TITLE 327 WATER POLLUTION CONTROL DIVISION

LSA Document #14-58

SUMMARY/RESPONSE TO COMMENTS FROM THE SECOND COMMENT PERIOD

The Indiana Department of Environmental Management (IDEM) requested public comment from November 15, 2017, through February 1, 2018, on IDEM's draft rule language. IDEM received comments from the following parties:

American Electric Power (AEP)
Biomonitor, Inc. (BIO)
CWA Authority, Inc. (CWA)
Duke Energy (DUKE)
Greensburg, City of, represented by Bingham Greenebaum Doll (GRB)
Hoosier Environmental Council (HEC)
Indiana Coal Council (ICC)
Indiana Energy Association (IEA)
Indiana Manufacturers Association, Inc. (IMA)
Indianapolis Power and Light Company (IPL)
Northern Indiana Public Service Company (NIPSCO)
Peabody Energy (PE)
Sierra Club Hoosier Chapter (SC)
United States Environmental Protection Agency Region 5 (EPA5)

Following is a summary of the comments received and IDEM's responses thereto:

Extended Comment Period Request

Comment: The proposed metal criteria changes, especially for selenium, need to be reviewed for their appropriateness for Indiana. Additional data and information should be evaluated. The amount of material to review and its complex nature makes for a time consuming process. An extension of 30 days to the comment period is requested. (ICC, PE)

Response: IDEM agreed to extend the original comment period end date by an additional 30 days, to February 1, 2018.

Workgroup Requested

Comment: IDEM should convene a workgroup to discuss the draft rule, especially guidance for the implementation of the selenium criteria. (ICC, IEA, IMA, CWA, AEP, NIPSCO, DUKE, IPL)

Response: IDEM appreciates this suggestion and acknowledges the challenges that a fish tissue criterion presents in water quality-based permitting. In lieu of a workgroup, IDEM is working with specific interested parties and state agency partners, including Indiana Department of Natural Resources biologists, Illinois Environmental Protection Agency, and IDEM's Office of Water Quality biologists, to develop draft guidance documents to assist with the collection of fish tissue for implementation of the selenium criteria and for implementation of the intermittent water column element.

Support for the Draft Rule

Comment: Opinion about the scientific validity of any proposed change in pollutant

criteria may vary; however, it is in Indiana's best interest to keep up with the latest generally accepted values for these criteria. The proposed criteria, based on current science and National Recommended Water Quality Criteria (NRWQC), achieve that goal. (SC, HEC)

Response: IDEM appreciates the comments supporting the metals rulemaking.

Rule Formatting Suggestions

Comment: The draft rule language at 327 IAC 2-1-6(a)(1)(E) should be revised by:

(1) deleting the lead in line that has been added in bold font at the end of clause (E) that read, "**The following apply where applicable:**";

(2) deleting the existing rule language at the end of item (i)(BB) that reads, "which ~~table~~ incorporates subdivision (4), Table 6-3; and";

(3) adding a new subitem (CC) to read, " **subdivision (4), Table 6-3; and**";

(4) moving the draft rule's subitem (CC) to new subitem (DD); and

(5) ending item (ii) with "**for substances for which an AAC is not specified in item (i).**" and deleting the three subitems that follow.

(GRB)

Response: The following are IDEM's responses to the formatting suggestions in the same number order as presented in the comment:

(1) According to the Indiana Rules Drafting Manual, there must be a lead in line connecting clause (E) with the item and subitems that follow it.

(2), (3), and (4) these suggested formatting revisions have been considered; however, since the referenced table (which is now subdivision 5, Table 6-2) does not establish new criteria and is included in the rule to provide examples of the equation-based criteria established in Table 6-1 at different hardness levels, the requested change was not made.

(5) In the draft rule language of item (ii), the connecting conjunction between subitem (BB) and (CC) is "or" not "and" as shown in the commenter's letter. If item (ii) ended with "**for substances for which an AAC is not specified in item (i).**" it would mean that all of the subitems of item (i) apply rather than as the draft rule language uses "or" to indicate that only one of the subitems of item (ii) need be applicable. The draft rule at 327 IAC 2-1-6(a)(1)(E)(ii) has been revised since the draft rule was posted in the Indiana Register for the Second Notice of Comment Period, but the reason for using "or" rather than "and" between subitems (AA) and (BB) is the same as described in this response.

Comment: At 327 IAC 2-1-6(a)(5)(D) and (E) and 327 IAC 2-1-6(a)(6)(C), Table 6-3a, 6-3b, and 6-3c each has a footnote [1] that includes the rule language that reads, "instead of the criteria in this clause". The commenter suggests that clarity would be improved by deleting "clause" and inserting "table". (GRB)

Response: The suggestion to use "clause" instead of "table" at these various locations has been included in the draft rule for consideration of preliminary adoption though the citations have changed since the draft rule was posted for second notice comment period.

Comment: At 327 IAC 2-1-6(a)(1)(C), the language "or otherwise impairs the designated uses of the surface waters" should be added after "to an extent that creates a nuisance." (HEC)

Response: IDEM relies on these narrative standards to try to address unsightly or deleterious conditions, whether they impair the designated use or not.

Comment: The label that applies to metals in Table 6-1 currently reads, "(total recoverable)". However, not all of the metals criteria for aquatic life in the table are expressed as

total recoverable. IDEM needs to update the label that applies to metals contained in Table 6-1 to be consistent with Tables 6-2 and 6-2a. (EPA5)

Response: The concern and possible confusion noted in this comment is being addressed in this rulemaking.

In order to provide clarity for metals criteria that apply to waters outside of the Great Lakes System, IDEM is creating separate tables for aquatic life criteria and human health criteria currently listed together in Table 6-1. In the draft rule for consideration of preliminary adoption, the aquatic life criteria table (new Table 6-1) incorporate the acute and chronic criteria equations shown in Table 6-2 in the current rule; human health criteria in Table 6-1 are moved to a new table, Table 6-4. This reformatting for numeric criteria that apply to waters outside of the Great Lakes System mirrors the formatting for corresponding tables for aquatic life and human health criteria for waters within the Great Lakes System. Selenium criteria are included in stand-alone tables Table 6-1a and Table 6-1b in 327 IAC 2-1-6 (waters outside the Great Lakes System), and Table 8-1a in 327 IAC 2-1.5-8 (waters within the Great Lakes System).

Compliance Schedule

Comment: At the same time that IDEM is proposing the revisions to the water quality standards for metals, similar criteria are being considered as part of the federal Steam Electric Power Effluent Limitations Guidelines (ELG) Rule, which is currently being reviewed by U.S. EPA. Compliance technology required to meet a new water quality standard could also contribute to meeting a new ELG standard. IDEM should develop a guidance document that addresses possible coordination of the water quality standards and the ELG standards, timing of implementation of the new standards, and options such as compliance schedules for meeting the new standards. (NIPSCO)

Response: The proposed metal criteria in the draft rule for consideration of preliminary adoption are intended to protect designated uses for all waters of the state, are applied across a variety of industrial and municipal discharges, and are no more stringent than U.S. EPA's NRWQC. IDEM is open to discussing the need to develop guidance for affected dischargers once U.S. EPA revises the ELG Rule.

Aluminum

Comment: The Indiana Coal Council (ICC) supports the application of the hardness based aluminum criteria, but IDEM must remove the use of the total recoverable form of aluminum and move to a more representative analysis method. According to research (He and Ziemkiewicz 2016), the use of total recoverable methods can dissolve aluminosilicate clay particles, which biases results. The New Mexico Environment Department recognized this bias when it implemented the hardness based standard by adding the following statement to its regulations: "the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize mineral phases as specified by the department." ICC recommends the use of the dissolved form of aluminum, which would be consistent with 327 IAC 2-1-8.1(b), which states, "The use of dissolved metal to set and measure compliance with water quality standards for aquatic life is the recommended approach because dissolved metal more closely approximates the bioavailable fraction of the metal in the water column than does total recoverable metal." Alternately, ICC recommends the use of the acid soluble form of aluminum originally recommended by U.S. EPA in the 1988 criteria document. (ICC)

Comment: IDEM has proposed criteria for total aluminum. This analytic method will ultimately measure nontoxic forms of aluminum present in suspended sediments and will overestimate the actual toxicity of the aluminum present in the sample. IDEM needs to change

the analytic method to a less rigorous acid digestion, such as the dissolved analytic method or allow for prefiltration of the sample to remove the nontoxic forms of aluminum associated with suspended sediments in the sample. (PE)

Comment: The WER-based aluminum criteria using a total recoverable analytical measurement is a straightforward analytical method, but there is a concern that a moderately acidified sample would result in the detection of both toxic and nontoxic aluminum forms (Santore et al., 2017). Recent research suggests that a more vigorous acidification step, termed "acid extractable" aluminum, would yield only the forms of aluminum that contribute to toxicity. Therefore, IDEM should delay adopting either the proposed WER-based or the U.S. EPA's currently recommended aquatic life criteria for aluminum. (AEP)

Comment: At 327 IAC 2-1-6(a)(3), in Table 6-2, IDEM needs to explain the derivation of the equations (especially the source of the underlying toxicity data) that are proposed in the draft rule for new aquatic life criteria for aluminum. Both the maximum (acute aquatic concentration) and average (chronic aquatic concentration) are expressed as WER values that are normalized presumably by the total hardness of a receiving stream. It would be an acceptable approach if the applicable maximum and average ambient aluminum criteria are based on site-specific information. (AEP)

Comment: IDEM is urged to withdraw the proposed WERs-based aluminum criteria and consider adopting the U.S. EPA's revised criteria when it is finalized. U.S. EPA issued draft revised aquatic life criteria for aluminum in 2017 that indicates the pH, dissolved organic carbon (DOC), and total hardness have an effect on the bioavailability and, therefore, the toxicity of aluminum. U.S. EPA accounted for the joint effect of these three variables by developing a multiple linear regression model, normalized at standard pH, DOC, and hardness values. Based on the water quality characteristics at a given site, the applicable freshwater acute and/or freshwater chronic criteria may be either less stringent or more stringent than the default criteria. (AEP)

Comment: In 2017, U.S. EPA released a draft aluminum 304(a) criteria document, which found that aluminum bioavailability and toxicity are influenced by pH and dissolved organic carbon in addition to hardness. The relationship between pH and aluminum toxicity to aquatic life is nonlinear, meaning aluminum is least toxic to aquatic organisms at values around neutral pH and increases as pH either increases or decreases. The U.S. EPA's 2017 draft aluminum document includes newly published toxicity data for aluminum, including new chronic data for the unionid mussel, fatmucket (*Lampsilis siliquoidea*), which is ranked as the third most sensitive genus in the draft 304(a) aluminum chronic dataset when normalized to pH 7, hardness of 100 mg/l as $CaCO_3$, and dissolved organic carbon of 1.0 mg/l. According to the U.S. Fish and Wildlife Service website of federally-listed threatened, endangered, and proposed species (revised July 25, 2017), there are ten endangered or threatened mussel species and critical habitat for one mussel species in Indiana. U.S. EPA recommends that IDEM revise its aluminum proposed criteria to incorporate the most current scientific information about aluminum toxicity to aquatic organisms. This may be accomplished by adopting the U.S. EPA 2017 draft document or by modifying its proposal based on IDEM's work to address the technical recommendations of the U.S. EPA 2017 draft document. (EPA5)

Comment: Footnotes in tables 6-2 and 8-1 state, "The applicable pH range for determining the aluminum criterion is within 6.5 and 9.0." These footnotes imply there are no aluminum water quality criteria if the waterbody pH is above 9.0 or below 6.5. If this is not IDEM's intent, then the footnotes need clarification. (EPA5)

Response: IDEM removed the proposed criterion for aluminum for both the waters within and outside of the Great Lakes System from the draft rule for consideration of preliminary

adoption. Since the time IDEM initiated this rulemaking to update certain metals water quality criteria, U.S. EPA published aluminum aquatic life ambient water quality criteria for freshwaters under Section 304(a)(1) of the Clean Water Act (NRWQC) on December 14, 2018. The NRWQC reflects the latest scientific knowledge about aluminum toxicity to aquatic life. Bioavailability is the measure of whether a substance in the environment is available to affect living organisms, and the bioavailability of aluminum is dependent on the chemistry of the water. The more bioavailable the aluminum is, the more likely it is to cause a toxic effect. The water chemistry parameters that have the greatest impact on aluminum's bioavailability are pH, total hardness, and dissolved organic carbon (DOC) (U.S. EPA, 2018).

The 2018 NRWQC applies a multiple linear regression model using a site's pH, DOC, and hardness to derive its aluminum criterion. IDEM's aluminum criterion initially proposed in the draft rule at second notice of comment period does not reflect the current scientific knowledge that incorporates bioavailability considerations. IDEM is evaluating the implementation issues related to the 2018 NRWQC for aluminum and will consider adopting the 2018 NRWQC in a future rulemaking.

Arsenic

Comment: It is of concern that IDEM is removing arsenic (III) from Indiana's WQC for the protection of human health. While the national criteria are still under revision, it seems advisable to retain the existing criteria until the national criteria have been released. (HEC)

Response: IDEM is retaining the current arsenic (III) criteria for the protection of human health in Indiana's WQC for surface waters outside of the Great Lakes System in the draft rule for consideration of preliminary adoption.

Comment: U.S EPA supports adoption of IDEM's proposed criteria for arsenic, which is U.S. EPA's existing 304(a) criteria recommendations for arsenic (U.S. EPA, 1996). (EPA5)

Response: IDEM appreciates this comment supporting the metals rulemaking. IDEM is retaining the arsenic (III) criteria for human health for waters outside of the Great Lakes System in the draft rule for consideration of preliminary adoption. IDEM is not adopting the U.S. EPA 304(a) NRWQC for total arsenic.

Comment: For arsenic, IDEM is proposing to remove the "Outside the Mixing Zone" and "Point of Water Intake" human health criteria. Even though all drinking water use waters must also meet the Safe Drinking Water Act's Maximum Contaminant Level after conventional treatment, this does not protect the organism-only human health use (Outside the Mixing Zone). U.S. EPA recommends maintaining the arsenic criteria update as proposed in the table that accompanied the First Notice of Comment Period which changed the current older criteria to be consistent with the most recent 304(a) recommendations. (EPA5)

Response: IDEM is retaining the arsenic (III) criteria for the protection of human health in Indiana's WQC for waters outside of the Great Lakes System in the draft rule for consideration of preliminary adoption.

Beryllium

Comment: It is of concern that IDEM is removing beryllium from Indiana's WQC for the protection of human health. While the national criteria are still under revision, it seems advisable to retain the existing criteria until the national criteria have been released. (HEC)

Response: U.S. EPA has not issued 304(a) NRWQC for "organism only (Indiana's "outside of the mixing zone")" or "water + organism (Indiana's "point of water intake")" for

beryllium, so IDEM removed these criteria from the draft rule for consideration of preliminary adoption. However, U.S. EPA has published a Maximum Contaminant Level (MCL) for beryllium under the U.S. EPA's National Primary Drinking Water Regulations.

Cadmium

Comment: U.S EPA supports adoption of IDEM's proposed criteria for cadmium, which is U.S. EPA's 2016 304(a) criteria recommendations for cadmium. (EPA5)

Response: IDEM appreciates this comment supporting the metals rulemaking.

Comment: It is of concern that IDEM is removing cadmium from Indiana's WQC for the protection of human health. While the national criteria are still under revision, it seems advisable to retain the existing criteria until the national criteria have been released. (HEC)

Response: U.S. EPA has not issued 304(a) NRWQC for "organism only (Indiana's "outside of the mixing zone")" or "water + organism (Indiana's "point of water intake")" for cadmium, so IDEM removed these criteria from the draft rule for consideration of preliminary adoption. However, U.S. EPA has published a Maximum Contaminant Level (MCL) for cadmium under the U.S. EPA's National Primary Drinking Water Regulations.

Chromium (III)

Comment: U.S EPA supports adoption of IDEM's proposed criteria for chromium (III), which is U.S. EPA's existing 304(a) criteria recommendations for chromium (III) (U.S. EPA, 1996). (EPA5)

Response: IDEM appreciates this comment supporting the metals rulemaking.

Comment: It is of concern that IDEM is removing chromium (III) from Indiana's WQC for the protection of human health. While the national criteria are still under revision, it seems advisable to retain the existing criteria until the national criteria have been released. (HEC)

Response: U.S. EPA has not issued 304(a) NRWQC for "organism only (Indiana's "outside of the mixing zone")" or "water + organism (Indiana's "point of water intake")" for chromium (III), so IDEM removed these criteria from the draft rule for consideration of preliminary adoption. However, U.S. EPA has published a Maximum Contaminant Level (MCL) for chromium (III) under the U.S. EPA's National Primary Drinking Water Regulations.

Chromium (VI)

Comment: It is of concern that IDEM is removing chromium (VI) from Indiana's WQC for the protection of human health. While the national criteria are still under revision, it seems advisable to retain the existing criteria until the national criteria have been released. (HEC)

Response: U.S. EPA has not issued 304(a) NRWQC for "organism only (Indiana's "outside of the mixing zone")" or "water + organism (Indiana's "point of water intake")" for chromium (VI), so IDEM removed these criteria from the draft rule for consideration of preliminary adoption. However, U.S. EPA has published a Maximum Contaminant Level (MCL) for chromium (VI) under the U.S. EPA's National Primary Drinking Water Regulations.

Copper

Comment: U.S. EPA recommends that IDEM adopt the U.S. EPA's 2007 304(a) recommendations for copper, which is the biotic ligand model (BLM), rather than the hardness-based criteria equation, because the copper BLM represents the most current science intended to protect the biota in Indiana's waters. If IDEM adopts the copper BLM, U.S. EPA would be

willing to work with IDEM to develop implementation procedures that address how the BLM would be applied where data for the BLM input parameters are not currently available or IDEM could use state-collected data to develop state-specific default input values provided such default values would result in copper criteria that are protective of the aquatic life use. New data on copper toxicity have been published subsequent to U.S. EPA's 2007 304(a) criterion recommendation, and U.S. EPA would be able to assist IDEM in locating this new data. (EPA5)

Response: IDEM is not adopting U.S. EPA's 2007 304(a) recommendations for copper for waters within and outside of the Great Lakes System at this time. IDEM is withdrawing the proposed aquatic life criteria for copper in waters outside of the Great Lakes System from the draft rule for consideration of preliminary adoption. IDEM intended to adopt the aquatic life criteria for copper within the Great Lakes System waters, which are not based on the BLM, but are more stringent than current copper criteria in waters outside of the Great Lakes System. While the current U.S. EPA 304(a) NRWQC for copper is the BLM, IDEM understands that U.S. EPA is actively evaluating the most recent data and science for certain metals, including copper, as part of a Cooperative Research and Development Agreement to re-evaluate NRWQC (U.S. EPA, 2018(a)). The Work Plan for this project, which is to develop an overarching bioavailability modeling approach to support updating U.S. EPA aquatic life water quality criteria for metals, includes a re-evaluation that could lead to revisions to the current BLM NRWQC for copper, which IDEM will evaluate for adoption when finalized.

Lead

Comment: HEC objects that the draft rule contains a less stringent criteria for lead and removes the lead criteria for human health. Lead is extremely neurotoxic. In 2012, the Center for Disease Control adopted a statement that there is no safe level of lead exposure for children. It is difficult to imagine that the science of aquatic life toxicology has found evidence that lead is less toxic than we used to believe. IDEM needs to restore the previous lead criteria. (HEC)

Response: IDEM is withdrawing the proposed acute and chronic aquatic life criteria for lead for surface waters within and outside of the Great Lakes System from the draft rule for consideration of preliminary adoption. For surface waters outside of the Great Lakes System, IDEM is retaining the current criteria, which are the 304(a) NRWQC and are more stringent than the second notice draft rule criteria. For waters within the Great Lakes System, IDEM proposes to adopt the NRWQC for lead, which are more stringent than the second notice draft rule criteria. U.S. EPA has not published human health 304(a) NRWQC for lead so IDEM is removing the current criteria for lead, for the point of water intake, for surface waters outside of the Great Lakes System. Please note that U.S. EPA has published a Maximum Contaminant Level (MCL) for lead under the U.S. EPA's National Primary Drinking Water Regulations.

Comment: IDEM is proposing hardness-based lead criteria based on additional new data published subsequent to a partial revision of U.S. EPA's 304(a) criteria. States are allowed under federal regulation at 40 CFR 131.11(b)(1)(iii) to establish numerical values based on other scientifically defensible methods, taking into account new toxicity data published to date. There are new data on lead toxicity published subsequent to U.S. EPA's 1984 304(a) criteria recommendation. Wang et al., 2010 demonstrates that enough data may be available to satisfy the 8 minimum data requirements (MDR) and derive criteria for lead consistent with U.S. EPA's preferred criteria derivation approach using least square regression. U.S. EPA is evaluating the most recent data and science for lead as part of a Cooperative Research and Development Agreement. U.S. EPA recommends that IDEM either conduct a literature review and update the lead criteria as appropriate or provide its rationale to show that the proposed criteria are based on

a sound scientific rationale and protective of aquatic life uses. (EPA5)

Response: In the draft rule for consideration of preliminary adoption, IDEM is withdrawing the proposed acute and chronic aquatic life criteria for lead for waters outside of the Great Lakes System and will retain the current acute and chronic aquatic life criteria for lead, which are USEPA's current 304(a) NRWQC for lead. For waters within the Great Lakes System IDEM is proposing, in the draft rule for consideration of preliminary adoption, the current U.S. EPA 304(a) NRWQC for lead.

Nickel

Comment: The new proposed aquatic life criteria for nickel are lower than they used to be. However, according to published information regarding studying of "Acute and Chronic Toxicity of Nickel to a Cladoceran (*Ceriodaphnia dubia*) and an Amphipod (*Hyalella azteca*)" by Keithly, Brooker, DeForest, Wu, and Brix (Environmental Toxicology and Chemistry, Vol. 23, No. 3, pp.691-696, 2004), the new criteria still won't come close to keeping one of our common effluent toxicity testing animals (*Ceriodaphnia dubia*) from failing the tests. The chronic criteria suggest that 100 µg/l of nickel should protect aquatic life. But the Keithly et.al. study found chronic effects to *Ceriodaphnia* at concentrations as low as 7 µg/l. Biomonitor, Inc. has had several instances of having to explain that nickel is the cause of effluent toxicity even when the nickel limits are being met. The nickel criteria should be considered for lowering beyond the proposed criteria in the LSA Document #14-58 draft rule. (BIO, HEC)

Response: IDEM appreciates these comments. IDEM is proposing to adopt U.S. EPA's current 304(a) NRWQC for nickel. U.S. EPA is actively evaluating the most recent data and science for certain metals, including nickel, as part of a Cooperative Research and Development Agreement to re-evaluate 304(a) NRWQC. The Work Plan for this project, which is to develop an overarching bioavailability modeling approach to support updating U.S. EPA aquatic life water quality criteria for metals, includes a re-evaluation that could lead U. S. EPA to revise the current NRWQC for nickel (U.S. EPA, 2018(a)). If this happens, IDEM will consider adopting the revised NRWQC for nickel in a future rulemaking.

Comment: The proposed revisions to the nickel human health criteria are consistent with the U.S. EPA's national criteria, which were first listed as national recommended human health criteria in 1998. The City of Greensburg strongly supports the proposed revisions to the nickel human health criteria. (GRB)

Response: IDEM appreciates this comment supporting the metals rulemaking.

Comment: IDEM's proposal is to adopt criteria for nickel that is U.S. EPA's existing 304(a) criteria recommendations for nickel (U.S. EPA, 1996). Please be aware that U.S. EPA is actively evaluating the most recent data and science for these metals as part of a Cooperative Research and Development Agreement. U.S. EPA expects that this reevaluation could lead to revisions to the 304(a) recommendations for nickel. (EPA5)

Response: IDEM is aware of the Cooperative Research and Development Agreement under which certain metals, including nickel, are being evaluated.

Nitrate and Nitrite

Comment: U.S. EPA supports IDEM's revision of Table 6-1 by removing the criteria for nitrate and nitrite and placing updated nitrate and nitrite criteria based on U.S. EPA 's most recent 304(a) criteria recommendations at 327 IAC 2-1-6(e)(6). (EPA5)

Response: IDEM appreciates this comment supporting the metals rulemaking.

Selenium

Comment: Selenium is particularly toxic to aquatic life, but its regulation is complicated since the toxicity is most closely related to its concentration in fish eggs and tissues. There was an extensive process at the federal level to draft the National Recommended Water Quality Criteria for selenium (USEPA 2016 NRWQC), and adoption of those recommendations is the best approach for Indiana. (HEC)

Response: IDEM appreciates this comment supporting the metals rulemaking.

Comment: ICC commissioned an analysis of appropriate selenium water quality criteria for protection of aquatic life from GEI Consultants, Inc. (GEI) of Denver, Colorado. IDEM needs to consider the GEI report (dated November 2017) and base state specific selenium criteria on the report for the following reasons:

(1) The issues identified in the GEI report are valid, use U.S. EPA methodology, and are based on scientific literature, some of which was available to U.S. EPA at the time of the NRWQC development and some of which is new.

(2) The GEI report acknowledges background water quality in Indiana and the dampening of toxicity caused by competition with sulfate.

(3) The GEI report recommends that IDEM assess waterbodies for selenium based on the presence or absence of sturgeon because the fish is ecologically relevant but also relatively rare in Indiana waters.

(4) The GEI report includes fathead minnow in the list of species considered for selenium toxicity. Including fathead minnow will add a regionally significant species for warm water streams.

(ICC, IMA, DUKE, PE)

Comment: The current IDEM proposed criteria in the draft rule would adopt the national criteria with only slight modification, which is not an appropriate approach for Indiana waters. Instead, the selenium water quality criterion recommended in the GEI report would be a more appropriate basis for an Indiana water quality standard than the national criteria. The following are scientific justifications as to why IDEM should develop a state specific selenium criterion: (ICC, IMA, NIPSCO, DUKE, PE)

- The inclusion of a white sturgeon toxicity study in the national criteria development overly influenced the data. The white sturgeon were the most sensitive species in the database even though it showed only a partial dose response relationship. Sturgeon generally do not occupy the smaller streams, which are a large proportion of the waterbodies in Indiana. If the draft selenium criterion is applied to all Indiana waters, it would be an overly conservative approach for most of the state. Therefore, IDEM is obligated to apply a two-part criteria, one for water with sturgeon present and one without sturgeon.
- U.S. EPA used several conservative assumptions that deviate from typical practice when the appropriate threshold for sturgeon was determined. IDEM should review the analysis methods used by U.S. EPA for consistency with IDEM's derivation methods.
- The national criteria did not fully include available data for fathead minnows, which are often a dominant species in smaller warm water streams. Fathead minnows are ecologically significant in Indiana, and it is important to include this species in the selenium derivation procedure.
- The national criteria included three studies for bluegill. One of the studies showed that an

increased concentration of selenium led to a decrease in toxicity, which is an inconsistent result with the other two studies and does not make sense. Therefore, the third study must be excluded from the final criteria since bluegill are adequately protected by inclusion of the other two studies.

- The fish tissue to water column conversion method used in the national criteria was unconventional, was not adequately justified by U.S. EPA, and ignored the dynamic relationship between water concentration and uptake that have a significant influence on the resulting criteria. Scientific literature (DeForest et al., 2017) published since the national criteria were developed offers better conversion of fish tissue values to water column values and should be used by IDEM.
- IDEM should not default to U.S. EPA's methods for calculating conversion factors because U.S. EPA diverged from its typical regression-based conversion factors, which are more accurate at the high and low ranges, in developing its recommended selenium criterion.
- Sulfate levels typical of Indiana waters can significantly reduce selenium bioavailability and lessen selenium toxicity of a water column concentration. Sulfate concentrations can be elevated in coal mining regions due to the dissolution of pyrite. A sulfate dependent selenium criterion is recommended to allow for this impact on selenium toxicity.

Response: On behalf of the Indiana Coal Council (ICC), GEI Consultants, Inc. (GEI), proposed state-specific selenium criterion elements for IDEM consideration: "Recommended Updates to Indiana's Selenium Aquatic Life Standards, November 2017 (GEI, 2017)." The document proposed several approaches to modify the proposed selenium criterion. Some of these approaches are appropriate and acceptable, and others are not, as described in the multi-page comment response below. GEI has offered many of these recommendations previously to U.S. EPA during the comment period for draft selenium National Recommended Water Quality Criteria under Section 304(a) of the Clean Water Act ("NRWQC"; 2014 Draft NRWQC for External Peer Review and 2015 Draft NRWQC), as described below. Many reviewers, including American Electric Power, Duke Energy, Indiana Coal Council, Indiana Energy Association, Indiana Manufacturers Association, Indianapolis Power and Light Company, Northern Indiana Public Service Company, and Peabody Energy, provided comments in support of the findings and recommendations presented in the GEI document.

In order to facilitate a response to comments that reference this document, IDEM is providing the following general response (starting with "BACKGROUND") to the major recommendations presented in the GEI report. U.S. EPA provides guidance for modifying NRWQC, and IDEM evaluated if GEI's comments proposed acceptable methodologies for deriving an Indiana-specific criterion.

BACKGROUND

Selenium toxicity to aquatic life and aquatic-dependent wildlife

Selenium is a naturally occurring metal that is nutritionally essential in small amounts, but toxic at higher concentrations. Of all aquatic taxa, fishes are the most sensitive to elevated concentrations of selenium. Although selenium may cause acute toxicity at high concentrations, the most adverse effect on aquatic organisms is due to its bioaccumulative properties; these chronic effects are found at lower concentrations than acute effects (U.S. EPA, 2016(a)). The most sensitive adverse effects of selenium are reproductive effects on the exposed offspring (larval deformity and mortality) because of maternal transfer of selenium to eggs. In Belews Lake, North Carolina, where these impacts were first observed and described in the U.S. (1977), selenium toxicity was identified as the cause of deformities to the spine, head, fins, and eyes of

larval fish, and the subsequent reproductive failure that decimated 29 resident species in the lake (Young et al., 2010). Movement of selenium through the aquatic food web (e.g., aquatic plants, invertebrates and fish) has also been shown to lead to selenium bioaccumulation in aquatic-dependent wildlife. Numerous studies have documented adverse ecosystem impacts, not only to fishes and other aquatic life, but to aquatic-dependent wildlife, especially birds (Young et al., 2010, U.S. EPA, 2018(b)).

U.S. EPA National Recommended Water Quality Criteria for the Protection of Aquatic Life under Section 304(a) of the Clean Water Act

U.S. EPA publishes National Recommended Water Quality Criteria under Section 304(a) of the Clean Water Act (NRWQC). Aquatic life criteria for toxic chemicals are the highest concentration of specific pollutants or parameters in water that are not expected to pose a significant risk to most species in a given environment. When U.S. EPA develops NRWQC, they follow a prescribed methodology (Stephan et al., 1985). State and tribal governments may use these NRWQC or use them as guidance in developing their own criteria.

U.S. EPA regulations at 40 CFR 131.11(b)(1)(ii) provide that states and authorized tribes may establish water quality criteria that are "modified to reflect site-specific conditions". The site-specific criteria must be based on sound scientific rationale, protect designated uses, and are subject to U.S. EPA approval or disapproval under Section 303(c) of the Clean Water Act. Recalculated site-specific criteria should provide the same level of protection intended for aquatic life as the national criteria (for example, protect 99% of individuals in 95% of the species in aquatic communities from acute and chronic effects of the chemical or stressor, or both) but at a specific site.

U.S. EPA defines a "site" as all waters in the state, region, or watershed or as a specific waterbody or segment of waterbody. The Water Quality Standards Handbook (U. S. EPA, 2017) summarizes the following procedures for deriving site-specific criteria:

- Recalculation Procedure. This method is intended to consider relevant differences between the sensitivity of species in the national dataset and those at the site. However, recalculation can consist of any updates or revisions in the data set (not necessarily site-specific updates) and, therefore, be conducted such that it is effectively an update to the national WQC.
- Water-Effect Ratio Procedure. This method provides for the use of a water-effect ratio to consider observed differences between the toxicity of a chemical in laboratory dilution water and in site water.
- Resident Species Procedure. This method is intended to consider differences for both the aquatic organisms present at a site and differences in toxicity of site water and lab water.

U.S. EPA details the first of these procedures in *Revised Deletion Process for the Site-Specific Recalculation Procedure for Aquatic Life Criteria* (U.S. EPA, 2013*)*. Any corrections to the national dataset must be approved by U. S. EPA. Any additions to the national dataset must be approved by U.S. EPA. The deletion process may be applied if appropriate, meaning a taxonomic group is not present at the site.

While states and stakeholders can provide comments on the interpretation of toxicity studies and toxicological endpoints proposed during the comment period for draft NRWQC, U.S. EPA does not approve modification of toxicological endpoints (for example, species or genus mean acute or chronic values) in the species sensitivity distribution of a final NRWQC based on re-interpretation of studies used to derive the criteria.

U.S. EPA's *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2016*

(U.S. EPA, 2016(a)) selenium criterion document recommends that states and authorized tribes adopt a multi-media criterion into their water quality standards. The criterion has four elements and U.S. EPA recommends that states include all four elements into their standards. Two elements are based on the concentration of selenium in fish tissue (eggs and ovaries, and whole-body or muscle) and two elements are based on the concentration of selenium in the water column [two 30-day chronic values for lentic ("still water") and lotic ("flowing water") aquatic systems, and an intermittent chronic value]. Aquatic communities are expected to be protected by this chronic criterion from any potential acute effects of selenium, so the NRWQC does not include acute criterion elements.

GEI CONSULTANTS: RECOMMENDED UPDATES TO INDIANA'S SELENIUM AQUATIC LIFE STANDARDS, NOVEMBER 2017

GEI recommended that IDEM amend the selenium 2016 NRWQC to reflect a more appropriate criterion for Indiana. Their recommendations included: (1) amending selected toxicity studies and data used for the species sensitivity distribution for U.S. EPA criteria development; (2) using amended toxicity endpoints to derive alternate fish tissue and water column criteria elements; and (3) proposing criteria for portions of the state where sturgeon are not resident species in surface water. Additionally, GEI proposed that IDEM adopt or allow alternative approaches for deriving conversion factors and water column elements, including for acute criteria, which would deviate from those proposed in the 2016 selenium NRWQC. IDEM's comments regarding these GEI recommendations are as follow:

1. GEI Review of Selected Toxicity Studies and Egg-Ovary Data Used for U.S. EPA NRWQC

   GEI proposed modifying the egg-ovary toxicity endpoints for three genera/species included in the species sensitivity distribution ("SSD") that U.S. EPA developed to calculate the egg-ovary criterion element for the 2016 selenium NRWQC. GEI's recommended modifications for white sturgeon (*Acipenser transmontanus*) and bluegill (*Lepomis macrochirus*) toxicity endpoints result in a less stringent egg-ovary criterion element (17.3 milligrams/kilogram dry weight, "mg/kg dw") than the 2016 selenium NRWQC (15.1 mg/kg dw).

   For the fathead minnow (*Pimephales promelas*), GEI stated it was not one of the fish species included in the selenium NRWQC SSD and proposed that Indiana include a species mean chronic value from their 2008 study. However, U.S. EPA cites a fathead minnow toxicity study as one of the acceptable maternal transfer reproductive studies used to derive the NRWQC for selenium (Table 3.1, U.S. EPA 2016(a)), as discussed below, and includes it in the SSD (Section 3.1.6, U.S. EPA 2016(a)).
   IDEM has determined that these GEI recommendations are not acceptable, as described below.

   White Sturgeon (*Acipenser transmontanus*): Of the taxa used to derive the 2016 selenium NRWQC, white sturgeon, representing the taxonomic Family Acipenseridae, Order Acipenseriformes, are the most sensitive to the toxic effects of selenium. For a proposed Indiana state-specific criterion, GEI proposed a less stringent egg-ovary chronic value endpoint for white sturgeon (17.8 mg/kg dw) than U.S. EPA derived for the NRWQC SSD (15.6 mg/kg dw). U.S. EPA considered a 17.8 mg/kg dw chronic value endpoint in a draft criterion document distributed for external peer review, but upon review and consideration of comments, determined that 15.6 mg/kg dw was the appropriate chronic

endpoint for the white sturgeon toxicity study used for deriving the 2016 selenium NRWQC (U.S. EPA, 2015(b)).

During the comment period for the 2015 draft selenium criterion, GEI recommended, on behalf of the Colorado Wastewater Utility, that U.S. EPA retain the 17.8 mg/kg dw chronic toxicity endpoint that was proposed in the 2014 draft selenium criterion document distributed for external peer review. GEI disagreed with the model U.S. EPA used to derive the EC_{10} chronic toxicological endpoint for white sturgeon proposed for the 2015 draft criterion.[1]

U.S. EPA did not accept GEI's recommendation (U.S. EPA 2016(b), p. 154-155) and defended the model approach used to derive the white sturgeon egg-ovary EC_{10} (for combined edema and deformities) of 15.6 mg/kg dw. Further, U.S. EPA noted that white sturgeon is a commercially and recreationally important fish species in the Pacific Northwest, serves as a surrogate for other sturgeon species in the United States, and has a population listed as endangered in the Kootenai River in Idaho and Montana. Given these factors, a conservative species mean chronic value is appropriate.

While white sturgeon is not a resident species in Indiana, three Acipenseriformes species (shovelnose sturgeon, lake sturgeon, and American paddlefish) reside in Indiana waters. In Indiana, lake sturgeon (*Acipenser fulvescens*) is a state-endangered species (IDNR, 2019(a)).

GEI's recommendation is not based on new information or updates to the SSD data set; it is based on an alternate interpretation of existing data. GEI's proposed data modification does not reflect updated toxicity findings. It does not conform to the Recalculation Procedure, and it does not result in a fish tissue criterion specific to Indiana waters that provides the same level of protection intended for aquatic life as the national criteria. The GEI recommendation would result in a less stringent chronic value endpoint for a fish taxon that is sensitive to selenium toxicity and includes an Indiana state-endangered species.

Bluegill (*Lepomis macrochirus*): GEI disagreed with U.S. EPA's inclusion of the Hermanutz et al. (1992, 1996) studies to derive one of the toxicological endpoints (EC_{10} for larval edema) for bluegill sunfish. Bluegill sunfish is the species second most sensitive to the toxic effects of selenium in the NRWQC SSD. Removing the Hermanutz et al. studies would result in a less stringent egg-ovary species mean chronic value (24.4 mg/kg dw) for bluegill sunfish than the final species mean chronic value (20.6 mg/kg dw) published in the 2016 NRWQC. U.S. EPA and peer reviewers reviewed and vetted the Hermanutz et al. studies for the 2016 final NRWQC document (U.S. EPA 2016(a), pp. 40-44), and they determined that both studies are important and appropriate for understanding selenium toxicity.

[1] "The EC_{10} is the concentration of a chemical that is estimated to result in a 10 percent effect in a measured chronic endpoint (e.g., growth, reproduction, or survival). For selenium, in all cases, the effect endpoint used in the estimation of chronic values (e.g., EC_{10}s) is an effect on offspring (with exposure via maternal transfer) from parents exposed to selenium via diet. (U.S. EPA 2016a)."

GEI's recommendation is not based on new information or updates to the SSD data set; it is based on a disagreement with U.S. EPA's inclusion of a primary study used in the NRWQC SSD. GEI's proposed data modification does not reflect updated toxicity findings. It does not conform to the Recalculation Procedure, and it does not result in a fish tissue criterion specific to Indiana waters that provides the same level of protection intended for aquatic life as the national criteria. Applying the GEI recommendation will result in a less stringent chronic value endpoint for a fish taxon that is sensitive to selenium toxicity and is widely distributed in Indiana surface waters.

Fathead Minnows (*Pimephales promelas*): U.S. EPA selected a study by Schultz and Hermanutz (1990) to support inclusion of fathead minnows (*Pimephales promelas*) into the 2016 selenium NRWQC SSD. U.S. EPA did not derive a specific chronic value from the toxicological endpoint, larval edema and lordosis, because of uncertainty in the data set but, U.S. EPA did estimate a genus mean chronic value ("< 25.6 mg/kg dw").

GEI proposed that Indiana include a species mean chronic value (60.2 mg/kg dw egg-ovary) from their authored 2008 fathead minnow maternal selenium transfer study (GEI Consultants, 2008) for an Indiana-specific SSD. U.S. EPA reviewed but did not include GEI's 2008 study for the NRWQC SSD. U.S.EPA does, however, cite the study as supporting U.S. EPA findings that fathead minnows are not as sensitive to the effects of selenium as other species (U.S. EPA 2016 (a), p.106). A summary of the study is included in Appendix E ("Other Data") of the NRWQC (U.S. EPA, 2016(a) p 644-645). U.S. EPA noted the following: "Although there is an indication of effect due to selenium exposure in both the embryonic and larval endpoints, there is too much variation in the responses observed with the embryos and insufficient response observed with the larvae to derive a reasonable estimate of effect levels."

GEI stated that modifying the NRWQC SSD to include their 2008 fathead minnow study "results in a slightly revised database from that presented in the 2016 selenium NRWQC, now consisting of ten species in nine genera." This is not correct. Although EPA did not derive a precise toxicity endpoint, the fathead minnow is already included in EPA's SSD used in NRWQC calculations. Fathead minnow toxicity information is shown on Table 3.1, "Maternal Transfer Reproductive Studies," (U.S. EPA, p 45-46). The fathead minnow estimated genus mean chronic value (< 25.6 mg/kg dw egg-ovary) ranks seventh of the nine fish genera mean chronic values. The tenth fish genera in the SSD, *Gambusia*, is viviparous (live-bearing, versus egg-laying), so a genus mean chronic value was not derived for the egg-ovary criterion element calculation.

The total number of genus mean chronic value toxicity endpoints available to derive the selenium chronic criterion is 15. These include ten fish genera (*Acipenser*, *Salmo*, *Lepomis*, *Micropterus*, *Oncorhynchus*, *Pimephales*, *Gambusia*, *Esox*, *Cyprinodon*, and *Salvelinus*). Added to these are the tested invertebrate genera *Centroptilum*, *Brachionus*, and *Lumbriculus*, and two waived genera (crustaceans) (U.S. EPA 2016(a), Section 3.1.6, p 60).

Including GEI's data would not impact the egg-ovary criterion element. U.S. EPA's estimated genus mean chronic value ("< 25.6 mg/kg dw) and GEI's proposed alternate

genus mean chronic value (60.2 mg/kg dw) do not change the relative sensitivity rank for the four most sensitive genera used in the egg-ovary criterion element calculations (Stephan et al., 1985); these ranged from 15.6 mg/kg dw egg-ovary (*Acipenser*) to 25.3 mg/kg dw egg-ovary (*Oncorhynchus*).

GEI's recommendation is not based on new information or updates to the SSD data set; it is based on an alternate interpretation of existing data. GEI's proposed data modification does not reflect updated toxicity findings. It does not conform to the Recalculation Procedure, and it does not result in a fish tissue criterion specific to Indiana waters that provides the same level of protection intended for aquatic life as the national criteria.

2. Conversion Factors: U.S. EPA and the United States Geological Survey (USGS) developed an equation based on a mechanistic model of bioaccumulation to translate the egg-ovary elements to whole-body, muscle, and water column elements for the 2016 selenium NRWQC. The equation includes a species-specific trophic transfer factor (TTF) value, a species-specific egg-ovary to whole body conversion factor (CF), and a site-specific enrichment factor. The TTF represents the transfer of selenium from one trophic level to the next higher trophic level.

   GEI disagreed with U.S. EPA's application of median-derived conversion factors to translate the egg-ovary criterion element to the whole fish/muscle and water column criterion elements. GEI, instead, proposed a regression-based approach. GEI provided this comment during the 2015 draft selenium NRWQC. U.S. EPA provided the following response: "EPA noted that both GEI and NAMC commented that conversion factors (CFs) derived using a median were inappropriate; GEI comments did not provide specific reasons for why medians were inappropriate, but rather, that regressions would be more appropriate (U.S. EPA 2016(b), p. 188)."

   For the 2016 final selenium NRWQC, U.S. EPA retained the use of the median to derive CFs in the criteria document for several reasons, including that (1) the median is a non-parametric measure of central tendency that does not require an assumption of linearity; (2) it is direct and simple analysis that can easily be verified and replicated with simple spreadsheet tools; and (3) more complex analyses did not yield results that were different or superior (U.S. EPA 2016(b), p. 188-189). A chart comparing the CFs derived by each method is shown in Appendix N of the 2016 selenium NRWQC (U.S. EPA, 2016(a), Table N-3, p N-15).

   GEI's proposed modification of the conversion factor methodology does not conform to the Recalculation Procedure, and it does not result in a fish tissue criterion specific to Indiana waters that provides the same level of protection intended for aquatic life as the national criteria.

3. Non-Sturgeon Waters criterion: GEI proposed using the Recalculation Procedure described above to propose a "non-sturgeon waters" criterion for portions of Indiana. Applying the Recalculation Procedure is an acceptable approach to derive a site-specific criterion (SSC) for portions of Indiana.

   To support their argument for a "sturgeon absent" selenium criterion, GEI stated

"sturgeon in Indiana are generally found in larger waterbodies and would not be expected to be present in smaller creeks and streams; therefore, it is not necessary to retain *Acipenser* in the selenium database to be protective of waterbodies that do not support sturgeon." GEI did not provide specific sturgeon distribution or abundance data.

There is precedence for a "non-sturgeon waters" selenium SSC. The State of Idaho promulgated the 2016 selenium NRWQC into its state water quality standards and included justification for an SSC for non-sturgeon waters (State of Idaho, November 2017). IDEM evaluated GEI's recommendation to modify the selenium criterion for portions of the state that are non-sturgeon waters. This request is consistent with provisions in the recalculation procedure (U.S. EPA, 2013) to modify the SSC in the NRWQC for portions of the state where these species, or species for which they are a surrogate in the NRWQC SSD, do not occur at the site.

According to U.S. EPA's Recalculation Procedure (U.S. EPA, 2013), because some tested species might be needed to represent untested species that occur at the site, the deletion process does not provide for simplistic deletion of all species that do not occur at the site. Rather, the deletion process is designed to ensure that each species, genus, family, order, class, and phylum that occurs both at the site and in the national toxicity dataset is retained in the site-specific toxicity dataset.

White sturgeon (*Acipenser transmontanus*), representing the Family Acipenseridae, Order Acipenseriformes, is the aquatic organism most sensitive to the effects of selenium in the 2016 NRWQC SSD. While this species is not found in Indiana, it serves as a surrogate in Indiana for two sturgeon species (lake sturgeon (*Acipenser fulvescens*) and shovelnose sturgeon (*Scaphirhynchus platorynchus*)) and one paddlefish species (American paddlefish (*Polyodon spathula*)) in the Order Acipenseriformes (U.S. EPA, 2013; see Appendix 1), which are not included in the SSD. The taxonomic relationship among these species is shown in Table 1, below. Shading indicates shared taxonomic rank.

Table 1. Acipenseriformes taxonomic classification for Indiana species: White sturgeon as a surrogate species for lake sturgeon, shovelnose sturgeon, and American paddlefish in the Species Sensitivity Distribution (SSD) used to derive the 2016 NRWQC for selenium. Shading indicates shared taxonomic rank.

	White Sturgeon	Lake Sturgeon	Shovelnose Sturgeon	American Paddlefish
Phylum	Chordata	Chordata	Chordata	Chordata
Class	Actinopterygii	Actinopterygii	Actinopterygii	Actinopterygii
Order	Acipenseriformes	Acipenseriformes	Acipenseriformes	Acipenseriformes
Family	Acipenseridae	Acipenseridae	Acipenseridae	Polyodontidae
Genus	*Acipenser*	*Acipenser*	*Scaphirhynchus*	*Polyodon*
Species	*transmontanus*	*fulvescens*	*platorynchus*	*spathula*
Resident?	No	Yes	Yes	Yes
Tested?	Yes	No	No	No

IDEM is including a selenium site-specific criterion for "Non-Acipenseriformes Waters"

outside of the Great Lakes System in the draft rule for consideration of preliminary adoption.

- IDEM is not including a selenium site-specific criterion for "Non-Acipenseriformes Waters" within the Great Lakes System. Lake sturgeon (*Acipenser fulvescens*) are resident in Lake Michigan and are actively being reintroduced (after being extirpated) into Lake Erie. IDEM has determined that all waters in Indiana's Great Lakes System will be classified as "Acipenseriformes Waters".
- Certain upstream waters outside of the Great Lakes System where Acipenseriformes are not expected to be found but may serve as habitat or spawning areas, or contribute to downstream water quality, will be evaluated, and may be classified as "Acipenseriformes Waters."

Sturgeon and Paddlefish (Order Acipenseriformes) Occurrence and Habitat:
IDEM consulted with IDEM and Indiana Department of Natural Resources (IDNR) fisheries biologists regarding the occurrence, distribution, and abundance of sturgeon and paddlefish species in Indiana and also consulted with the Ohio River Valley Sanitation Commission (ORSANCO) and Illinois biologists regarding species occurrence and distribution in interstate waters. IDEM also consulted scientific literature documenting species occurrence and distribution in Indiana (Blatchey, 1938; Bruch et al., 2016; Gerking, 1945; Phelps et al., 2011; Simon, 2011; Wallus, 1990).

Order Acipenseriformes
Acipenseriformes (sturgeon and paddlefish) are primitive, ray-finned fishes whose evolution dates back 250 to 300 million years ago. They retain the physiological traits of their ancient ancestors, such as a cartilaginous endoskeleton and hetero-caudal fin, and are considered "relic fish". While there are inherent differences among species, Acipenseriformes are one of the largest, longest lived, and slowest growing freshwater fishes in the world. Species within the Order Acipenseriformes spawn many times during their lifetimes but have protracted spawning that spans from every couple of years up to nine years, depending upon the species. The eggs of many species are harvested for processing into caviar. Because of the value of caviar, Acipenseriformes are particularly vulnerable to overexploitation in addition to other threats, including pollution and habitat fragmentation. Many species are considered to be at risk of extinction. In order to prevent further decline of sturgeon resources, all species in the Order Acipenseriformes were placed under the species protection system of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Convention in 1997 (Ctarci, 2004).

Indiana has three resident species of Acipenseriformes:

- *Acipenser fulvescens* (Lake sturgeon) was once widespread in the Great Lakes and in Indiana's larger rivers and streams prior to overharvesting and hydrologic modification (dams) that blocked river spawning habitat. Lake sturgeon are slow-growing, long-lived fish, with males living up to 50 years and females living up to 150 years. Females begin reproducing between 14 and 33 years of age and, then, only produce eggs every three to twelve years. Mature lake sturgeon can reach lengths of greater than six feet and weights over 100 pounds. The current lake

sturgeon population is estimated to be one percent of its historic abundance. Lake sturgeon currently occur in Lake Michigan and are being restocked into Lake Erie (USFWS, 2019). Indiana lake sturgeon found in the Lower Wabash and White River are the species' last known naturally reproducing population in the Ohio River basin. They are an Indiana State Endangered Species (IDNR 2019(a)). In Indiana, harvesting or taking of Lake Sturgeon is illegal (IDNR, 2019(b)).

- S*caphirhyncus platorynchus* (Shovelnose sturgeon) are common in Indiana rivers. This is the smallest species of freshwater sturgeon native to North America, reaching only two feet in length, with an average weight of 5.5 pounds, and with life spans of up to thirty years. Shovelnose sturgeon begin spawning between five to seven years of age, and females do not produce eggs every year (IDNR 2012(a)). Like other Acipenseriformes species, shovelnose sturgeon eggs are harvested for caviar production. IDNR biologists have observed a decline in their population in recent years due to overharvesting and poaching. As with other Acipenseriformes, the historic occurrence and distribution of this species has been impacted by hydrological modifications of large rivers, specifically, the construction of dams. IDEM and IDNR biologists have documented the presence of shovelnose sturgeon in the following state and interstate waters: Eel River, Lake Michigan, Mississinewa River, Ohio River, Salamonie River, Sugar Creek, Tippecanoe River, Wabash River, and White River (East Fork and West Fork). Shovelnose sturgeon spawn in tributaries to these waters.
- *Polyodon spathula* (American paddlefish) are rare to occasional in Indiana. They occur in Indiana's large rivers, including the Ohio River and its tributaries. American paddlefish is the only extant species worldwide in the paddlefish family, Polyodontidae; the Chinese paddlefish (*Psephurus gladius*) was declared extinct in December 2019 (Zhang et al., 2019). American paddlefish are often referred to as primitive fish or relict species because they retain some morphological characteristics of their early ancestors, including a skeleton that is almost entirely cartilaginous, and a paddle-shaped rostrum (snout) that extends nearly one-third their body length. American paddlefish can reach a length of seven feet and a weight of 160 pounds. They may live 30 to 60 years, and are slow to mature, with males first spawning at seven years of age, and females at nine to ten years of age. During most of its life, a paddlefish lives in quiet or slow-flowing waters, but for spawning, this species must have access to a large, free-flowing river with gravel bars that frequently flood (IDNR, 2012(b)). To protect the declining population in Indiana, it is illegal for anglers to take a paddlefish in state waters, and commercial fishermen cannot take paddlefish from the Ohio River (IDNR, 2019). IDEM and IDNR biologists have documented the presence of American paddlefish in similar waters as the shovelnose sturgeon, plus the interstate Ohio River and its tributaries, and the interstate Greater Miami River watershed.

Determining the resident fish species that occur at the site:
For its analysis, IDEM did not consider the removal of other genera from the site-specific data set for the purposes of recalculating the selenium criterion for non-Acipenseriformes waters for portions of Indiana. The remaining NRWQC SSD nine fish genera include many Indiana resident genera/species or stocked species, in addition to those reviewed previously: *Oncorhynchus* (Rainbow trout, Chinook salmon, and Coho salmon), *Salmo*

(Brown trout), *Salvelinus* (Lake trout), *Micropterus* (Largemouth bass, Smallmouth bass, and Spotted bass), and *Esox* (Northern pike, Muskellunge, Grass pickerel, and Tiger muskie). Other Indiana species represented in the genus *Lepomis*, represented in the SSD by Bluegill sunfish *(Lepomis macrochirus*), include Green sunfish, Orange spotted sunfish, Redear sunfish, and Warmouth (IDNR, 2018(a)). These species may be present in waters where Acipenseriformes do not occur at the site.

Recalculating the Selenium criterion elements based on resident fish species
IDEM used the Recalculation Procedure and U.S. EPA methodologies (Stephan et al., 1985) to derive site-specific egg-ovary, whole-fish, and muscle criterion elements for portions of Indiana outside the Great Lakes System where fishes in the Orders Acipenseriformes do not occur at the site. IDEM has determined that there are no other Order Acipenseriformes species in Indiana other than *Acipenser fulvescens* (lake sturgeon), *Scaphirynchus platorynchus* (shovelnose sturgeon) and *Polyodon spathula*,(American paddlefish) for which *Acipenser transmontanus (white sturgeon)* serves as a surrogate species in the NRWQC SSD. For the recalculation, IDEM used genus mean chronic values (GMCVs) included in the national toxicity dataset for each of the fish tissue criterion elements. IDEM removed the *Acipenser* GMCV from the national toxicity dataset, then recalculated the selenium criterion elements based on the remaining GMCVs in the national dataset. To do this, we arranged the remaining GMCVs from lowest to highest, as shown on Table 2, for the egg-ovary toxicity dataset. We applied this ranking and calculation process for each criterion element, using the GMCVs from the national toxicity dataset for each criterion element. Given that there are species-specific conversion factors for selenium bioaccumulation in different fish tissue types, this hierarchy changes depending upon the tissue type analyzed (U.S. EPA, 2016a). Per the Stephan et al (1985) methodology, we used the GMCVs from the four most sensitive genera, and the revised number of genera ("N") to calculate the egg-ovary criterion element (Table 3), whole-body criterion element (Table 4) and muscle criterion element (Table 5) to calculate site-specific criterion elements for non-Acipenseriformes waters.

Table 2. Egg-Ovary Species Sensitivity Distribution for Selenium: Ranked fish egg-ovary genus mean chronic values (GMCVs) for waters of the state within and outside of the Great Lakes System ("Waters") and site-specific criterion elements outside of the Great Lakes system where Acipenseriformes do not occur at the site ("Site-Specific").

"Waters" N = 15[a]			**"Site-specific" N = 14[a]**		
Rank	**GMCV[b] (mg Se/kg dw egg-ovary)[c]**	**Species**	**Rank**	**GMCV[b] (mg Se/kg dw egg-ovary)[c]**	**Species**
9	56.2	Dolly Varden *Salvelinus malma*			
8	34	Northern pike *Esox lucius*	8	56.2	Dolly Varden *Salvelinus malma*
7	27	Desert pupfish *Cyprinodon macularius*	7	34	Northern pike *Esox lucius*
6	26.3	Largemouth bass *Micropterus salmoides*	6	27	Desert pupfish *Cyprinodon macularius*
5	<25.6[d]	Fathead minnow	5	26.3	Largemouth bass

		Pimephales promelas			*Micropterus salmoides*
4	25.3	Cutthroat trout *Oncorhynchus clarkii*	4	<25.6[d]	Fathead minnow *Pimephales promelas*
		Rainbow trout *Oncorhynchus mykiss*	3	25.3	Cutthroat trout *Oncorhynchus clarkii*
3	21.0	Brown trout *Salmo trutta*			Rainbow trout *Oncorhynchus mykiss*
2	20.6	Bluegill sunfish *Lepomis macrochirus*	2	21.0	Brown trout *Salmo trutta*
1	15.6	White sturgeon *Acipenser transmontanus*	1	20.6	Bluegill sunfish *Lepomis macrochirus*

[a]N: number of species in the Species Sensitivity Distribution. The table includes egg-ovary data for fishes in the SSD. *Gambusia,* an additional fish species in the national dataset, has a reproductive value expressed as an adult whole-body fish since it is an oviparous genus (live-bearer versus egg-layer). Also in the national dataset are the tested invertebrate genera *Centroptilum*, *Brachionus*, and *Lumbriculus*, and two waived genera (crustaceans).

[b]GMCV: genus mean chronic value.

[c]mg Se/kg dw: milligrams of selenium per kilogram, dry weight

[d]GMCV not calculated, but estimated, due to variability in the observations among replicates in toxicity studies. The chronic value in this table is included to show it is in the range of selenium effects concentrations (U.S. EPA, 2016 (a), p 46). The estimated GMCV was not used in the calculation of either the NRWQC or the Indiana site-specific criterion for waters outside of the Great Lakes System.

Table 3. Calculation of the Indiana site-specific egg-ovary criterion element for selenium

Genus	Rank	GMCV[a]	ln(GMCV)	ln(GCMV)^2	P=R/(N+1)[b]	Sqrt(P)
Micropterus	4	26.3	3.27	10.69	0.27	0.52
Oncorhynchus	3	25.3	3.23	10.44	0.20	0.45
Salmo	2	21	3.04	9.27	0.13	0.37
Lepomis	1	20.6	3.03	9.15	0.07	0.26
		sum	12.57	39.55	0.67	1.59
					N[c]	14
					S^2[d]	1.28
					S	1.13
					L[e]	2.69
					A[f]	2.95
					FCV[g]	**19.0**

Notes:

[a]Selenium concentration in mg/kg dw. See Table 2, above, and U.S. EPA 2016(a), p 45-49 for egg-ovary toxicity data.

[b]Cumulative probability

[c]Total number of GMCVs in data set

[d]$S^2 = \frac{\sum(\ln GMCV)^2 - (\sum \ln GMCV)^2/4}{\sum P - (\sum \sqrt{P})^2/4}$

[e]$L = [\sum \ln GMCV - S(\sum \sqrt{P})]/4$

[f]$A = S(\sqrt{0.05}) + L$
[g]FCV = Final chronic value in mg/kg dw; $FCV = e^A$

Table 4. Calculation of the Indiana site-specific whole- body criterion element for selenium

Genus	Rank	GMCV[a]	ln(GMCV)	ln(GCMV)^2	P=R/(N+1)[b]	Sqrt(P)
Esox	4	14.2	2.65	7.04	0.27	0.52
Salmo	3	13.2	2.58	6.66	0.20	0.45
Oncorhynchus	2	11.6	2.45	6.01	0.13	0.37
Lepomis	1	9.9	2.29	5.26	0.07	0.26
		sum	9.98	24.96	0.67	1.59
					N[c]	14
					S^2[d]	2.03
					S	1.42
					L[e]	1.93
					A[f]	2.25
					FCV[g]	**9.5**

Notes:
[a]Selenium concentration in mg/kg dw. See U.S. EPA 2016(a) p 49-51 for whole-body toxicity dataset.
[b]Cumulative probability
[c]Total number of GMCVs in data set
[d]$S^2 = \frac{\sum(\ln GMCV)^2 - (\sum \ln GMCV)^2/4}{\sum P - (\sum \sqrt{P})^2/4}$
[e]$L = [\sum \ln GMCV - S(\sum \sqrt{P})]/4$
[f]$A = S(\sqrt{0.05}) + L$
[g]FCV = Final chronic value in mg/kg dw; $FCV = e^A$

Table 5. Calculation of the Indiana site-specific muscle criterion element for selenium

Genus	Rank	GMCV[a]	ln(GMCV)	ln(GCMV)^2	P=R/(N+1)[b]	Sqrt(P)
Esox	4	21.7	3.08	9.47	0.27	0.52
Salmo	3	18.5	2.92	8.51	0.20	0.45
Lepomis	2	15.9	2.77	7.65	0.13	0.37
Oncorhynchus	1	14.3	2.66	7.08	0.07	0.26
		sum	11.42	32.71	0.67	1.59
					N[c]	14
					S^2[d]	2.68
					S	1.64
					L[e]	2.21
					A[f]	2.57
					FCV[g]	**13.1**

Notes:
[a]Selenium concentration in mg/kg dw. See U.S. EPA 2016(a) p 52-54 for muscle toxicity dataset.
[b]Cumulative probability

[c]Total number of GMCVs in data set
[d]$S^2 = \frac{\sum(\ln GMCV)^2 - (\sum \ln GMCV)^2/4}{\sum P - (\sum \sqrt{P})^2/4}$
[e]$L = [\sum \ln GMCV - S(\sum \sqrt{P})]/4$
[f]$A = S(\sqrt{0.05}) + L$
[g]FCV = Final chronic value in mg/kg dw; $FCV = e^A$

Indiana fish tissue criterion elements for waters outside of the Great Lakes System where fishes in the Order Acipenseriformes (sturgeon and paddlefish) do not occur at the site

IDEM's recalculated criterion elements are presented in Table 6, below, and are compared to U.S. EPA 2016 NRWQC, IDEM's 2nd Notice Metals Rulemaking, and GEI's Proposed IN State-Specific Criteria.

Criteria presented in the draft rule for consideration of preliminary adoption include the 2016 NRWQC chronic criterion numeric fish tissue elements for waters within and outside of the Great Lakes System ("Waters"). IDEM's Draft Rule for consideration of preliminary adoption includes site-specific selenium criterion elements with less stringent numeric fish tissue elements for those waters outside of the Great Lakes System where neither sturgeon nor paddlefish occur ("Site-specific"). The criteria include the footnotes included in the 2016 NRWQC for selenium, with clarifying modifications specific to Indiana rules and processes.

Upon receipt of an application for a site-specific determination that fishes in the Order Acipenseriformes do not occur at the site, IDEM will review available species occurrence and distribution information for lake sturgeon (*Acipenser fulvescens*), shovelnose sturgeon (*Scaphirynchus platorynchus*) and paddlefish (*Polyodon spathula*) Site-specific criterion elements apply only after IDEM has determined, and U.S. EPA approves IDEM's determination, that fishes in the Order Acipenseriformes do not occur at the site.

Table 6. Summary Comparison Table: U.S. EPA 2016 NRWQC, GEI, and Indiana proposed selenium fish tissue criterion elements for waters of the state within and outside the Great Lakes System ("Waters") and site-specific criterion elements where Acipenseriformes do not occur at the site ("Site-Specific").

	Egg-ovary mg/kg dw		**Whole-Body mg/kg dw**		**Muscle mg/kg dw**	
Source	Waters	Site-specific*	Waters	Site-specific*	Waters	Site-specific*
U.S. EPA 2016 NRWQC	15.1		8.5		11.3	
IN 2017 2nd Notice Metals Rulemaking Proposed	15.1		8.5		11.3	
GEI 2017 IN State-Specific Proposed	17.3	20.7	9.0	9.6	12.3	13.1
IN 2020 Draft Rule	**15.1**	**19.0**	**8.5**	**9.5**	**11.3**	**13.1**

*****These criteria are applicable to surface waters of the state for which the department has made a site-specific determination, and U.S. EPA has approved, that fishes in the Order Acipenseriformes (sturgeon, paddlefish) do not occur at the site, as defined at 327 IAC

2-1-9(37)**.**

4. GEI's Derivation of Water Column Criterion Elements
   GEI proposed alternate approaches to derive alternate water column criterion elements for lentic waters, lotic waters, and intermittent discharges.

   Sulfate acute toxicity: GEI noted high sulfate waters have the potential to reduce acute selenium toxicity and, therefore, the water column elements developed on a national scale may be overprotective of some Indiana waters that have high sulfate. GEI proposed that site or regional water column criteria may be appropriate depending on ambient sulfate concentrations. However, the 2016 selenium NRWQC does not define a relationship between selenium concentrations and sulfate and does not include acute criterion elements.

   U.S. EPA notes that "including any type of sulfate relationship in the national criterion would necessitate having sulfate measurements to accompany all observed selenium water concentrations included in the derivation database. The absence of an accompanying sulfate observation would necessitate excluding the water observation. The resulting reduction in the number of sites included in the database would reduce the confidence in its ability to represent the nation's waters. For the above reasons, U.S. EPA has not included a sulfate relationship in the 2016 selenium criterion. (U.S. EPA 2016 (a), p. 130-131)."

   Furthermore, the 2016 selenium NRWQC does not include acute criterion elements. U.S. EPA notes (U.S. EPA 2016(a). p xii) the following:

   > Although selenium may cause acute toxicity at high concentrations, the most deleterious effect on aquatic organisms is due to its bioaccumulative properties. These chronic effects are found at lower concentrations than acute effects. Organisms in aquatic environments exposed to selenium accumulate it primarily through their diets and not directly through water (Chapman et al., 2010). The best science also indicates that selenium toxicity occurs primarily through transfer to the eggs and subsequent reproductive effects. Consequently, in harmony with the recommendations of expert panels (U.S. EPA 1998; Chapman et al., 2010) and with peer review and public comments on previous U.S. EPA (2004, 2014, 2015) drafts, U.S. EPA developed a chronic criterion reflective of the reproductive effects of selenium concentrations on fish species.

   Considering sulfate acute toxicity to derive Indiana selenium water quality criteria is not supported by the NRWQC or Indiana-specific data.

   Regression based approach to derive water column criteria elements:
   GEI recommended a regression approach proposed by DeForest et al. (2017) to calculate the water column criteria for lentic and lotic waters. U.S. EPA noted that this approach, outlined in a 2014 study, yields similar results as the U.S. EPA approach, which is based on an equation that includes a species-specific trophic transfer factor (TTF) value, a conversion factor, and an enrichment factor.

> The water column values calculated using this are strikingly similar to EPA's water column recommendations of 3.1 µg/l and 1.5 µg/l for lotic and lentic systems. This result further substantiates and supports U.S. EPA's water column values, despite the use of different analytic methods in the two approaches (U.S. EPA, 2016 (b), p. 54).

However, GEI's proposed water column criterion elements of 4.2 µg/l in lotic system and 2.2 µg/l in lentic systems are less stringent than U.S. EPA's NRWQC (3.1 µg/l in lotic systems and 1.5 µg/l in lentic systems). This is because GEI used the less stringent (higher) proposed egg-ovary criterion element value (17.3 mg/kg dw vs 15.1 mg/kg dw) that resulted from their revisions to the genus mean chronic value toxicity endpoints (GMCV) for white sturgeon (17.7 mg/kg versus 15.6 mg/kg) and bluegill sunfish (24.4 mg/kg dw versus 14.7 mg/kg dw). Applying these revised GMCVs resulted in the less stringent egg-ovary criterion element, and thus less stringent water column criterion elements. Using the model of DeForest et al. with U.S. EPA's 2016 selenium NRWQC egg-ovary criterion element (15.1 mg/kg dw) calculated at the 75th quartile derives water column criteria elements of 2.8 µg/l for lotic waters and 1.7 µg/l for lentic waters. These values are equivalent to the NRWQC criterion elements calculated using the TTF methodology at the 20th percentile. IDEM agrees that since U.S. EPA has determined that this methodology provides equivalently protective water column criterion elements as their analytic methodology, the regression-based approach may be considered for deriving site specific criterion elements.

Acute intermittent exposure criterion element: GEI proposed an acute criterion element ("site-specific") to replace the intermittent exposure element, based on a biokinetic model for one-day and four-day pulses. The 2016 selenium NRWQC does not include acute criterion elements. U.S. EPA's intermittent water column criterion is derived to protect against chronic impacts, which occur at lower concentrations than acute impacts. Therefore, this recommendation is inconsistent with NRWQC recommendations, and IDEM does not support it (see comment regarding sulfate, above).

Selenate-dominated waters: For selenate-dominated waters, GEI proposed a sulfate-dependent model for the proposed site-specific water column criteria. U.S. EPA responded to this comment (U.S. EPA, 2016(b), p. 117) as follows:

> EPA decided not to include a sulfate correction factor in the 2016 selenium criterion due to uncertainties in the science. The Deforest et al. 2014 report referred to in the NAMC and API 2015 public comments notes that a sulfate-dependent selenium criteria would apply only to selenate-dominated, well-oxygenated streams, which is a small subclass of waters in the U.S. The publication discussed experiments to assess influence of sulfate on selenate uptake on only one species of macrophyte (*Lemna minor*) and one algal species (*Pseudokirchnella subcapitata*), a very limited data set of primary producers. The authors themselves note that, "It does need to be emphasized here, however, the analysis currently does not include Se data for periphyton and benthic diatoms, as these data are not available." The authors also note that "due to methodological challenges and high costs, it is difficult to comprehensively evaluate the influence of sulfate on bioconcentration and transfer up the food chain." Similarly, EPA

describes effects of mercury on aquatic life, but did not adjust the chronic criterion."

GEI did not provide Indiana specific data to support development of a selenate-dominated criterion, and IDEM does not support GEI's proposed model.

Indiana site-specific water column criterion elements for waters outside of the Great Lakes System where fishes in the Order Acipenseriformes do not occur at the site.

IDEM used the DeForest et al. (2017) regression model to calculate water column elements for non-Acipenseriformes waters using the recalculated egg-ovary criterion element (19 mg/kg dw). As noted above, U.S. EPA concurred that this approach yields similar results as the U.S. EPA approach, which is based on an equation that includes a species-specific trophic transfer factor (TTF) value, a conversion factor, and an enrichment factor. This approach yields water column criterion elements of 5.5 µg/l for lotic waters and 2.7 µg/l for lentic waters at the 75th quartile.

Criteria in the draft rule to be presented for consideration of preliminary adoption include the 2016 NRWQC chronic criterion numeric water column elements for waters within and outside of the Great Lakes System ("Waters"). The draft rule for consideration of preliminary adoption also includes site-specific selenium criterion elements with less stringent numeric water column elements for those waters outside of the Great Lakes System where neither sturgeon nor paddlefish (Order Acipenseriformes) occur at the site ("Site-specific"). The criteria include the footnotes included in the 2016 NRWQC for selenium, with clarifying modifications specific to Indiana rules and processes.

Upon receipt of an application for a site-specific determination that fishes in the Order Acipenseriformes do not occur at the site, IDEM will review available species occurrence and distribution information for lake sturgeon (*Acipenser fulvescens*), shovelnose sturgeon (*Scaphirynchus platorynchus*) and paddlefish (*Polyodon spathula*) Site-specific criteria apply only after IDEM has determined, and U.S. EPA approves IDEM's determination, that Acipenseriformes do not occur at the site.

Table 7. Summary Comparison Table: U.S. EPA 2016 NRWQC, GEI, and Indiana proposed lotic ("flowing") and lentic ("still") water column criterion elements for waters of the state within and outside the Great Lakes System ("Waters") and site-specific criterion elements where Acipenseriformes do not occur at the site ("Site-Specific").

Source	Lotic µg/l		Lentic µg/l	
	Waters	Site-specific*	Waters	Site-specific*
U.S. EPA NRWQC 2016	3.1		1.5	
IN 2017 2nd Notice Metals Rulemaking Proposed	3.1		1.5	
GEI 2017 IN State-Specific Proposed	4.2	7.2	2.2	3.2
IN 2020 Draft Rule	**3.1**	**5.5**	**1.5**	**2.7**

*These criteria are applicable to surface waters of the state for which the department has made a site-specific determination, and U.S. EPA has approved, that fishes in the Order Acipenseriformes (sturgeon, paddlefish) do not occur at the site, as defined at 327 IAC 2-1-9(37)**.**

Comment: The draft rule includes a water quality criterion for selenium that is based on

the NRWQC at Section 304(a) of the Clean Water Act. IDEM needs to develop a state specific criterion for selenium based on regional water quality and biological conditions and that incorporates advances in the science that have occurred since the release of the U.S. EPA's NRWQC. U.S. EPA's guidance documents state that the NRWQC are only recommendations and a state can pursue a state criterion that is independent of the national recommended criterion. (ICC, IMA, AEP, NIPSCO, DUKE, PE)

Comment: The U.S. EPA's 2016 national criteria for selenium are based on a select number of data usage decisions that are focused on a national scale and not necessarily appropriate criteria for Indiana waters. In fact, the U.S. EPA data set is limited in sampling locations and does not contain data from Indiana. (NIPSCO)

Response: U.S. EPA publishes NRWQC on a national scale using species representative of organisms present nationally. As discussed in the GEI response section, the selenium 2016 NRWQC SSD fish genera include Indiana resident genera/species or stocked species, or taxa that represent these species, and, thus, is protective of taxa in Indiana waters. Most fish genera in the NRWQC SSD are represented in Indiana, for example: *Acipenser* (lake sturgeon, shovelnose sturgeon, American paddlefish); *Oncorhynchus* (Rainbow trout, Chinook salmon, and Coho salmon); *Salmo* (Brown trout), *Salvelinus* (Lake trout), *Micropterus* (Largemouth bass, Smallmouth bass, and Spotted bass), *Esox* (Northern pike, Muskellunge, Grass pickerel, and Tiger muskie); *Lepomis*, (Bluegill sunfish, Green sunfish, Orange spotted sunfish, Redear sunfish, and Warmouth (IDNR, 2018(a)).

In the draft rule for consideration of preliminary adoption, IDEM is proposing a site-specific criterion for those waters of the state outside of the Great Lakes System where fishes in the Order Acipenseriformes do not occur at the site. To propose additional Indiana site-specific chronic criteria for selenium based on regional water quality and biological conditions that incorporate advances in the science used to publish the 2016 selenium NRWQC, IDEM would require sufficient paired water column and fish tissue data representing regional water conditions or toxicity studies specific to species in Indiana, or both. These data are lacking.

Comment: IDEM's 2016 fish tissue sampling program provides ambient fish tissue selenium concentrations (fillets) within the White River basin. These data did not exceed the proposed fish tissue WQC for selenium when converted to a dry weight basis. In addition, Indiana has not identified waters where beneficial uses are impaired by the presence of selenium. Therefore, Indiana's current selenium chronic aquatic criterion (CAC) of 35 µg/l, except at water intakes where the criterion is 10 µg/l, appears to be protective of beneficial uses in the White River. These data would support IDEM adopting the U.S. EPA's 2016 fish tissue-based WQC but continuing to use the current water column criteria or one that is recalculated to be appropriate for Indiana waters. (IPL)

Response: While 2016 fish tissue sampling in the White River did not show exceedances of the proposed selenium fish tissue criterion element, these samples were not paired with selenium surface water samples. Indiana's current selenium chronic aquatic criterion (CAC) for waters outside of the Great Lakes System of 35 µg/l date from U.S. EPA's first NRWQC (U.S. EPA, 1980), which did not consider the bioaccumulative properties of selenium, because they were not well understood at that time. U.S. EPA has revised this criterion several times (1987 and 1998-1999), but Indiana has not updated its rules to incorporate these updates. The chronic water column criterion elements proposed in the draft rule for consideration of preliminary adoption are derived from the egg-ovary criterion element in accordance with the latest science and U.S. EPA's 2016 selenium NRWQC.

Comment: The current IDEM proposed criteria in the draft rule would adopt the national criteria with only slight modification, which is not an appropriate approach for Indiana waters. Instead, the selenium water quality criterion recommended in the GEI report would be a more appropriate basis for an Indiana water quality standard than the national criteria. The following are scientific justifications as to why IDEM should develop a state specific selenium criterion: (ICC, IMA, NIPSCO, DUKE, PE)

- The national criteria contain water column concentrations that are approaching the analytical limits of testing methods and are further complicated by interference from other parameters.

Response: The sensitivity of available analytical methods is not a factor that is used in the development of a water quality criterion. Instead, this issue is addressed when a water quality criterion is implemented.

- The sedimentary geology that dominates Indiana is known to be a natural source of elevated selenium. Therefore, IDEM will need to implement a standard that protects the aquatic life in this type of geology without imposing overly stringent criteria.

Response: U.S. EPA publishes NRWQC on a national scale using species representative of organisms present nationally, over a range of geological and ecological conditions. IDEM is proposing a site-specific criterion for those waters of the state outside of the Great Lakes System, where Order Acipenseriformes do not occur at the site. To propose additional Indiana site-specific chronic criteria for selenium, based on regional water quality and biological conditions that incorporate advances in the science used to publish the 2016 selenium NRWQC, IDEM would require sufficient paired water column and fish tissue data representing water conditions impacted by regional geology for prescribed areas in Indiana. These data are lacking. However, stakeholders may develop these data and propose site-specific criteria using the procedures established in the rules.

- U.S. EPA's method of determining potential impacts from intermittent discharges is an oversimplification that essentially applies the chronic criterion adjusted based on the number of days of discharge. This method does not account for the changes in selenium biodynamics that would occur during intermittent pulses. Another method of determining acute criteria resulting from short-term pulses of water is to use a biokinetic model to predict fish tissue concentrations resulting from intermittent pulses of selenium into the water column.

Response: Like the lentic and lotic criterion elements, the intermittent-exposure criterion element protects against cumulative exposure of selenium from multiple short-term discharges that may cause an excursion of the fish tissue criterion element. U.S. EPA derived the intermittent exposure criterion element directly from the chronic water criterion element by algebraically rearranging the chronic water criterion element to establish a limit on an intermittent elevated concentration occurring over a specified percentage of time, while simultaneously accounting for background concentrations. The intermittent exposure criterion was developed to protect aquatic life from chronic selenium impacts, while the biokinetic model was designed to protect against acute selenium impacts. According to the 2016 NRWQC for selenium, although selenium may cause acute toxicity at high concentrations, the most deleterious effects on aquatic organisms are due to its bioaccumulative properties from chronic exposures. These chronic effects are found at lower concentrations than acute effects. IDEM

concluded that U.S. EPA's intermittent selenium exposure criterion element was derived appropriately to protect aquatic taxa from adverse chronic impacts.

Comment: The water column values are nearing the limit of analytical accuracy regarding current test methods. Therefore, without developing state-specific selenium criteria, the national criteria in the draft rule will require unnecessary resources and expenditures for the regulated community. (IEA, NIPSCO)

Comment: The proposed selenium water column criteria for lentic waterbodies is so low as to approach the limit of analytical accuracy of current testing methods. For example, the minimum reporting limit for selenium measured using U.S. EPA's Method 200.8 is 1.0 µg/l, as reported by our contract laboratory, and this minimum reporting level is attainable only in the absence of routinely present chemical interferences detected by the instrument. The presence of inter-element interferences will likely make proof of compliance challenging, if not impossible. IDEM needs to implement criteria that are realistic relative to analytical determinations and do not cause noncompliance due to analytical uncertainty. (NIPSCO)

Response: The sensitivity of available analytical methods is not a factor that is used in the development of a water quality criterion. Instead, this issue is addressed when a water quality criterion is implemented.

Comment: The development of site-specific WQC under 327 IAC 2-1-13 uses a procedure that depends on calculations based on data requirements from multiple taxa. The U.S. EPA's 2016 selenium WQC were developed based on a different approach using fish tissue-based effects data. Aqueous WQC for selenium were then back-calculated from tissue concentrations associated with threshold effects using a broad data set. Fish are the most sensitive species to effects from selenium, and other taxa are not necessary for developing site-specific criteria that are protective of all aquatic organisms. IDEM should clarify that the recalculation procedure can be used with available and relevant fish tissue toxicity data and selenium uptake models, for example, as described in U.S. EPA 2016, or based on the best available science. An improvement on U.S. EPA's model could be made by including the interaction between selenium and sulfate (DeForest et al., 2017). (IPL)

Response: U.S. EPA used selenium toxicity data that expressed the adverse impacts to aquatic biota. For selenium, the most adverse impacts are reproductive effects, expressed in maternal egg and ovary tissue. While the 2016 NRWQC for selenium used genus mean chronic value (GMCV) toxicity endpoints based on egg-ovary data rather than water column data, U.S. EPA used methodologies to calculate criterion elements consistent with standard NRWQC methodologies including statistical procedures as described by Stephan et al (1985). EPA did use a trophic transfer approach to calculate GCMV toxicity endpoints for the other fish tissue criterion elements, but separately ranked each set of GMCV, then calculated each criterion element per statistical procedures outlined by Stephan et al (1985).

The total number of GMCV toxicity endpoints available to derive the selenium chronic criterion elements is 15. These include ten fish genera (*Acipenser*, *Salmo*, *Lepomis*, *Micropterus*, *Oncorhynchus*, *Pimephales*, *Gambusia*, *Esox*, *Cyprinodon*, and *Salvelinus*). Added to these are the tested invertebrate genera *Centroptilum*, *Brachionus*, and *Lumbriculus*, and two waived genera (crustaceans) (U.S. EPA 2016(a), Section 3.1.6, p 60). While fish taxa are more sensitive to the chronic effects of selenium than other aquatic taxa, it is not acceptable per U.S. EPA methodologies to eliminate aquatic species from the Species Sensitivity Distribution because they are less sensitive to a chemical than other aquatic species; rather, the methodology prescribes that acceptable toxicity data from a distribution of aquatic taxa must be included.

Please note that eliminating taxa from the SSD reduces the number of taxa or "N" for the statistical calculation, potentially resulting in more stringent criterion elements.

The recalculation procedure is an acceptable method for calculating a site-specific criterion for the fish tissue criterion elements (U.S. EPA 2016(a), p 103), and IDEM used these procedures in combination with guidance from U.S. EPA (2013) to derive site-specific selenium fish tissue criterion elements for portions of Indiana outside of the Great Lakes System where Acipenseriformes do not occur at the site. IDEM determined that it is not acceptable to use the recalculation procedure to derive fish tissue criterion elements for Great Lakes System waters, since most of the genera in the NRWQC SSD would occur at the site, or represent resident species that occur at the site. However, either of the mechanistic modeling or empirical bioaccumulation factor methodologies (U.S. EPA 2016(a), Appendix K) are acceptable procedures for deriving a site-specific water column criterion element for waters within and outside of the Great Lakes System.

Regarding sulfate concentrations in Indiana waters, and their impact on selenium, U.S. EPA noted in the 2016 NRWQC that "including any type of sulfate relationship in the national criterion derivation would necessitate having sulfate measurements to accompany all observed selenium water concentrations included in the derivation database. That is, the absence of an accompanying sulfate observation would necessitate excluding the water observation. The resulting reduction in the number of sites included in the database would reduce the confidence in its ability to represent the nation's waters. For the above reasons, EPA has not included a sulfate relationship in the 2016 selenium criterion." (U.S. EPA. 2016(a), p. 130-131)

Comment: In 327 IAC 2-1-6, table 6-2a, the CAC are differentiated on the basis of "lentic" and "lotic" aquatic systems and exposure duration. The lentic criteria will result in pervasive reasonable potential to exceed for all industries. IDEM needs to consider Indiana specific data and/or alternative models to derive selenium criteria representative of Indiana waters. Additionally, a footnote should be added to this table defining lentic and lotic aquatic systems as non-flowing surface waters and flowing surface waters, respectively. (IEA, IPL)

Response: IDEM does not anticipate that the lentic water column criterion element will result in pervasive reasonable potential to exceed for many industries, given the limited industries with processes that have the potential to discharge elevated concentrations of selenium. IDEM has not added a footnote defining lotic and lentic aquatic systems to the selenium criterion for waters outside of the Great Lakes System (327 IAC 2-1-6(a)(1)(4)(A), Table 6-1a) and within the Great Lakes System (327 IAC 2-1.5-8(a)(3)(B), Table 8-1a) or the site-specific criterion for Non-Acipenseriformes waters outside of the Great Lakes System (327 IAC 2-1-6(a)(1)(4)(B)), but will include a definition in implementation guidance.

Comment: The proposed selenium criteria are overly stringent and do not represent actual thresholds of adverse effects based on field studies. U.S. EPA's criterion document does not demonstrate adverse effects to sensitive aquatic life when lentic and lotic waterbodies have water column selenium concentrations about 1.3 micrograms per liter (µg/l) and 3.1 µg/l, respectively. Instead of the proposed selenium criteria that would put facilities discharging a detectable amount of selenium into a pervasive reasonable potential to exceed condition, IDEM should adopt the current Great Lakes Water Quality Guidance average selenium water quality criterion of 5 µg/l. This criterion is based on measured water selenium concentrations in a lentic setting where the unaffected portion of the lake had healthy and sustaining fish populations. (AEP)

Comment: The selenium water quality criteria that U.S. EPA selected for lotic and lentic systems are based on a probability distribution curve for the water column concentrations

attained from the egg-ovary tissue criterion. This methodology is very prescriptive for such a wide range of environments. The data actually demonstrate that water concentrations protective of the tissue criterion can range from 0.27 µg/l to 52.0 µg/l for lentic sites and 0.11 µg/l to 55.3 µg/l for lotic sites, depending on the site-specific factors. This range supports studies and standards specific to Indiana waters. IDEM needs to consider alternative methodologies that will better represent site-specific conditions in Indiana for establishing water quality standards. (NIPSCO)

Response: IDEM lacks statewide paired fish tissue and water column data to support and use alternate approaches to develop state-specific selenium water quality criterion elements for Indiana surface water. Without enough scientifically qualified Indiana-specific data, modifications to the NRWQC cannot be supported.

Comment: In 327 IAC 2-1-6, table 6-2a, footnotes [2] and [3], which indicate that the fish tissue elements take precedence over the proposed water column criteria for selenium when both elements are measured, are acceptable. However, the last sentence of footnote [5] talks about "...in the absence of steady-state condition fish tissue data." There is a concern that permits could be issued using this provision to incorporate water quality-based effluent limitations (WQBELs) for selenium in NPDES permits before a permittee would be allowed to submit fish tissue data. Neither U.S. EPA nor IDEM has defined what constitutes "steady state condition fish tissue data." (AEP)

Response: U.S. EPA has defined a "steady state" condition as an existing discharge that has not received new or increasing inputs of selenium and will provide further clarification when they publish final implementation guidance documents. In the draft rule for consideration of preliminary adoption, IDEM is including the following footnote in the selenium criterion table to clarify this term: "Fish tissue elements are expressed as steady-state; the aquatic system should not be experiencing new or increasing inputs of selenium." IDEM implementation guidance will include additional clarifying information. Generally, when any major changes to water column selenium concentrations occur, IDEM will require a minimum duration of 12 months before fish tissue may be sampled to assess bioaccumulation in the resident fish population. IDEM will consider site-specific factors that could shorten or lengthen this estimated time frame. IDEM is developing a guidance document that will detail how to collect paired fish tissue and water column data that can be used for reasonable potential determinations for water column permit limits, and to develop site-specific water column criterion elements where warranted. Entities have the option to use these methodologies to collect paired data to evaluate site-specific selenium concentrations in surface water and biota and to consult with IDEM to determine if an application for site-specific water column criterion elements may or not be warranted.

Comment: Fish tissue sampling plans are largely new and may not be well understood by the NPDES-regulated community. Therefore, IDEM should establish specific guidelines for fish tissue sampling requirements in order to support consistent and appropriate implementation of the fish tissue criteria. (NIPSCO)

Comment: Footnote 1 of tables 6-2a and 8-1a states: "Egg or ovary supersedes any whole-body, muscle, or water column element when fish egg or ovary concentrations are measured." The footnote clearly states that fish tissue criterion take precedence over water column criterion provided fish tissue data are available. For this reason, IDEM should develop implementation guidance to encourage and assist the regulated community to evaluate the fish tissue criterion. (NIPSCO)

Response: IDEM is in the process of developing guidance for the collection of fish tissue

data, water column data, or both for implementation of the selenium aquatic life criteria. IDEM will consider the comment and suggestion during the development of implementation guidance.

Comment: Footnote 3 of Tables 6-2a and 8-1a states: "Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured." Fish tissue concentration, on its own, is sufficient to assess compliance with the selenium WQC regardless of surface water concentrations. U.S. EPA derives its aqueous WQC directly from fish toxicity data. Therefore, measuring selenium in the tissues of fish inhabiting receiving waters is a direct and reliable approach to assessing compliance with selenium WQC and protection of beneficial uses without the need for water concentration data. IDEM should revise footnote 3 to delete the need for measuring water concentrations when fish whole-body or muscle tissues are collected or clarify why selenium measurements in water are needed to evaluate compliance with the WQC when fish whole-body or muscle tissues are collected. This would also be consistent with the requirements associated with fish egg or ovary tissues. (IPL)

Response: The NRWQC is derived to protect aquatic life, including fish, the most sensitive receptors, from the harmful effects of selenium. Indiana NPDES permit regulations at 327 IAC 5-2-11(d) require that, for continuous discharges, all permit limits shall, unless impracticable, be stated as maximum daily and average monthly limitations. Harvesting fish to measure selenium in the tissues of fish inhabiting receiving waters on a weekly or monthly basis as a permit condition would adversely impact the resident fish community. This would conflict with Indiana's rules at 327 IAC 2-1-3(a)(1)(2), which provide that surface waters of the state will be capable of supporting a well-balanced, warm water aquatic community, and where temperatures permit, put-and-take trout fishing.

IDEM is developing a guidance document that will detail how to collect paired fish tissue data and water column data that can be used for reasonable potential determinations for water column permit limits and to develop site-specific water column criterion elements where warranted.

Comment: Footnotes 6 and 7 of Tables 6-2a and 8-1a use the term "elevated", but there is no definition of this term. In this case, the term "elevated" is not describing exceedances, potential adverse effects, or impairment. The term is describing the number of days when there is a discharge or other anthropogenic activity potentially increasing selenium concentrations. The term "elevated selenium concentration" in footnotes 6 and 7 should be replace with "discharge" or otherwise defined. (IPL)

Response: U.S. EPA uses "elevated" to define the f_{int} variable used in the intermittent exposure equation. The variable represents the fraction of any 30-day period during which selenium concentrations in an intermittent discharge exceed the applicable lentic or lotic water column criterion element. Retaining "elevated" to define the f_{int} variable is appropriate. IDEM will address implementation of the intermittent criterion element in a future guidance document.

Comment: Implementation guidance describing fish collection and analysis methodologies are necessary to provide a reliable and consistent basis for determining compliance with the proposed selenium WQC. An implementation guidance document should be developed with the following considerations:

- Target species for selenium tissue analysis should be relatively abundant and commonly encountered at the target sampling location so they are available during successive sampling efforts and selenium analysis results can be compared among locations. Species to be samples should have a known and sufficiently small home range. The sampled

species should not be listed as threatened, endangered, or rare by the Indiana Department of Natural Resources or the U.S. Fish and Wildlife Service. The sampled species should be easy to identify and be a species that may accumulate high concentrations of selenium.

- Tissues should be composited from multiple, for example three to ten, individual fish of the same species, especially if smaller fish are caught, to be consistent with standard practice for collecting fish data used in regulatory reporting (IDEQ 2017, WVDEP 2017, U.S. EPA 2016, OEHHA 2005, U.S. EPA 2000). Composited whole fish or fillets should also follow the 75 percent rule where fish are of similar size so that the length of the smallest fish should be at least 75 percent of the length of the largest fish of a species.
- A minimum number of composite samples or locations, or both, should be targeted in waters to be analyzed. Hitt and Smith (2014) reported that sample sizes of fewer than five fish did not achieve 80% power to detect near-threshold values and that larger sample sizes may be necessary if tissue concentrations are near the criterion.
- Averaging tissue results from individual fish for comparison to the criterion should be acceptable if data can be obtained from individual fish.
- Fish collection methods that have minimal impact on non-target species are preferred. WVDEP (2017) and KDEP (2014) provide sampling guidance that includes fish collection by standard electroshocking methods over at least 100 meters starting as close as possible to the source.
- Reference sites may be included in fish tissue sampling programs to establish background selenium concentrations, where practical.
- Quality control samples for chemical analysis of selenium in tissues should include standard reference materials, duplicates, and matrix spike samples, consistent with U.S. EPA methods (2016), for quality assurance.
- Freeze drying of fish tissues minimizes selenium losses and should be the standard for selenium analysis along with closed vessel microwave digestion to minimize selenium losses. Alternatively, wet tissue analysis can be conducted with dry weight values calculated based on a tissue moisture determination. Freeze drying allows for the moisture content and selenium analyses to be conducted on the same tissue, but analyses of wet tissues require separate tissues to be analyzed to estimate moisture content to convert measurements to dry weight.
- Frequency of fish tissue collection must be established in an implementation guidance. Monthly sampling of fish tissue, as the typical NPDES permit requirement for metals analysis, would be costly and, likely, unnecessary since fish tissue concentrations respond slowly to changing water concentrations. Kentucky (KDEP 2014) adopted an approach where fish tissue samples are only required if aqueous selenium concentrations exceed the WQC. Less frequent fish tissue analysis might be required as, for example, U.S. EPA recommends biennial sampling of fish tissues to evaluate compliance with U.S. EPA's 2001 NRWQC for mercury, if resources allow or a minimum of every five years (U.S. EPA 2010).
- Compliance with selenium criteria must be described in guidance, especially a determination as to whether compliance is met if quarterly water samples exceed the aqueous WQC but annual fish tissue samples do not exceed the tissue-based WQC.
- IDEM should clarify how multiple fish tissue samples, for example, five composite fish tissue concentrations, would be compared to the fish tissue WQC. Each of these samples would be considered a contemporaneous replicate, for example, consisting of the same species collected at roughly the same location and at the same time, so a statistical

measure of the data would be appropriate for comparison with the fish tissue WQC. Presumably, an exceedance would need to be statistically significant for any action to occur.

(IPL)

Response: IDEM is in the process of developing guidance for the collection of fish tissue data, water column data, or both kinds of data for implementation of the selenium aquatic life chronic criterion, and for development of a site-specific water column criterion element using the bioaccumulation factor modeling method performance-based approach described in Appendix K of the 2016 NRWQC for selenium. IDEM appreciates the comments and suggestions and is considering them during the development of implementation guidance. IDEM has shared a preliminary draft implementation guidance with entities interested in using it to conduct paired fish tissue and water column samples. IDEM will use results and feedback to refine and finalize this guidance. IDEM is also developing a separate guidance document for implementation of the intermittent water column criterion element; this guidance document is in an earlier stage of development.

Comment: U.S. EPA's draft "Technical Support for Adopting and Implementing EPA's 2016 Selenium Criterion in Water Quality Standards" discusses the use of a performance-based approach for adopting site-specific water column elements. This is described as a set of procedures to facilitate translation of the fish tissue criterion to a water column criterion. IDEM should apply a performance-based approach to site-specific selenium standards development for Indiana waters. The GEI report discusses three methods for determining appropriate water column concentrations. The most defensible method for chronic selenium criteria derivation is the quantile regression approach discussed in detail in the GEI report and DeForest et al. (2017). Another valid method for chronic exposures that may be appropriate on a site-specific basis is implementation of a sulfate-dependent criteria, outlined in both the GEI report and DeForest et al. (2017). For intermittent pulses of selenium (for example, acute criteria) the GEI report recommends use of a selenium biokinetic model based on DeForest et al. (2016). Although it oversimplifies selenium biodynamics, the U.S. EPA's mechanistic model that is outlined in Appendix K of the U.S. EPA national criteria document may be adequate and appropriate in limited situations. A performance-based approach to site-specific criteria development should allow these discussed methodologies for site-specific criteria development. This will streamline the site-specific standards process and avoid requiring U.S. EPA approval of every individual site-specific standard that may be developed. (ICC, IMA, PE)

Response: IDEM includes provisions for using either the empirical bioaccumulation factor or mechanistic modeling methodologies provided in Appendix K of the 2016 NRWQC for selenium to derive site-specific criterion water column criterion elements. However, because these are site-specific criterion elements, they were written to be consistent with the provisions for site-specific criteria in rule at 327 IAC 2-1-8.9 for waters outside of the Great Lakes system and 327 IAC 2-1.5-16 for waters within the Great Lakes system. U.S. EPA approval would be needed for every site-specific selenium criterion that is developed.

The use of the three methods cited and described in the GEI report is not acceptable, as described previously and summarized herein. There is a lack of Indiana-specific fish tissue and water column paired data to provide a scientifically defensible model for the quantile regression approach. Use of sulfate-dependent criteria to derive alternate water column elements or the selenium biokinetic model for an intermittent water column criterion element is not acceptable because both are used to derive acute criterion elements, and the NRWQC only includes chronic criterion elements. U.S. EPA noted as such in its response to GEI comments regarding these two

approaches. Because the most sensitive adverse effects of selenium are reproductive effects (larval deformities and mortality) on the offspring of exposed fish, U.S.EPA evaluated chronic effects from long term exposure, and the NRWQC include only chronic criterion elements. U.S. EPA concluded that shorter-term intermittent or pulsed exposures to elevated levels of selenium may also result in bioaccumulation through the aquatic food web and may subsequently adversely affect fish reproduction. U.S. EPA derived the intermittent exposure criterion element directly from the chronic water criterion element, not an acute criterion element, by algebraically rearranging the chronic water criterion element. The intermittent criterion element establishes a limit on an intermittent elevated concentration occurring over a specified percentage of time, while accounting for the selenium background concentration (U.S. EPA 2016(a) p 32-33).

Comment: U.S. EPA's draft technical support documents are imperfect and need consideration before being made final, but they can still be a resource to an IDEM-led workgroup for developing implementation guidance for fish tissue sampling. The chief concern is U.S. EPA's decision not to give primacy of the fish tissue criteria over the new stringent water criteria for NPDES permitting purposes. (IEA, DUKE, IPL)

Comment: In addition to U.S. EPA's draft technical support documents, the U.S. EPA's 2010 Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion may also be a helpful resource for describing how a tissue-based WQC can be implemented. (IPL)

Response: IDEM appreciates the comments and suggestions.

Comment: U.S. EPA supports IDEM's proposal to adopt the U.S. EPA's 2016 304(a) criteria recommendations for selenium (U.S. EPA 2016); however, there are some significant omissions in IDEM's proposal from the U.S. EPA recommendations for selenium. These include the following omissions from Tables 6-2a and 8-1a:

(1) In footnote 1, "fish tissue elements are expressed as steady-state" has been removed.

(2) Footnote 4 no longer includes the sentence, "water column values are the applicable criterion element in the absence of steady-state fish tissue data."

(3) In footnote 6, "fish tissue data provide instantaneous point measurements that reflect integrative accumulation of selenium over time and space in fish populations at a given site", has been removed.

(4) In Tables 6-2a and 8-1a and corresponding footnotes, "Monthly average exposure" is not specified for the criterion element for lentic and lotic aquatic systems. IDEM has simply referred to a "(30 day)". U.S. EPA recommends a monthly average exposure and duration of 30 days.

The language that was removed from footnotes 1 and 4 needs to be reinserted into the Tables 6-2a and 8-1a because these statements are critical components to ensuring that aquatic life is adequately protected from new discharges of selenium into a waterbody until a steady state is achieved. New inputs are defined as anthropogenic activities that result in an increased load of selenium being released into a lentic or lotic waterbody. New anthropogenic inputs likely increase the selenium in the food web, resulting in increased bioaccumulation of selenium in fish over time. It could take months to years for selenium concentrations in fish tissue to fully reflect ambient water concentrations depending on many site-specific factors including site dynamics, hydrology, and the complexities of a specific food web at a given site. Assessing waterbodies that have new selenium inputs using fish tissue that is not in steady state may not appropriately identify an impairment in a waterbody and will delay corrective actions for that waterbody. (EPA5)

Response: IDEM has incorporated all of these comments either directly into the criterion

table (Comment (4)) or into the footnotes (Comments (1), (2) and (3)) of the draft rule for consideration of preliminary adoption for waters within (327 IAC 2-1.5-8(b)(3)(B), Table 8-1a) and outside of the Great Lakes System (327 IAC 2-1-6(a)(4)(A), Table 6-1a) and the site-specific criterion for Non-Acipenseriformes waters outside of the Great Lakes System (327 IAC 2-1-6(a)(4)(B), Table 6-1b).

Comment: IDEM needs to clarify its decision to remove the language in footnote 6. U.S. EPA's criterion recommendation for selenium recognizes that appropriately representative fish tissue data are a valid and defensible method to assessing condition and attainment where loadings of selenium are not changing. U.S. EPA also acknowledges that a single fish tissue data point may not constitute a representative sample for a site for purposes of assessing attainment. For these reasons, U.S. EPA recommends that the language removed from footnote 6 be reinserted. (EPA5)

Response: IDEM has incorporated footnote 6 of the 2016 selenium NRWQC back into the footnotes of the draft rule for consideration of preliminary adoption for waters within and outside of the Great Lakes System and the site-specific criterion for Non-Acipenseriformes waters outside of the Great Lakes System. The footnote reads as follows: "Fish tissue data provide instantaneous point measurements that reflect integrative accumulation of selenium over time and space in fish assemblages at a given site".

Comment: In Tables 6-2a and 8-1a and corresponding footnotes, IDEM needs to more specifically define what "30 day" means in the context of the duration of its proposed selenium criterion. The proposed rule language seems to indicate that the inclusion of "(30 day)" for both the lotic and lentic aquatic systems means that IDEM sees these values as either a 30-day average or that they have a 30-day duration. U.S. EPA recommends that these criterion elements are monthly average exposures and that the duration for these criterion elements are 30 days. (EPA5)

Response: In the draft rule for consideration of preliminary adoption, IDEM has included within the criterion tables, for waters within and outside of the Great Lakes System and the site-specific criterion for Non-Acipenseriformes waters outside of the Great Lakes System, a monthly average exposure of a 30-day duration for the lentic and lotic water column criterion elements, as expressed in the 2016 selenium NRWQC.

Comment: U.S. EPA recommends that IDEM changes the selenium proposed criteria to be consistent with U.S. EPA's 2016 selenium criteria document or provide rationale to show that the proposed changes to the 2016 selenium criteria are based on a sound scientific rationale and protective of aquatic life uses in Indiana with regard to the following:

(1) Tables 6-1 and 8-1 and footnote 1 in Table 8-1 specify a 4-day average duration for selenium; however, Tables 6-2a and 8-1a specify instantaneous and 30-day durations. U.S. EPA believes IDEM intends the durations specified in Tables 6-2a and 8-1a.

(2) Table 8-1 lists selenium as "selenium (dissolved)"; however, Table 8-1a specifies that water column values are based on dissolved total selenium in water. U.S. EPA believes IDEM intends that the water column values are based on dissolved total selenium in water.

(EPA5)

Response: IDEM has incorporated these recommendations into the draft rule for consideration of preliminary adoption. The duration and frequency of the fish tissue and water column criterion elements in the selenium criterion tables for waters within the Great Lakes

System, waters outside of the Great Lakes System, and Non-Acipenseriformes waters outside of the Great Lakes System incorporate the 2016 selenium NRWQC recommendations for duration and frequency. The draft rule for consideration of preliminary adoption includes a footnote to each table that states, "Water column values are based on dissolved total selenium in water and are derived from fish tissue values via bioaccumulation modeling."

Selenium Implementation Guidance

Comment: U.S. EPA has issued four draft guidance documents focused on implementation of the selenium standard. However, because the documents are only drafts, IDEM and stakeholders cannot rely on them for guidance. Implementation of the selenium criteria affects water quality standards, water quality-based effluent limitations (WQBELs) in NPDES permits, 303(d) and 305(b) analyses, and proper sampling and implementation of a fish tissue based criterion. Without implementation guidance explaining how the selenium criteria will apply to these aspects, a selenium criteria should not be adopted. IDEM has developed no implementation guidance to accompany the selenium criteria in the draft rule that has been published for Second Notice of Comment Period. If selenium criteria are adopted, IDEM should immediately begin work on implementation guidance with stakeholder input and postpone use of the adopted selenium criteria in developing WQBELs in NPDES permits until the implementation guidance is finalized. (ICC, IMA, CWA, DUKE)

Response: IDEM believes that implementation of this rule is better addressed in a subsequent guidance document. IDEM is currently developing draft guidance for collection of fish tissue data, water column data, or both, for implementing Indiana's selenium aquatic life criterion. IDEM is also evaluating the need for subsequent guidance documents pertaining to various topics.

Comment: U.S. EPA has addressed in draft guidance documents and in the recommended selenium criteria the application of the criteria on streams with no fish and on new discharges. Both of these application issues are directly related to implementation of the selenium criteria in NPDES permits and assessment of streams for attainment of the criteria in the 303(d) process of assessing waterbody impairment. IDEM needs to address these two issues in implementation guidance and should not adopt selenium criteria until this is accomplished. (ICC, IMA)

Response: IDEM is evaluating the need for subsequent guidance documents pertaining to various topics. IDEM is currently developing draft guidance for collection of fish tissue data, water column data, or both, for implementing Indiana's selenium aquatic life criterion.

Silver

Comment: IDEM is proposing U.S. EPA's existing 304(a) hardness-based equation for silver. However, this criterion is based on the 304(a) aquatic life criterion issued in 1980. The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. A criterion maximum concentration (CMC) derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the criteria should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines (U.S. EPA 2002). Because IDEM's acute criterion for silver is expressed as an acute aquatic criterion (AAC) which equals the FAV/2, the proposed equation must be divided by 2. Footnote 3 in Table 6-2 is proposed to be deleted; however, footnote 3, "One half (½) of the FAV as calculated by procedures developed by U.S. EPA in 1980..." should be retained because it applies to silver. Please be aware that U.S. EPA is evaluating the most recent data and science for silver as part of a Cooperative Research

and Development Agreement. (EPA5)

Response: The CMC for silver has been corrected in the draft rule for consideration of preliminary adoption to reflect the current U.S. EPA NRWQC at 304(a) of the CWA.

Zinc

Comment: IDEM's proposal is to adopt criteria for zinc that is U.S. EPA's existing 304(a) criteria recommendations for zinc (U.S. EPA 1996). Please be aware that U.S. EPA is actively evaluating the most recent data and science for this metal as part of a Cooperative Research and Development Agreement. U.S. EPA expects that this reevaluation could lead to revisions to the 304(a) recommendations for zinc. (EPA5)

Response: IDEM is aware that U.S. EPA is evaluating metal data through the Cooperative Research and Development Agreement.

References Cited:

Blatchley, W.S. 1938. The Fishes of Indiana. The Nature Publishing Co. Indianapolis, IN. USA. 121pp.

Bruch, R.M, T.J. Haxton, R. Koenigs, A. Welsh and S. J. Kerr. 2016. Status of Lake Sturgeon (*Acipenser fulvescens* Rafinesque 1817) in North America. Journal of Applied Ichthyology (Suppl. 1) 32:162-190.

Ctarci, Camillo. 2004. World Markets and industry of Selected Commercially Exploited Aquatic Species with an International Conservations Profile: Sturgeon (Acipenseriformes). FAO Fisheries Circular No. 990. Rome. 186 pp. Available online: http://www.fao.org/3/y5261e/y5261e00.htm

DeForest, D. K., K.V. Brix, J.R. Elphick, C.J. Rickwood, A.M.H. DeBruyn, L.M. Tear, G. Gilron, S.A. Hughes, and W.J. Adams. 2017. Lentic, lotic, and sulfate-dependent waterborne selenium screening guidelines for freshwater systems. *Environmental Toxicology and Chemistry* 36: 2503-2513.

GEI Consultants. 2008. Maternal transfer of selenium in fathead minnows, with modeling of ovary tissue to whole body concentrations. Project 062790. Chadwick Ecological Division, Littleton, CO.

GEI Consultants, Inc. 2017. Recommended updates to Indiana's selenium aquatic life standards. Available online (pages 35-69): https://www.in.gov/idem/cleanwater/files/wqs_rulemaking_tables_second_notice_comments.pdf

Gerking, S.D. 1945. Investigations of Indiana Lakes and Streams. IN Department of Conservation, and the Department of Zoology at Indiana University. Indianapolis, IN 165pp.

Hermanutz, R.O., K.N. Allen, T.H. Roush, and S.F. Hedtke. 1992. Effects of elevated Se concentrations on bluegills (*Lepomis macrochirus*) in outdoor experimental streams. *Environmental Toxicology and Chemistry* 11:217-224.

Hermanutz, R.O., K.N. Allen, N.E. Detenbeck, and C.E. Stephan. 1996. Exposure of bluegill (*Lepomis macrochirus*) to selenium in outdoor experimental streams. U.S. EPA Report. Mid-Continent Ecology Division. Duluth, MN.

Indiana Department of Natural Resources (IDNR). 2012(a). Shovelnose Sturgeon (*Scaphirhynchus platorynchus*). Indiana Division of Fish and Wildlife's Animal Information Series. Available online April 1, 2019: https://www.in.gov/dnr/fishwild/files/fw-shovelnose_sturgeon.pdf

Indiana Department of Natural Resources (IDNR). 2012(b). Paddlefish (*Polyodon spathula*). Indiana Division of Fish and Wildlife's Animal Information Series. Available online April 1, 2019: https://www.in.gov/dnr/fishwild/files/fw-paddlefish.pdf

Indiana Department of Natural Resources (IDNR). January 2018. Fishes of Indiana. Available online February 18, 2020: https://www.in.gov/dnr/fishwild/files/fw-Fishes_Of_Indiana.pdf

Indiana Department of Natural Resources (IDNR). December 2019(a). Endangered and Special Concern Species List. Indiana Division of Fish and Wildlife. Available online February 18, 2020: https://www.in.gov/dnr/naturepreserve/files/fw-Endangered_Species_List.pdf

Indiana Department of Natural Resources (IDNR). 2019(b). 2019-2020 Indiana Fishing Regulation Guide. Available online March 28, 2019: http://www.eregulations.com/wp-content/uploads/2019/02/19INFW_LR.pdf

Phelps, Q.E., S. J. Tripp, M. J. Hamel, J. Koch, E. J. Heist, J. E. Garvey, K. M. Kappenman and M. A. H. Webb. 2016. Status of knowledge of the Shovelnose sturgeon (*Scaphirhynchus platorynchus*, Rafinesque, 1820). J. Appl. Ichthyol. 32 (Suppl. 1) (2016), 249–260. ISSN 0175–8659 doi: 10.1111/jai.13241

Schultz, R. and R. Hermanutz. 1990. Transfer of toxic concentrations of selenium from parent to progeny in the fathead minnow. *Bulletin of Environmental Contamination and Toxicology* 45:568-573.

Simon, T.P. 2011. Fishes of Indiana. Indiana University Press. Bloomington, IN. USA 345pp.

State of Idaho. November 2017. Justification for site-specific selenium criterion for aquatic life in portions of Idaho. Department of Environmental Quality, Water Quality Division; Boise. Available online: http://www.deq.idaho.gov/media/60180859/58-0102-1701-justification-site-specific-selenium-criterion-aquatic-life-portions-of-idaho-1117.pdf

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman, and W.A. Brungs. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. PB85-227049. National Technical Information Service, Springfield, VA. Available online: https://www.epa.gov/sites/production/files/2016-02/documents/guidelines-water-quality-criteria.pdf

St. Pierre, R. & Runstrom, A. (U.S. Fish & Wildlife Service) 2004. *Acipenser fulvescens*. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2004: e.T223A13036599. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T223A13036599.en. Downloaded on 01 February 2019.

Surprenant, C. (U.S. Fish & Wildlife Service) 2004. *Scaphirhynchus platorynchus*. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2004: e.T19943A9111959. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T19943A9111959.en. Downloaded on 01 February 2019.

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2004: e.T19943A9111959. http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T19943A9111959.en. Downloaded on 01 February 2019.

U.S. Environmental Protection Agency (EPA). 1980. Ambient Water Quality Criteria for Selenium. EPA-440/5-80-070. National Technical Information Service, Springfield, VA.

U.S. Environmental Protection Agency (EPA). 1987. Ambient Water Quality Criteria for Selenium. EPA-440/5-87-006. National Technical Information Service.

U.S. Environmental Protection Agency (EPA). 1995. Ambient Water Quality Criteria for Selenium.

U.S. Environmental Protection Agency (EPA). 2002. Draft Aquatic Life Water Quality Criteria for Selenium. February 2002. Office of Water, Washington, DC.

U.S. Environmental Protection Agency (EPA). 2004. Draft Aquatic Life Water Quality Criteria for Selenium - 2004. EPA-822-D-04-001. Office of Water, Washington, DC.

U.S. Environmental Protection Agency (EPA). 2013. Revised deletion process for the site-specific recalculation procedure for aquatic life criteria. EPA 823-T-13-001. Office of Water. Available online: https://www.epa.gov/sites/production/files/2015-08/documents/revised_deletion_process_for_the_site-specific_recalculation_procedure_for_aquatic_life_criteria.pdf

U.S. Environmental Protection Agency (EPA). 2015(a). Draft Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2015. EPA 822-P-15-001. Office of Water 4304T, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 2015 (b). EPA Response to External Peer Review Comments on the External Peer Review Draft Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2014. Office of Water 4304T, Washington, D.C. https://www.epa.gov/sites/production/files/2015-10/documents/epa-response-external-peer-review-comments-selenium.pdf

U.S. Environmental Protection Agency (EPA). 2016 (a). Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2016. EPA 822-R-16-006. Office of Water 4304T, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 2016 (b). EPA Response to Public Comments on the 2015 Draft Selenium Aquatic Life Ambient Water Quality Criterion. Office of Water 4304T, Washington, D.C. https://www.epa.gov/sites/production/files/2016-07/documents/selenium_freshwater_2016_response_to_comment.pdf

U.S. Environmental Protection Agency (EPA). 2016 (c). EPA Response to Public Comments on the 2014 External Peer Review Draft Aquatic Life Ambient Water Quality Criterion for Selenium-Freshwater. Office of Water 4304T, Washington, D.C. https://www.epa.gov/sites/production/files/2016-07/documents/2014_response_to_public_comment_on_external_peer_review_draft_aquatic_life_criterion_for_selenium-freshwater.pdf

U.S. Environmental Protection Agency (U.S. EPA). 2017. Water Quality Standards Handbook. Chapter 3: Water Quality Criteria. Office of Water. EPA-823-B-17-001.

U.S. Environmental Protection Agency (U.S. EPA). 2018(a). Cooperative Research and Development Agreement for Aquatic Life Bioavailability Modeling for Metals. Available online: https://www.epa.gov/sites/production/files/2018-10/documents/metals-crada-workplan-2018.pdf

U.S. Environmental Protection Agency, Region 9 and Office of Water (U.S. EPA). 2018(b). DRAFT Aquatic Life and Aquatic-Dependent Wildlife Selenium Water Quality Criterion for Freshwaters of California. Available online: https://www.epa.gov/sites/production/files/2019-03/documents/ca_statewide_se_tsd_508_compliant.pdf

U.S. Fish and Wildlife Service (USFWS). 2016. Great Lakes Sturgeon Website. Available online April 1, 2019: https://www.fws.gov/midwest/sturgeon/

Wallus, R., T.P. Simon and B.L. Yeager. 1990. Reproductive biology and early life history of fishes in the Ohio River drainage. Volume 1: Acipenseridae through Esocidae. Tennessee Valley Authority. Chattanooga, TN. USA. 273pp.

Young, T.F., Finley, K., Adams, W., Besser, J., Hopkins, W., Jolley, D., McNaughton, E., Presser, T.S., Shaw, P., and Unrine, J., 2010, Selected case studies of ecosystem contamination by selenium, in Chapman, P.M., et al., eds., Ecological Assessment of Selenium in the Aquatic Environment: Society of Environmental Toxicology and Chemistry (SETAC) Press, Pensacola, Florida, p. 257-292. [https://pdfs.semanticscholar.org/acf0/5ea597d624c414b4fe40a59c9c37e67669...]

Zhang, Hui, et al. December 23, 2019. Extinction of one of the world's largest freshwater fishes: Lessons for conserving the endangered Yangtze fauna. *Science of the Total Environment* 710:136242. https://doi.org/10.1016/j.scitotenv.2019.136242