35.03
VA0090671	Alleghany County Lower Jackson River WWTP	TN	19,906.0	130.10
VA0003450	Applied Extrusion Technologies	TN	395.0	2.58
VA0006076	Clifton Forge Water Treatment Plant	TN	19.7	0.13
VA0003344	CSX Transportation Inc - Clifton Forge	TN	9.9	0.06
VA0091324	DGIF Paint Bank Fish Cultural Station	TN	1,145.4	7.49
VA0088544	Boys Home Inc STP	TN	1,223.1	7.99
VA0032115	Morris Hill STP	TN	764.4	5.00
VA0088552	Sponaugle Subdivision	TN	815.4	5.33
VA0090646	Tanglewood Manor Home for Adults	TN	917.3	6.00
VA0075574	VDOT I-64 Rest Area - Alleghany County	TN	764.4	5.00
VAG402026	Rothe, Martin Residence	TN	51.0	0.33
VAG402094	Shirley Residence	TN	51.0	0.33
VAG402098	Rogers Residence James O and Iris L	TN	51.0	0.33
15 Stormwater General Permits (Aggregate WLA)		TN	448.0	2.93
VAR102964	Kim Stan Landfill Superfund Site			
VAR050759	Alleghany Asphalt Plant - Lowmoor			
VAR050765	Bennett Lodging and Lumber Inc			
VAR050713	Bradley Saw Mill			
VAR051383	Clifton Forge Water Treatment Plant			
VAR051361	Covington Wastewater Treatment Plant			
VAR050182	General Chemical LLC			
VAR050408	Kestersons Used Parts			
VAR050415	Lear Corp - Covington			
VAR050440	Martin Coal Corp - Coal Handling Facility Inc			
VAR051392	Peters Mountain Landfill			
VAR050393	Westvaco - Low Moor Converting Plant			
VAG840047	Boxley Materials Company - Alleghany Plant			
VAG842020	Boxley Materials Company - Alleghany Plant			
VAG110170	Cliftondale Redi Mix			
Total			**220,134**	**1,438.8**

*Growing Season = June 1st – October 31st

Load Allocations

According to Federal regulations at 40 CFR §130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

The LA portion of the Jackson River nutrient TMDLs represent the contributions from all nonpoint sources. The nonpoint sources modeling, presented in Section 6.0 of the TMDL report, resulted in an average PO_4-P load during the growing season of 1,930 lbs. This corresponds to a

TP load of 2,880 lbs during the growing season. Similarly the modeling resulted in a total nitrogen load of 24,160 lbs during the growing season. No reductions are applied to the nonpoint source loads.

3) The TMDLs consider the impacts of background pollution.

Natural background was included as a component of the LAs for the Jackson River nutrient TMDLs. The LAs were developed using the calibrated EPA Chesapeake Bay Watershed Model HSPF, where the nutrient loads include the naturally occurring as well as human-induced contributions. The model was calibrated to water quality data that represents the cumulative impact from both naturally-occurring and human-induced sources.

4) The TMDLs consider critical environmental conditions.

According to EPA's regulation 40 CFR §130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the Jackson River is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[1]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst case" scenario condition. For example, stream analysis often uses a low flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The nutrient TMDLs for the Jackson River considered critical conditions because all of the allocations were developed during the periphyton growing season spanning June to October. The growing season is the most critical time in the Jackson River where conditions such as low flow and high temperature are most favorable to periphyton growth.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

The Jackson River nutrient TMDLs considered seasonal environmental variations by linking two dynamic/continuous models: HSPF and WASP. These two models explicitly account for seasonal variations in hydrology, climatic conditions, and watershed activities in order to establish the TMDL allocations. Therefore, the development of the Jackson River

[1]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

benthic TMDL effectively considered seasonal environmental variations.

6) The TMDLs include a Margin of Safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit; built into the modeling process by using conservative modeling assumptions, or explicit; taken as a percentage of the WLA, LA, or TMDL.

An implicit MOS was used for the Jackson River Nutrient TMDLs by using conservative target-setting assumptions. As described in Section III(1) of this decision rationale, benthic chlorophyll levels in streams ranging from 100-150 mg/m^2 are considered excessive and at nuisance level. The Jackson River TMDL uses a conservative periphyton target of 100 mg/m^2, which is the low-end of the recommended non-impaired periphyton range of 100-150 mg/m^2. Therefore, the TMDL target in this TMDL is conservative.

7) The TMDL has been subject to public participation.

EPA requires that TMDLs be subject to public participation. Public participation was included throughout the development of the Jackson River TMDL, as explained in Chapter 8.0 of the TMDL report. An initial public meeting was held to inform the public of the TMDL effort on September 28, 2006. Once a draft of the TMDL was available, a second public meeting was held on March 4, 2010, to solicit public comment on the draft. A thirty-day comment period was also initiated. No written responses were received during the comment period.

IV. Discussion of Reasonable Assurance

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, EPA Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

As indicated in Section III (2) of this Decision Rationale, no reductions were applied to the existing nonpoint source nutrient loads in the Jackson River watershed. Therefore, no reasonable assurance is required for the load allocations prescribed by the TMDLs.

The issuance of an NPDES permit(s) provides the reasonable assurance that the wasteload allocations prescribed by the TMDLs will be achieved. This is because 40 CFR §122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with "the assumptions and requirements of any available wasteload allocation" in an approved TMDL. Virginia will utilize the VPDES program, which typically includes consideration of Virginia’s 1997 Water Quality Monitoring, Information and Restoration Act requirements during the permitting process, to implement the WLA portion of the TMDLs.

USACE Section 216 Study

The Jackson River TMDL is recommending the existing flow augmentation schedule for the Gathright Dam be modified to restore natural stream flow variability. The proposed flow release modification is intended to remediate current water quality problems by simulating or mimicing natural storm events, particularly during the critical growing period of the periphyton. The TMDL modeling and monitoring studies have demonstrated pulses during critical periods can and do scour and flush excess periphyton downstream. This action results in improved biological communities in the river below Covington. Therefore, this TMDL is unique because implementation will require an increase in flow in the main stem of the Jackson River. The flow augmentation study, insuring that the Virginia aquatic life standards will be met, is being implemented and finalized through a Section 216 study authorized by Section 216 of the River and Harbor and Flood Control Act of 1970 (Public Law 91-611), dated 31 December 1970, which states:

> *"The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."*

The overall purpose of the flow augmentation feasibility study is to ensure the timely and economical completion of a quality Feasibility Report that will review the existing conditions of the Gathright Dam and Lake Moomaw Federal project to determine if any changes to release procedures would significantly enhance habitat and benefit water quality downstream of the project on the Jackson River to the confluence with the head of the James River. The primary focus of the study will be directed to fine tuning the water release procedures during low flow conditions by incorporating new techniques, such as pulsing, to better mimic natural stream conditions that occurred before the project existed. These release modifications shall be developed to protect the in-lake fishery and downstream fisheries. Habitat enhancement shall address benthic organisms, siltation, and water quality. The Feasibility Study shall be fully consistent with and in support of the goals, mandates, and direction of the Chesapeake Bay Agreement and other pertinent State and Federal statutes and initiatives.

There is a reasonable assurance that the §216 study will be implemented through a flow augmentation in the main stem of the Jackson River leading to the attainment of the identified endpoint. The USACE and the VADEQ entered and signed an official agreement funding the §216 study which ensures that the flow augmentation study will be implemented and completed in the next three years. Further, a Feasibility Cost Sharing Agreement between the USACE Norfolk District and the Commonwealth of Virginia, the study's local sponsor, was executed in December 21, 2009. A Project Management Plan was also approved which outlines the steps necessary for the completion of the 216 study. Additionally, memorandums of understanding were executed between VADEQ, MeadWestvaco and the Virginia Department of Game and Inland Fisheries for the development of a monitoring Quality Assurance Project Plan and the coordination of the monitoring plan itself.

ATTACHMENT 8 –

FOIA EPA-HQ-009040 Request, Response and Email Chain

HALL & ASSOCIATES

Suite 701
1620 I Street, NW
Washington, DC 20006-4033
Telephone: (202) 463-1166 Web: http://www.hall-associates.com Fax: (202) 463-4207

Reply to E-mail:
aenglish@hall-associates.com

July 31, 2014

Via FOIA Online

National Freedom of Information Officer
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW (2822T)
Washington, DC 20460
Facsimile: (202) 566-2147

Re: Freedom of Information Act Request for Records Concerning the Categorization of Diurnal Variation in Dissolved Oxygen as an Impairment of Water Quality

To Whom This May Concern:

This is a request for a public records pursuant to the Freedom of Information Act ("FOIA"), 5 U.S.C. Section 552, as implemented by the Environmental Protection Agency ("EPA") at 40 C.F.R. Part 2. For purposes of this request, the definition of "records" includes, but is not limited to, documents, letters, memoranda, notes, reports, e-mail messages, policy statements, data, technical evaluations or analysis, and studies.

Background

The EPA, pursuant to Section 304(a) Clean Water Act, 33 U.S.C. § 1314(a) ("CWA" or the "Act"), has determined that, in order to be protective of public and ecological health, Dissolved Oxygen ("DO") concentration levels must be above a certain instantaneous minimum, 7-day mean and 7-day mean minimum, as set forth in Tables 1-3 of "Quality Criteria for Water 1986," EPA 440/5-86-001 (the "Gold Book"). The actual DO level suggested varies depending on whether the water body in question is a cold water or warm water habitat, whether the concentration is measured in the water column or intergravel, and, in salmonid waters, the life stage meant to be protected. *Id.* However, recently, EPA has indicated in several forums that a nutrient or aquatic life use impairment may be identified based solely on the degree of the DO variation occurring, even where the aforementioned minimum DO concentrations are being met.

Request

This request seeks any records which are the basis for EPA's assertion that diurnal DO variation, by itself, causes aquatic life impairment, including any public notices that EPA has reached this conclusion under Section 304(a) of the Act. In particular, this FOIA response should identify the scientific studies that form the basis for EPA's position and explain the degree of diurnal DO variation that may be expected to cause use impairment, even when DO levels do not fall below the minimum concentrations specified in the Gold Book.

***

Please contact the undersigned if the associated search and duplication costs are anticipated to exceed $250.00. Please duplicate the records that are responsive to this request and send it to the undersigned at the above address. If the requested record is withheld based upon any asserted privilege, please identify the basis for the non-disclosure.

If you have any questions regarding this request, please do not hesitate to contact this office so as to ensure that only the necessary document is duplicated.

Respectfully,

Alexander J. E. English
Hall & Associates
1620 I St., NW
Washington, DC 20006-4033
(202) 463-1166
aenglish@hall-associates.com

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 1 2 2014

OFFICE OF WATER

Alexander J.E. English
Hall & Associates
1620 I Street, NW
Washington, D.C. 20006-4033

Re: Freedom of Information Act Request EPA-HQ-009040

Dear Mr. English:

This letter is in response to the Freedom of Information Act (FOIA) request for public records concerning the Categorization of Diurnal Variation in Dissolved Oxygen (DO) as an Impairment to Water Quality from Hall and Associates, dated July 31, 2014, which asserts that "the Environmental Protection Agency (EPA) has indicated in several forums that a nutrient or aquatic life use impairment may be identified based solely on the degree of DO variation, even where the aforementioned minimum DO concentrations are being met." The request seeks "any records which are the basis for EPA's assertion that diurnal DO variation, by itself, causes aquatic life impairment, including any public notices that EPA has reached this conclusion under Section 304(a) of the Act. In particular, this FOIA response should identify the scientific studies that form the basis for EPA's position and explain the degree of diurnal DO variation that may be expected to cause use impairment, even when DO levels do not fall below the minimum concentrations specified in the Gold Book."

Enclosed you will find a submission of the responsive records for the EPA. This response includes pertinent language from the 1986 document entitled "Quality Criteria for Water" (EPA 440/5-86-001), available at *http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/upload/2009_01_13_criteria_goldbook.pdf*). These records are identified as Attachment 1.

You may appeal this response to the National Freedom of Information Officer, U.S. EPA, FOIA and Privacy Branch, 1200 Pennsylvania Avenue, NW (2822T), Washington DC 20640 (US Postal Service Only), FAX: (202)566-2147, Email: hq.foia@epa.gov. Only items mailed through the United States Postal Service may be delivered to 1200 Pennsylvania Avenue, NW. If you are submitting your appeal via hand delivery, courier service, or overnight delivery, you must address your correspondence to 1301 Constitution Avenue, NW, Room 6416J, Washington, DC, 20004. Your appeal must be made in writing, and it must be submitted no later than 30 calendar days from the date of this letter. The appeal letter should include the FOI number listed above. For quickest possible handling, the appeal letter and its envelope should be marked "Freedom of Information Act Appeal".

This concludes the EPA response to the FOIA Request EPA- HQ-2014-009040.

Sincerely,

Elizabeth Behl, Director
Health and Ecological Criteria Division

Enclosure

Attachment 1

In response to this FOIA request, EPA is providing the current, existing EPA published quality criteria guidance for states and authorized tribes to consider when developing water quality standards for dissolved oxygen. This guidance was published in the 1986 EPA document entitled, "Quality Criteria for Water" also known as "the Gold Book" (EPA 440/5-86-001), available at *http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/upload/2009_01_13_criteria_goldbook.pdf*) and contains a Table 1 on page 211 the provides the following criteria guidance values for States and authorized tribes to consider when developing water quality standards for dissolved oxygen.

Table 1. Water quality criteria for ambient dissolved oxygen concentration (mg/L).

	Coldwater Criteria		Warmwater Criteria	
	Early Life Stages [1,2]	Other Life Stages	Early Life Stages [2]	Other Life Stages
30 Day Mean	NA	6.5	NA	*5.0*
7 Day Mean	*9.5 (6.5)*	NA	*6.0*	NA
7 Day Mean Minimum	NA	5.0	NA	4.0
1 Day Minimum	*8.0* (5.0)	4.0	*5.0*	3.0

In the table above, italicized values are water column values to insure (intergravel DO concentrations) for early lifestages of coldwater species. For species that have early life stages exposed directly to the water column, the figure in the parentheses apply. The guidance notes that all minima should be considered as instantaneous concentrations to be achieved at all times. The document also discussed further restrictions that apply to highly manipulatable discharges.

These dissolved oxygen criteria magnitude, frequency, and duration elements reflect the best science available at the time. In addition to the recommended values in the "Gold Book", the EPA also included information that could be used by states reflecting the state of knowledge at the time regarding dissolved oxygen dynamics and the potential for impacts on aquatic life.

The Gold Book guidance also states "A daily minimum has been included to make certain that no acute mortality of sensitive species occurs as a result of lack of oxygen. Because repeated exposure to dissolved oxygen concentrations at or near the acute lethal threshold will be stressful and because stress can indirectly produce mortality or other adverse effects (e.g., through disease), the criteria are designed to prevent significant episodes of continuous or regularly recurring exposures to dissolved oxygen concentrations at or near the lethal threshold, by the use of a 7-day averaging period for early life stages, by stipulating a 7-day mean minimum value for other life stages, and by recommending additional limits for manipulatable discharges."

EPA's 1986 Gold Book (pp. 216-217) criteria also provided information for states and authorized tribes to consider regarding monitoring of dissolved oxygen and potential interpretation of dissolved oxygen data, which is relevant for consideration of the potential impacts of diurnal variation in DO related to this FOIA request

"The acceptable mean concentrations should be attained most of the time, but some deviation below these values would probably not cause significant harm. Deviations below the mean will probably be serially correlated and hence apt to occur on consecutive days. The significance of deviations below the mean will depend on whether they occur continuously or in daily cycles, the former being more adverse than the latter. Current knowledge regarding such deviations is limited primarily to laboratory growth experiments and by extrapolation to other activity related phenomena."

"Under conditions where large daily cycles of dissolved oxygen occur, it is possible to meet the criteria mean values and consistently violate the mean minimum criteria. Under these conditions the mean minimum criteria will clearly be the limiting regulation unless alternatives such as nutrient control can dampen the daily cycles." (underlining added)

"The significance of conditions which fail to meet the recommended dissolved oxygen criteria depend largely upon five factors: (1) the duration of the event; (2) the magnitude of the dissolved oxygen depression; (3) the frequency of recurrence; (4) the proportional area of the site failing to meet the criteria, and (5) the biological significance of the site where the event occurs. Evaluation of an event's significance must be largely case- and site-specific. Common sense would dictate that the magnitude of the depression would be the single most important factor in general, especially if the acute value is violated".

"A logical extension of these considerations is that the event must be considered in the context of the level of resolution of the monitoring or modeling effort. Evaluating the extent, duration, and magnitude of an event must be a function of the spatial and temporal frequency of the data. Thus, a single deviation below the criterion takes on considerably less significance where continuous monitoring occurs than where sampling is comprised of once-a-week grab samples. This is so because based on continuous monitoring the event is provably small, but with the much less frequent sampling the event is probably not small and can be considerably worse than indicated by the sample. The frequency of recurrence is of considerable interest to those modeling dissolved oxygen concentrations because the return period, or period between recurrences, is a primary modeling consideration contingent upon probabilities of receiving water volumes, waste loads, temperatures, etc. It should be apparent that return period cannot be isolated from the other four factors discussed above. Ultimately, the question of return period may be decided on a site-specific basis taking into account the other factors (duration, magnitude, areal extent, and biological significance) mentioned above. Future studies of temporal patterns of dissolved oxygen concentrations, both within and between years, must be conducted to provide a better basis for selection of the appropriate return period." (underlining added). The Gold Book identifies the 5 factors above as important in identifying the significance of conditions in situations where a Dissolved Oxygen criteria are not met.

From:	Beaman, Joe
To:	Alexander English
Cc:	John Hall; Beaman, Joe
Subject:	RE: Conversation this morning re: DO Variation as Water Quality Impairment (pursuant to Final Disposition, Request EPA-HQ-2014-009040)
Date:	Thursday, September 18, 2014 10:56:43 AM
Attachments:	State DO pH and Temperature Criteria (7).docx States Use of CMD in 303(d)305(b) Assessments.docx

Mr. English,

I am inserting clarification in your email below in bold – if and where necessary.

Also, I am sending along 2 documents that we prepared in working with the states up to this point on DO and other issues.

The first contains existing example language in some state standards and implementation guidance that both EPA and the states (in the ACWA WQS forum) discussed as example language that may provide flexibility for addressing issues with diurnal variation of DO.

The second is a compilation of state approaches to using continuous monitoring data, and

This first document in particular, seems to be informative to the discussion we had yesterday morning, as a follow on to the email follow up you sent following receipt of our FOIA response.

These were not submitted with the FOIA response, since you only asked for EPA science and guidance, or science that the EPA used regarding diurnal variability. Since we have not developed anything on DO since the Gold Book, the submission you received was the only responsive Agency documentation we have.

I hope this is helpful. Please give me a call if you have any questions.

Sincerely,

Joe Beaman
Senior Biologist, Office of Science and Technology
Office of Water, EPA
202-566-0420

From: Alexander English [mailto:aenglish@hall-associates.com]
Sent: Wednesday, September 17, 2014 11:08 AM
To: Beaman, Joe
Cc: John Hall
Subject: Conversation this morning re: DO Variation as Water Quality Impairment (pursuant to Final Disposition, Request EPA-HQ-2014-009040)

Mr. Beaman –

Thank you for taking the time to speak with me this morning to clarify the response which EPA provided to the above-referenced FOIA request. My understanding of our conversation is as follows:

- EPA's official policy/scientific guidance on the matter is contained entirely within the standards listed in the Gold Book, as provided in its Final Response.
- EPA currently has no official records dealing with DO variation as a water quality impairment in and of itself (that is, when DO levels never drop below the daily minimum OR the 7-day mean minimum)
- EPA has been made aware of this particular issue via discussions with the states and ACWA, and the Agency has received a white paper from ACWA raising the issue (among others).
- Your understanding is that enforcement issues most commonly arise at the state level when the daily (24-hour average) DO is interpreted/enacted as an instantaneous minimum, particularly now that continuous monitoring (versus daily grab samples) is more widespread. **I wouldn't say enforcement issues – from my perspective the issue is decisions to list on a respective state's 303(d) list**
- EPA has not yet begun the actual process of revising standards or providing implementation guidance for instantaneous minimum DO levels, but it is beginning to discuss what should be done, now that the issue has been brought to the Agency's attention. **I would say that initial discussions with the states to understand the issues has taken place through the ACWA WQS forum; EPA has not contemplated any actions or activity RE standards revision or implementation guidance at this time.**
- Any records particularly relating to implementation of DO variation as an impairment criteria in and of itself would most likely be located at the Regional offices, although the Office of Wetlands, Oceans, and Watersheds (OWOW) may have some additional information/records.

If I've misinterpreted something you said, or left something out, please don't hesitate to correct me. Thanks again for your call!

Regards,

Alexander J. E. English
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