ILLINOIS POLLUTION CONTROL BOARD
January 16, 2019

IN THE MATTER OF	)	
	)	
AMENDMENTS TO GENERAL USE	)	R18-32
WATER QUALITY STANDARDS	)	(Rulemaking – Water)
FOR CHLORIDE	)	

HEARING OFFICER ORDER

On May 21, 2018, Huff & Huff Inc. (Huff & Huff) filed a proposal to amend Section 302.208(g) of the Board's water pollution regulations (35 Ill. Adm. Code 302.208(g)), as well as add a new Section 302.214. The proposed amendments concern the Board's General Use water quality standard for chloride. On June 21, 2018, the Board accepted Huff & Huff's proposal for public comment without sending it to first notice. The hearing officer scheduled first hearing in this proceeding for January 23, 2019 and directed interested persons to file their prefilled testimony by January 2, 2019. The hearing officer also set January 16, 2018 as the deadline for pre-filing questions.

The Board and Staff have reviewed the proposed amendment, supporting materials, and pre-filed testimony filed before the January 2, 2019 deadline. Included as Attachment A, the Board submits with this order its questions for the proponents. Anyone may respond to the questions attached, as well as any other pre-filed questions in the record.

Because the hearings in this proceeding are held by videoconference, to afford all participants equal access, any document to be offered as a hearing exhibit that have not be included with prefiled testimony must be filed at least 24 hours before the scheduled start of the hearing. 35 Ill. Adm. Code 102.424(h). All filings in this proceeding will be available on the Board's website at https://pcb.illinois.gov in the rulemaking docket R18-32. Unless the Board, hearing officer, Clerk, or procedural rules provide otherwise, all documents in this proceeding must be filed electronically through the Clerk's Office On-Line (COOL). 35 Ill. Adm. Code 101.302(h), 101.1000(c), 101.Subpart J.

IT IS SO ORDERED.

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ATTACHMENT A
R18-32
AMENDMENTS TO GENERAL USE
WATER QUALITY STANDARDS FOR CHLORIDE

Pre-Filed Hearing Questions for
James Huff, Roger Klocek, Dr. David Soucek

Outreach

1. The Statement of Reasons states: "The Agency has promoted a pathway forward of watershed variances, relying on Best Management Practices to achieve a 500 mg/L…However, there was no testimony in the CAWS proceeding that achieving the 500 mg/L winter chloride standard was technically feasible, economically reasonable, or ecologically justified. Proceeding with the Agency's watershed approach will require the regulated community to continue striving to achieve an unachievable standard until someone comes up with an alternative approach, which is exactly what this proposal is intended to do." Proposal (Prop.) at 5.[1] "The current watershed variance approach will not result in resolving the existing winter chloride exceedances." Prop. at 7.

   The Statement of Reasons goes on to state: "Both the Illinois EPA and USEPA were approached about the possibility of conducting colder temperature toxicity testing, without success. Therefore, Huff & Huff, Inc. sent a letter to municipalities, counties, and industries, The Salt Institute, watershed groups, the Illinois Tollway, and the Illinois DOT, explaining the need to conduct colder temperature toxicity testing and requesting funding for that purpose." Prop. at 10.

   a. Can you provide a complete list of the regulated entities you had included in your outreach efforts?

   b. Please provide a list of all regulated entities that will be impacted by this proposed rulemaking.

   c. Please comment and provide support for whether these entities agree with your statement that the "regulated community" is "striving to achieve an unachievable standard."

Language of the Proposed Rule

2. The language of the proposed rule differs from the language for acute and chronic standards at 35 Ill. Adm. Code 302.208(a) and (b).

   The proposed language at 302.214(a)(i) and (b)(i) for the acute summer and winter standards states, "…shall not be exceeded **more than once every three years *on the***

[1] Proposal refers to the bate stamp number of the initial filing, including the Statement of Reasons and Attachments 1 through 5.

average…." Prop. at 4 (emphasis added). By comparison, Section 302.208(a) for the acute standard states, "…shall not be exceeded at any time…" 35 Ill. Adm. Code 302.208(a).

The proposed language at 302.214(a)(ii) and (b)(ii) for the chronic summer and winter standards states, "…shall not be exceeded **more than once every three years *by the arithmetic average*** of at least four consecutive samples collected over any period of four days…" Prop. at 4, emphasis added. By comparison, Section 302.208(b) states, "…shall not be exceeded by the arithmetic average of at least four consecutive samples collected over any period of at least four days…" 35 Ill. Adm. Code 302.208(b).

USEPA Ambient Water Quality Criteria for Chloride-1988 (EPA 440/5-88-001, 1988 USEPA Chloride Criteria, SR Att. 1) states for the chloride chronic criterion, "the four-day average concentration of dissolved chloride, when associated with sodium, does not exceed 230 mg/L more than once every three years on the average". For the chloride acute criterion, 1988 USEPA Chloride Criteria states, "if the one-hour average concentration does not exceed 860 mg/L more than once every three years on the average." Prop. at 45, Att. 1.

1988 USEPA Chloride Criteria explains, "The averaging periods of 'one hour' and 'four' were selected by the U.S. EPA on the basis of data concerning how rapidly some aquatic species react to increases in concentrations of some pollutants, and "three years" is the Agency's best scientific judgment of the average amount of time aquatic ecosystems should be provided between excursions (Stephan et. al. 1985; U.S. EPA 1985b)." Prop. at 46, Att. 1; at 94, Att. 2.

a. Please explain what is meant by and the difference between "on the average" and "arithmetic average" as used in the proposed language. Should just one of these terms be used consistently?

b. For the addition of "more than once every three years", please discuss how the departure from the language for acute and chronic standards at 35 Ill. Adm. Code 302.208(a) and (b) is consistent with USEPA's reasoning for the 1988 USEPA Chloride Criterion.

3. The proposed language at 302.214(a)(ii) for the chronic **summer** standard states, "…except for those waters for which a zone of initial dilution (ZID) has been approved by the Agency pursuant to Section 302.102." The proposed language at 302.214(b)(ii) for the chronic **winter** standard does not mention a ZID or mixing. By comparison, Section 302.208(b) for the chronic standard states, "…except for those waters in which the Agency has approved a mixing zone or in which mixing is allowed pursuant to Section 302.102." 35 Ill. Adm. Code 302.208(b).

Please explain if the proposed sections 302.214(a)(ii) and (b)(ii) for the chronic summer and winter standards should more closely mirror the mixing zone provisions provided in Section 302.208(b).

4. The proposed language at 302.214(a)(ii) and (b)(ii) for the summer and winter chronic standards do not contain language on how attainment status is determined. By comparison, Section 302.208(b) states, "[t]o calculate attainment status of chronic standards, the concentration of the chemical constituent in each sample is divided by the calculated water quality standard for the sample to determine a quotient. The water quality standard is attained if the mean of the sample quotients is less than or equal to one for the duration of the averaging period." 35 Ill. Adm. Code 302.208(b).

   Please explain if the proposed sections 302.214(a)(ii) and (b)(ii) for the chronic summer and winter standards should more closely mirror the attainment status provisions provided in 302.208(b).

5. In pre-filed testimony (PFT), Mr. Huff indicated that he inadvertently did not include two changes to the Board's Section 302.407(g)(2) and (g)(3), and Section 303.449, stating, "Specifically, the proposed language presented in the petition was also intended to replace Section 302.407(g)(2) and (g)(3), so that the same chloride seasonal standards would apply to the Chicago Area Waterway System and Lower Des Plaines River…I would recommend that the Board also harmonize the water quality standard for chlorides as found in 309.449 [sic] as found in this proposal.". Huff PFT at 12. Please provide draft language for these proposed changes.

Test Methods

6. The New England Bioassay (NEB) Reports on "Chronic Toxicity Testing at 10°C and 25°C Using *Ceriodaphnia dubia*" dated October 26, 2016 and November 13, 2017 (May 29, 2018 Mot.) used test methods based on EPA 821-R-02-013, "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms", Fourth Edition. Prop. at 125, Att. 2, App. D; Mot. at 17. The New England Bioassay Reports on acute toxicity used test methods based on EPA 821-R-02-12, "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 2002". Pet. at 198, Att. 2, App. D; May 29, 2018 Mot. at 5.

   The Illinois Natural History Survey (INHS) Report explains the test methods in detail but does not appear to cite to a specific USEPA method. Soucek PFT, Att. 2. Please indicate if the test methods used in the INHS Report correspond to or are derived from particular USEPA methods.

7. The 1988 USEPA Chloride Acute Criteria is based on the one-hour average concentration, and the Chronic Criteria is based on the four-day average concentration. Pet. at 45, Att. 1.

   The New England Bioassay and INHS tests made observations at test periods that ranged from 48-96 hours for acute testing and 7, 14, 21, 28, and 35 days for chronic testing. The Technical Support Document (TSD) (Prop., Att. 2) explains, "For smaller and

intermediate streams, durations longer than four days occurs less than once per year. For the large streams, durations extending between 11 and 14 days occur on the order of once every ten years. Certainly, chronic tests conducted over a 28 or 35-day time period do not represent conditions that occur in Illinois. The standard USEPA acute and chronic test periods are more appropriate, especially considering the margin of safety in the calculation method utilized by USEPA…" Pet. at 93, Att. 2.

a. Please explain what the "standard USEPA acute and chronic test periods" are and how they are different from the time periods used in the language of a criterion.

b. Please explain how data from the 48 to 96-hour tests and the 7, 14, and 21-day tests translate into standards that are based on one hour and four days.

8. In the INHS Report, for the Fingernail Clam, sodium chloride acute and chronic data at 25°C, please elaborate why the values in the tables at nominal chloride (100) are denoted as "unreliable." Prop. at 214.

9. In INHS Report for the Mayfly Chronic Data, what does "na" and "nc" stand for? Prop. at 215, Att. 2, App. B.

10. In the INHS Report, no chronic data was provided for Amphipods at 10°C. The INHS Report for Amphipods notes, "We have been having difficulty with control survival for *Hyalella* at 10°C. Two tests we have started have had ~50% survival within 7-10 days. Therefore, we will attempt to use older organisms (~14-d) to start a test to allow young amphipods to grow stronger prior to acclimation to cold temperature and testing." Prop. at 216, Att. 2, App. B. Please clarify if data was obtained using older organisms. If so, provide an update.

11. LC50 is defined as the "concentration at which it is estimated that 50% of the organisms will die" and NOEC is defined as the "no-observable effect concentration, the highest concentration at which there is no statistical reduction." May 29, 2018 Mot., NEB Report at 13. In the November 13, 2017 NEB Report, Tables 12 and 13, the values in the column for the Survival LC50 are almost consistently greater than the values in the column Survival NOEC. Please explain why the NOEC concentration is greater than the LC50 concentration.

Hardness of Test Waters.

12. Dr. Soucek described the hardness of the test waters for the December 4, 2017 INHS study stating, "Culture water was a reconstituted water (hereafter referred to as Duluth 100) with a nominal hardness of 100 mg/L as $CaCO_3$, prepared according to a formula developed at the US EPA laboratory in Duluth, Minnesota (Table 1)." Prop. at 214-217, Att. 2, App. B; Soucek PFT, Att. 2. at 3.

The October 26, 2016 NEB Report states, "Lab control water was laboratory-prepared moderately hard fresh water", and the "Acute Toxicity Data Form Cover Sheet" indicates a hardness of 88 mg/L $CaCO_3$. Prop. at 126, 127, 130, 132, 134, and 150. The January

26, 2017 NEB Report lists hardness of 86 mg/L as $CaCO_3$. Prop. at 177. The October 14, 2017 NEB Report lists hardness of 86 mg/L as $CaCO_3$. Prop. at 200. The November 13, 2017 NEB Report lists hardness of 84 mg/L as $CaCO_3$. May 29, 2018 Mot. at 19, 36.

a. Please confirm the hardness of the test waters in the NEB and INHS tests.

b. Please elaborate on the hardness scale and where the test waters fall in terms of moderately hard water.

Sulfate Concentration of Test Waters.

13. Table 1 of the INHS study refers to the recipe for "Duluth 100" test water as containing 38 mg/L Mg SO_4 (Magnesium Sulfate) and 40 mg/L Ca SO_4 (Calcium Sulfate). Soucek PFT, Att. 2 at 13. Please confirm the sulfate concentration of the test waters in the NEB and INHS tests.

Copies of Works Referenced for Rulemaking Record

14. Please provide a copy of each of the following for the record:

Stephan 2009. Referenced in the TSD (Prop. at 95) and Klocek PFT at 7.

Stephan, C.E. 2009a. "Calculation of Aquatic Life Criteria for Chloride", U.S. Environmental Protection Agency, Duluth, MN. 09FebChlorideCriteria.wpd. DRAFT 2-10-09.

Stephan, C.E. 2009b. "Summary of Data concerning the Chronic Toxicity of Sodium Chloride to Aquatic Animals." U.S. Environmental Protection Agency, Duluth, MN. 09JanChlorideCronic.wpd. DRAFT 1-15-09.

Stephan, C.E. 2009c. "Summary of Data concerning the Acute Toxicity of Sodium Chloride to Aquatic Animals." U.S. Environmental Protection Agency, Duluth, M., 09FebChlorideAcute.wpd. DRAFT 2-10-09

Stephan, C.E. 2009d. "Description of the Review of Results of Toxicity Tests on Chloride." U.S. Environmental Protection Agency, Duluth, MN, 09JanChlorideRev.wpd. DRAFT 1-15-09.

Stephan, C.E. 2009e. "Summary of Data Concerning the Acute Toxicity of Sodium Chloride to Aquatic Animals." U.S. Environmental Protection Agency, Duluth, MN. 09JanChlorideAcute.wpd. DRAFT 1-15-09.

Stephan, C.E. 2009f. "Multiple Regression Equation for Chloride." U.S. Environmental Protection Agency, Duluth, MN. 09JanChlorideEq.wpd. DRAFT 1-15-09.

Stephan, C.E. 2009g. "Calculation of Aquatic Life Criteria for Chloride." U.S. Environmental Protection Agency, Duluth, MN. 09JanChlorideCriteria.wpd. DRAFT 1-15-09.

Stephan, C.E. 2009h. "Results of Literature Search concerning the Toxicity of Chloride to Aquatic Animals." U.S. Environmental Protection Agency, Duluth, MN. 09JanChlorideRefs.wpd. DRAFT 1-15-09.

Stephan 2009 a, c:
www.iowadnr.gov/portals/idnr/uploads/water/standards/09mar_proposed.pdf

Stephan 2009b, e-h:
http://registry.mvlwb.ca/Documents/MV2001L2-0008/MV2001L2-0008%20-%20Site%20Specific%20Water%20Quality%20Objectives%20for%20Chloride%20-%20INAC%20Comments%20-%20Jan20%2009.pdf

USEPA. Referenced in TSD (Prop. at 94, 96, 98).

"Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses", USEPA (1985), Stephen C.E., Mount D.I,., Hansen D.J, Gentile J.R., Chapman G.A., Brungs W.A. [1985 USEPA Guidelines]

Iowa Department of Natural Resources. Referenced in Klocek PFT at 7.

Iowa Department of Natural Resources Memo, "Proposed Chloride Criteria Update", 03/02/2009. (Iowa DNR Memo 3/2/09)

Iowa Department of Natural Resources, "Understanding Iowa's Water Quality Standards", www.iowadnr.gov/portals/idnr/uploads/water/standards/ws_fact.pdf

567 Iowa Administrative Code, Chapter 61 Water Quality Standards, 61.3(3) Specific Water Quality Criteria, and Table 1 Criteria for Chemical Constituents
https://www.epa.gov/sites/production/files/2014-12/documents/ia-chapter61.pdf

Soucek. Referenced in Soucek PFT, Att. 1 at 6, 7, 11.

Soucek DJ, Linton TK, Tarr CD, Dickinson A, Wickramanayake N, Delos CG, Cruz LA. 2011. Inluence of water hardness and sulfate on the acute toxicity of chloride to sensitive freshwater invertebrates. Environmental Toxicology & Chemistry. 30(4):930-938.

Soucek DJ, Kennedy AJ. 2005. Effects of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates. Environmental Toxicology and Chemistry 24:1204-1210.

Soucek DJ (PI). 2008. Effects of hardness and sulfate on chloride toxicity to freshwater invertebrates. Great Lakes Environmental Center.

Linton. Referenced in Prop. at 115.

Linton, T.K. & Dickinson, A., Great Lakes Environmental Center (GLEC) and Illinois Natural History Survey (INHS). 2008. Acute Toxicity of Chloride to Select Freshwater Invertebrates. Final Draft Report to USEPA. 9-26-2008. (GLEC/INHS 2008)
http://www.fwspubs.org/doi/suppl/10.3996/052013-JFWM-033/suppl_file/patnodereference+s5.pdf

Stroud Water Research Center. Referenced in Huff PFT at 4; Klocek PFT at 3.

Eldridge, William H., David B. Arscott, John K. Jackson, "Stroud Water Research Center Expert Report on the Proposed Rulemaking by the Pennsylvania Environmental Quality Board [25 PA.CODE CH. 93] for Ambient Water Quality Criterion; Chloride (CH) [40 Pa.B 2264] [Saturday, May 1, 2010]", June 2010, Stroud Report #: 2010004. (2010 Stroud Expert Report)
http://www.irrc.state.pa.us/docs/2954/COMMENTS_PUBLIC/2954%2009-05-12%20CLEAN%20WATER%20ACTION%20PA.pdf

1988 USEPA Chloride Criteria and Stephan 2009 Updates

15. USEPA Ambient Water Quality Criteria for Chloride-1988 relied on a list of 12 genera of aquatic animals ranked by genus according to sensitivity to prescribe a chloride chronic criterion of 230 mg/L and acute criterion of 860 mg/L. The 1988 USEPA Chloride Criteria document was authored by Duane A. Benoit and coordinated by Charles E. Stephan with USEPA's Environmental Research Laboratory in Duluth, Minnesota. (EPA 440/5-88-001, 1988 USEPA Chloride Criteria, SR Att. 1 at iv, 8.)

Twenty years later in 2008, USEPA worked with Iowa DNR to reassess the studies used in the 1988 USEPA Chloride Criteria. Iowa DNR explained that through an extensive literature review, an updated list of studies was developed and gaps were identified in the research that resulted in new toxicity tests being performed in 2008 by ENVIRON International Corporation (ENVIRON 2009[2]). With the updated information, the list of aquatic animals expanded from 12 to 29 genera as ranked by genus according to sensitivity. These efforts are chronicled in the series of reports by Charles E. Stephan of USEPA in 2009 who assisted in development of the 1988 USEPA Chloride Criteria. "Understanding Iowa's Water Quality Standards" at 1; Stephan 2009a-h, Stephan 2009c at 1.

[2] ENVIRON International Corporation. 2009. "Chloride toxicity test results. Prepared for: Iowa Water Pollution Control Association. Project Number: #20-22235A.

Although USEPA was in the process of reassessing the 1988 chloride criteria, Stephan 2009 did not explicitly propose new USEPA chloride criteria. The 2010 Stroud Expert Report states, "the indication from Stephan (2009b) is that the new [US]EPA guidelines will shift to a weight of evidence approach…The implication is that the [US]EPA may consider environmental variables, such as hardness and sulfate that are likely to affect chloride toxicity when they update their criteria." 2019 Stroud Expert Report at 14.

a. Are you aware of any work USEPA may be currently doing to reassess the 1988 Chloride Criteria or to propose new chloride criteria?

b. Have you tried contacting Charles E. Stephan or someone else in his lab at USEPA about exploring the temperature variable in chloride toxicity with you?

c. When Iowa DNR worked with USEPA in hiring ENVIRON 2009 to conduct the additional toxicity tests, do you know how the work was funded? If so, do you think a similar source of funding would be available for toxicity tests focused on the temperature variable?

Iowa Water Quality Standards for Chloride

16. As noted in Mr. Klocek's PFT at 7, Iowa adopted water quality standards for chloride that are based on the equation developed by Stephan 2009c,f that is based on the water quality characteristic of hardness as well as sulfate concentration. Klocek PFT at 7 (citing to Iowa Department of Natural Resources Memo, "Proposed Chloride Criteria Update", 03/02/2009). The Iowa Water Quality Standards were approved by USEPA in 2010 and are considered "in effect for Clean Water Act purposes". *See* https://www.epa.gov/sites/production/files/2014-12/documents/ia-chapter61.pdf

The Iowa standard provides chloride standards for waters designated as "Class B" for protection of wildlife, fish, aquatic, and semiaquatic life under Iowa Administrative Code, Chapter 61 Water Quality Standards, 61.3(3) Specific Water Quality Criteria, b. Class "B" waters, Table 1 Criteria for Chemical Constituents. Table One sets for chloride Acute Criteria of 629 mg/L and Chronic Criteria of 389 mg/L, with Footnote (m) noting,

> "Acute and chronic criteria lists in main table are based on a hardness of 200 mg/L (as $CaCO_3$ (mg/L) and a sulfate concentration of 63 mg/L. Numerical criteria (μg/L) for chloride are a function of hardness ($CaCO_3$ (mg/L)) and sulfate (mg/L) using the equation for each according to the following table…"
>
> Acute
> 287.8 mg/L (Hardness in mg/L as $CaCO_3$)$^{0.205797}$ × (Sulfate mg/L)$^{-0.07452}$
>
> Chronic
> 177.87 mg/L (Hardness in mg/L as $CaCO_3$)$^{0.205797}$ × (Sulfate mg/L)$^{-0.07452}$

Iowa Adm. Code 61.3(3) Table 1, Footnote (m).

The Iowa DNR Memo (3/2/09) indicates that the equation format provides "Statewide default values for hardness and sulfate will be used unless site specific data is available." March 2, 2009 Iowa DNR Memo. Iowa DNR also explained, "Results of the research and toxicity testing completed for chloride show that chloride toxicity is heavily dependent on water hardness, and to a lesser degree, sulfate levels in the water. Using all of the literature and this most recent toxicity testing, [US]EPA [Stephan 2009] developed an equation (see below) for the acute and chronic criteria to protect Iowa's waters…The following statewide background values were determined by analyzing DNR [Iowa Department of Natural Resources] ambient water monitoring data from 2000 to 2007: Hardness: 200 mg/L as $CaCO_3$; Sulfate: 63 mg/L; Chloride: 34 mg/L". Iowa DNR, "Understanding Iowa Water Quality Standards" at 1.

The document goes on to state, "In 2005 and 2006, the State of Illinois worked with U.S. EPA to complete a review of research related to sulfate toxicity similar to the work done for chloride. The result of that work was a proposed criteria equation for sulfate based on background hardness and chloride levels. The similarities between the landscape and waterbodies of Iowa and Illinois and the high level of scientific review of this data allow for the same sulfate criteria proposed by Illinois to apply to protect aquatic life in Iowa's waters." Iowa DNR, "Understanding Iowa's Water Quality Standards" at 1-2.

a. Given this statement from Iowa DNR about the similarities between the landscape and waterbodies of Iowa and Illinois along with the fact that the Iowa chloride water quality standard was approved by USEPA, please comment on developing a chloride water quality standard similar in structure to Iowa's.

b. Please comment on whether chloride issues in Illinois could be addressed by a standard similar to Iowa's that included provisions for site-specific hardness and sulfate concentration, with the addition of a temperature component.

Water Quality Characteristics affecting Chloride Toxicity: Temperature, Hardness, Sulfate

The 1988 USEPA Chloride Criteria states, "Water quality criteria adopted in State water quality standards could have the same numerical values as criteria developed under [CWA] section 304. However, in many situations States might want to adjust water quality criteria developed under [CWA] section 304 to reflect local environmental conditions and human exposure patterns before incorporation into water quality standards." Prop. at 34, Att. 1.

Temperature.

17. The Statement of Reasons states that the current USEPA Ambient Water Quality Criteria for Chloride (1988) did not consider temperature in the derivation, and "nearly all tests were performed above 20°C (69oF)." Prop at 6. "[N]early all of the aquatic toxicity testing conducted prior to the testing contained in this Petition is at temperatures

experienced during the summer months." Prop. at 5. "There has been minimal research on the effect of temperature on the toxicity of chlorides." Prop. at 81. "…[T]his laboratory testing has been conducted at water temperatures between 23 and 25°C, basically peak summer temperatures." *Id*.

The Technical Support Document at Appendix A contains a literature survey on the toxicity of chlorides, with a focus on temperature effects. Prop. at 100-117.

a. Was the literature survey able to identify the majority of the temperatures used in the studies that USEPA and Iowa DNR compiled in the Stephan 2009c updated list?

b. Please comment on creating a table based on the Table in Stephan 2009c, "Summary of Data Concerning the Acute Toxicity of Sodium Chloride to Aquatic Animals," and including a column for temperature values from all the referenced studies available.

18. The proposal would replace the current single value chloride water quality standard with acute and chronic values split into two seasons: May – November and December – April. The reasoning behind the two seasons is that the current 500 mg/L chloride water quality standard is overly protective at winter temperatures and "too liberal" at maximum summer temperatures. Prop. at 4-5, 10.

The December – April proposed standards are based on winter water temperatures of 10°C, while the May – November proposed standards are based on summer water temperatures of 20-25°C. However, the proposal also recognizes that Illinois experiences intermediate temperatures such as those in the spring. The Statement of Reasons postulates, "There may well be a need for a spring standard as well, based on some intermediate temperature, such as 15°C; however, the science behind such a proposal is not currently available…In newer urban areas where [ ] retention basis are commonly employed, it is unlikely that the streams will achieve the proposed summer water quality standard during the spring months, and this will need to be explored during the regulatory proceeding." Prop. at 5.

The Statement of Reasons notes that Scott Twait of the Illinois EPA suggested, "other temperatures besides 10°C should be evaluated, but no funding from the Illinois EPA was available for such additional testing." Prop at 11. In response, Mr. Huff followed by noting that "USEPA has always pushed for seasonal limits (specific calendar months) rather than relying on specific temperatures to set water quality standards…" Prop. at 11.

a. Has USEPA approved water quality standards in the past based on temperature rather than season?

b. If new studies could be performed to evaluate other temperatures besides 10°C, would it be possible to derive chloride water quality standards based on

temperature rather than season to account for the variability in temperatures throughout the year and throughout the State of Illinois?

Hardness and Sulfate.

19. In R08-9(D), Mr. Klocek explained that the work done by Iowa DNR and USEPA "resulted in the development of chloride criteria that are based on concentrations of hardness and sulfate levels that can be site specific, and are more consistent with the current scientific understanding about toxicity of chloride to aquatic organisms." R08-9(D), PFT Roger Klocek, November 22, 2013, Exh. B "Winter Chloride Toxicity Criteria on the Chicago Sanitary and Ship Canal, A Re-Evaluation Based on Current Species Present" at 1.

The chloride criteria based on hardness and sulfate was derived by Stephan 2009a,f in the form of the following equation:

Criterion Maximum Concentration, CMC (Acute Chloride Criterion) =
$287.8\ (\text{Hardness in mg/L as } CaCO_3)^{0.205797} \times (\text{Sulfate mg/L})^{-0.07452}$

Criterion Continuous Concentration, CCC (Chronic Chloride Criterion) =
$177.87\ (\text{Hardness in mg/L as } CaCO_3)^{0.205797} \times (\text{Sulfate mg/L})^{-0.07452}$

Stephan 2009a at 8, 14.

Mr. Klocek continued that based on this equation, "Iowa adopted new chloride standards in 2009 (USEPA approved 2010), with Pennsylvania, Missouri, and Wisconsin currently in the process of adopting similar standards as Iowa. Indiana adopted new chloride standards in 2012." R08-9(D) PFT Roger Klocek, November 22, 2013, Exh. B "Winter Chloride Toxicity Criteria on the Chicago Sanitary and Ship Canal, A Re-Evaluation Based on Current Species Present" at 1; *see also* March 2, 2009 Iowa DNR Memo.

a. Please provide citations to and summaries of the new chloride standards adopted or proposed for Pennsylvania, Missouri, Wisconsin, and Indiana.

b. Please comment on mirroring one of those standards for protecting Illinois waterways.

20. Table in Stephan 2009c, "Summary of Data Concerning the Acute Toxicity of Sodium Chloride to Aquatic Animals," includes the hardness and sulfate concentrations of the test waters in each of the studies.

a. Please comment on adding to the creation of the table described above, based on the Table in Stephan 2009c, "Summary of Data Concerning the Acute Toxicity of Sodium Chloride to Aquatic Animals", the hardness and sulfate concentrations from the studies performed by INHS and NEB for this rulemaking.

b. Please comment on adding to this table the acute value LC50 results from the studies performed by INHS and NEB for this rulemaking for each test temperature. Please comment on including both the acute value and normalized acute values using the equation developed by Stephan 2009c at 1:

$$NAV = AV \times (300 \text{ mg/L Hardness at } CaCO_3)^{0.205797} \times (65 \text{ mg/L sulfate})^{-0.07452}$$

where
NAV =Normalized Acute Value
AV = Acute Value

21. Iowa DNR explained that statewide background values for hardness and sulfate were determined by analyzing water monitoring data from 2000 to 2007, leading to the default values for hardness of 200 mg/L as $CaCO_3$ and Sulfate of 63 mg/L unless site specific data is available. Iowa DNR, "Understanding Iowa Water Quality Standards" at 1; Iowa DNR Memo 3/2/09. For Illinois, the Statement of Reasons include Table 2 of "Impacts of Road Salt Runoff on Water Quality of the Chicago, Illinois, Region" Report that shows the sulfate (SO_4) concentration data for MWRDGC river stations for the period 2007-2008. Sulfate concentrations varied from 34 mg/L (Chicago River) to 497 mg/L (Thorn Creek). Prop. at 225, Att. 3.

a. Does Illinois have sufficient ambient water monitoring data to determine statewide background values for hardness and sulfate?

b. Please comment on providing information on hardness and sulfate concentrations of waters throughout the State of Illinois and how they vary.

c. Please elaborate on the hardness scale and where the test waters used in the studies by INHS and NEB fall in relation to hardness in waters throughout Illinois.

d. Are hardness and sulfate concentrations typically monitored in streams where water quality compliance is assessed such that site-specific values can be determined?

e. Please describe how Illinois waterways are tested for hardness and sulfate, if it is typically done with other ongoing water quality monitoring, and how much it costs.

f. For permitted dischargers with water quality based effluent limits, how much would it cost to include effluent and instream sampling for hardness and sulfate?

Derivation of Water Quality Criteria Dependent on Water Quality Characteristics

22. The proposal would provide fixed acute and chronic standards dependent on a two-season calendar year rather than site-specific temperature or other water quality characteristics

such as hardness or pH. The proposal reasons that "USEPA has always pushed for seasonal limits (specific calendar months) rather than relying on specific temperatures to set water quality standards…" Prop. at 10.

The Board's water quality standards rely on specific temperature ranges for equations of the chronic standard for total ammonia nitrogen (35 Ill. Adm. Code 302.212(b)(2), 302.412(c), 302.Appendix C), giving separate equations for various temperature ranges and times of the year (early life stage present (March-October) and early life state absent (November-February)); Temperature and pH-Dependent Values of the CS (Chronic Standard) for Fish Early Life Stages Absent and Present (35 Ill. Adm. Code 302.Tables B and C). The standard requires "The water quality standard for each water body must be calculated based on the temperature and pH of the water body measured at the time of each ammonia sample." 35 Ill. Adm. Code 302.212(d), 302.412(e).

Additionally, some of the Board's water quality standards are dependent on site-specific water quality characteristics such as pH and hardness. The total ammonia nitrogen standard mentioned above is dependent on pH as well as temperature. Hardness is a variable in equations for the water quality standards of sulfate, cadmium, trivalent chromium, copper, fluoride, lead, manganese, nickel, zinc, silver. *See* 35 Ill. Adm. Code 302.208(e), (h), 302.407(e), (g).

a. Are you aware of why the current General Use chloride water quality standard is under 35 Ill. Adm. Code 302.208(g) for single-value standards instead of 302.208(e) Numeric Water Quality Standards for the Protection of Aquatic Organisms?

b. Is there any reason revised chloride water quality standards couldn't take on an equation form and be under 302.208(e) Numeric Water Quality Standards for the Protection of Aquatic Organisms? If so, please provide possible draft language.

23. The Boards rules contain specific procedures on deriving acute aquatic toxicity criterion dependent on water chemistry. *See* 35 Ill. Adm. Code 302.618 (Determining the Acute Aquatic Toxicity Criterion – Toxicity Dependent on Water Chemistry). These procedures are used to determine the aquatic water quality criteria for "Other Toxic Substances". *See* 35 Ill. Adm. Code 302.210(a) and 302.410(a). The rule at 35 Ill. Adm. Code 302.618 provides procedures for calculating criterion if data are available to show that a relationship exists between a water quality characteristic and acute toxicity to two or more species. Such water quality characteristics include temperature, hardness, and pH. The rule states, "The procedures must be used if the toxicity of a substance is dependent upon some other water quality characteristic." 35 Ill. Adm. Code 302.612(b).

The Section 302.618 procedures describe a regression method similar to the regression method used by Stephan 2009f to develop the exponent values in the equation used in the Iowa standards: $(\text{Hardness})^{0.205797}\ (\text{Sulfate})^{-0.07452}$. The data for the regression analysis relied on information provided by the INHS and Great Lakes Environmental Center in a 2008 report. Stephan explains,

> "U.S. EPA hired the Great Lakes Environmental Center (GLEC) and the Illinois Natural History Survey (INHS) to perform toxicity tests concerning the effect of hardness and sulfate on the toxicity of chloride to selected aquatic animals. The equations presented in Figures 1 through 7 of the GLEC and INHS (2008) report can be used to make the aquatic life criterion for chloride dependent on both hardness and sulfate." "Multiple regression was performed on the data presented on pages 29 and 36 of GLEC and INHS (2008) concerning the effects of hardness and sulfate on the toxicity of chloride to C. dubia." Stephan, "Multiple Regression Equation for Chloride", 1-15-2009 (Stephan 2009f) at 1.

The GLEC and INHS (2008) Report is cited in the R18-32 petition (Pet. at 115): Linton, T.K. & Dickinson, A., GLEC and INHS. 2008. Acute Toxicity of Chloride to Select Freshwater Invertebrates. Final Draft Report to USEPA. 9-26-2008.

a. Is it possible to develop a water quality standard equation for chloride similar to the equation used for the Iowa standard that incorporates site-specific hardness and sulfate as well as temperature?

b. If it is possible to do a multiple regression analysis on hardness and sulfate, could one be done for temperature to develop a slope that could be used to derive an equation-based standard that is dependent on hardness, sulfate, and temperature?

24. The Jackson and Funk (2019) report cited by Mr. Klocek uses linear regression to describe the relationship between temperature and acute chloride toxicity for four genera of mayflies across a range of temperatures: 5, 7.5, 10, 12.5, 15, 20, and 25°C. Results are plotted in Figure 4 of the Jackson and Funk (2019) Report as sloped lines on a graph of 96-hour LC50 acute values versus temperature. The slope, intercept and other linear regression results suitable for deriving an equation are listed as well. Klocek PFT, Att. 2.

Could any of this data be used to develop a mathematical relationship for an equation–based standard that is dependent on hardness, sulfate, and temperature?

Statewide Applicability of General Use Water Quality Standard

25. The TSD states that the derivation of the proposed chloride water quality standards followed the USEPA protocol: "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses", USEPA (1985), Stephen C.E., Mount D.I., Hansen D.J., Gentile J.R., Chapman G.A., Brungs W.A. Prop. at 94, 96, 98.

For the site-specific rule for the CSSC (35 Ill. Adm. Code 303.449), CITGO used a different USEPA method to derive acute and chronic standards for the winter months: "Delos, Charles G. 2013. Revised Deletion Process for the Site-Specific Recalculation

Procedure for Aquatic Life Criteria, USEPA, EPA-823-R-13-001. *See* R08-9(D), slip op. at 72 (September 18, 2014).

Please explain why a method different from the one used for the CSSC site-specific rulemaking is used for this rulemaking for General Use Waters.

26. To select a temperature at which to conduct laboratory tests on aquatic life that is representative of a winter temperature in Illinois, Huff & Huff used the 75th percentile of all Illinois stream temperature data. Huff PFT at 6. Appendix B, Tables 1 and 2, of the TSD contain the 75th Percentile for all Illinois Stream Temperature Data for 2002-2016 for either December-March or December-April. Prop. at 119-120, Att. 2. The tables include Station Codes.

    a. Based on the information in the tables, can you identify the locations where the readings were taken?

    b. Do these locations cover the State of Illinois from north to south?

    c. Please explain how the 75th percentile is considered representative of all of Illinois during December - April.

    d. Please describe how much the ambient water temperature varies from northern Illinois to southern Illinois from month to month during the months of December-March?

    e. Given this range in temperature, would a standard based on tests at 10°C still be considered representative of southern Illinois water bodies?

27. The TSD states, "Chloride concentrations above the 500 mg/L level are not unique to these two waterways [CAWS and LDPR] but occur during snow melt periods in all urban streams within Illinois." Prop. at 79. To support this statement, the rulemaking proposal includes monitoring data for chlorides on chloride concentrations during the winter months showing occurrences over 500 mg/L in the CSSC, North Branch of the Chicago River, Cal-Sag Channel, DuPage River and Salt Creek, East Branch of the DuPage River, and West Branch of the DuPage River. Prop. at 84-90, 121-122.

    a. Other than streams in the Greater Chicago Area, please list the rivers or streams that could be classified as "urban streams" in Illinois.

    b. Are you aware of chloride monitoring data for other urban streams within Illinois that are General Use Waters that demonstrate concentrations above 500 mg/L during certain times of the year?

    c. Do you know of chloride monitoring data for urban streams in other states with winter climate conditions similar to Illinois?

28. The Statement of Reasons states, "Both the Illinois EPA and USEPA were approached about the possibility of conducting colder temperature toxicity testing, without success." Prop. at 10.

    a. Would you please comment on estimating the costs and time to conduct additional studies at a range of temperatures?

    b. Would you please comment on estimating the additional costs and time to derive acute and chronic chloride water quality standards if additional information were available for acute toxicity across a range of temperatures?

    c. Would you please comment on estimating the additional costs and time to derive an equation-based water quality standard for chloride standard similar to Iowa's that includes provisions for site-specific hardness and sulfate concentration, with the addition of a temperature component.

TSD Table 1: Chloride Genus and Species Mean Acute Values (GMAV, SMAV)

Calculation of SMAV and GMAV.

29. TSD Table 1 contains a list of aquatic species ranked according to their genera by sensitivity to chloride from 34 to 1, with 34 being the most resistant and 1 being the most sensitive. Each ranking is based on the Genus Mean Acute Value (GMAV), which is the geometric mean of the individual Species Mean Acute Values (SMAV). Table 1 also includes a column for Cumulative Probability, which is used later in the calculation of the proposed acute and chronic standards. Cumulative Probability is calculated as $P = R/(N + 1)$ where R is the rank and N is the number of genera ranked. Prop. at 53, 55, Att. 1.

    Please describe how a GMAV is calculated from multiple SMAVs by the use of geometric mean. As an example, please show how the GMAV for Daphnia of 3023 mg/L in Table 1 was calculated from the three SMAVs for Daphnia abigua, pulex, and magna, which were adjusted from the values in Stephan 2009c by a factor of 1.3 according to Footnote 2 in TSD Table 1. Prop. at 95.

Tests Relied Upon in Compiling TSD Table 1.

30. From this list, the calculation of the acute and chronic criterion is based on the GMAV of the four most sensitive genera. USEPA 1985 Guidelines at 16. The four genera listed as the most sensitive to chloride toxicity by Stephan 2009, ranked from least to most, were 4. Lampsilis (mussel), 3. Daphnia (water flea), 2. Ceriodaphnia (water flea), and 1. Sphaerium (fingernail clam). Stephan 2009a at 5. The GMAVs were based on the geometric mean of the Species Mean Acute Values (SMAV) based on multiple tests from various laboratories. The GMAVs relied on 3 different species values for Lampsilis, 23 for Daphnia, 39 for Ceriodaphnia, and 2 for Sphaerium. Stephan 2009(c).

    While TSD Table 1 initially relies on the Stephan 2009 list, it adds a sensitive genera based on the new testing by INHS: Mayflies, Neocloeaon triangulifer. The Table also adjusted the SMAVs and GMAVs for Musculium, Haylella, Daphnia, Sphaerium, and

Ceriodaphnia based on the new test results from INHS and New England Bioassay. Since new test results show Neocloeaon as the most sensitive genera, the resulting four genera listed as most sensitive in TSD Table 1, ranked from least to most, were slightly different than the Stephan 2009 list: 4. Sphaerium, 3. Lampsilis, 2. Ceriodaphnia, and 1. Neocloeaon. Pet. at 95. Additionally, the GMAVs used in the ranking were significantly different than Stephan 2009 because of the adjustments based on the new test results.

The SMAVs and GMAVs used for three of the four most sensitive genera Sphaerium, Ceriodaphnia, and Neocloeon in TSD Table 1 were based on one test value each from NEB and INHS. Prop. at 95, 214-215; May 9, 2018 Mot. at 6. Although the new test values for Neocloeon added a new genera to the body of work relied upon in Stephan 2009, the new GMAVs for Sphaerium and Ceriodaphnia in TSD Table 1 completely replaced the GMAVs from Stephan 2009c that were derived from 2 tests for Sphaerium and 39 tests for Ceriodaphnia. As Mr. Huff explains, "Where 10-degree C toxicity data were available from our work, these results were substituted in the acute value table for the species tested." Huff PFT at 10.

a. Please comment on the variability in results that may be observed in toxicity testing of a particular species done in different laboratories under the same conditions.

b. Please comment on whether one study per species or genera is sufficient, especially for the most sensitive species when used as a basis for deriving a water quality standard.

d. Please cite to some established protocol, from USEPA or elsewhere, where substituting the GMAV from several previous tests with the GMAV from a single new test is prescribed? If not, could you please elaborate more on why this approach is appropriate?

Rank Order for Species in TSD Table 1.

31. In TSD Table 1, some of the species ranked by GMAV appear to be out of order. Would you please comment on potential revisions to TSD Table 1 based on the items below? Please comment on how this would affect the calculated Cumulative Probability, FAV (final acute value), FCV (final chronic value), and the proposed acute (CMC) and chronic (CCC) standards?

a. The SMAV and GMAV for the #20 ranked Hyalella azteca does not appear to agree with the SMAV and GMAV for the #6 ranked Hyalella azteca. Should both Hyalella azteca along with the Burlington Strain be considered under one rank for the genera Hyalella?

b. In the Stephan 2009a list, although Green sunfish, Lepomis cyanellus and Bluegill, Lepomis macrochirus have individual SMAVs of 9974.9 and 8406.5, they have one GMAV of 9157 since they belong to the same genera. However, in TSD Table 1, each has an individual GMAV (i.e., Greensunfish 9157; Bluegill

8406) and a separate ranking of 27 and 25, respectively. Should the GMAV of Bluegill, Lepomis macrochirus be the same as Greensunfish at 9157? If so, should they be considered under one rank?

c. Fingernail clam, Musculium sp. is included in TSD Table 1, however, it does not appear to be from the Stephan 2009a list, the USEPA 1988 Chloride Criteria list, the INHS, or NEB tests. Please elaborate why Musculium was added and the source of the SMAV of 3378 mg/L and GMAV 3151 mg/L.

c. Rank 24 is omitted from the list. Additionally, some of the species appear out of order based on GMAV as shown below. Should the ranks be renumbered?

GMAV	TSD Rank	Genus	Species
3350	8	Physa	gyrina
3331	6	Hyalella	azteca, Burlington
3151	9	Musculium	
3086	7	Villosa	delumbis, iris

32. In TSD Table 1, the 48-hr LC50 (Mean Lethal Concentration) values from the NEB 11-13-17 report were used as SMAV and GMAV for Ceriodaphnia dubia. The 96-hour LC50 values from the INHS report were used as the SMAV and GMAV for Sphaerium simile and Neocloeon triangulifier. Prop. at 95, 214-217; May 29, 2018 Mot. at 6. Please describe why the 48-hour and 96-hour LC50 results, while for different durations, both translate into a SMAV.

33. The values from the NEB Reports were reported in g/L sodium chloride (NaCl). The acute values (48-hour LC50) for Ceriodaphnia dubia in the November 13, 2017 report were reported at 3.62 g/L NaCl (10°C) and 1.92 g/L NaCL (25°C). May 29, 2018 Mot. at 6. The TSD converted g/L NaCl to mg/L as Cl to arrive at 48 hr LC50 values of 2197 mg/L Cl (10°C) and 1165 mg/L Cl (25°C). Prop. at 91, Att. 2. Please confirm if the conversion was based on the ratio of atomic mass of Na to Cl [35.453/(35.453+22.990) = 0.60662] as mentioned by Mr. Klocek (Klocek PFT at 3)?

34. TSD Table 1 also adjusted the SMAVs and GMAVs for Musculium, Haylella, Daphnia, Sphaerium, and Ceriodaphnia based on the new test results from INHS and NEB. Prop. at 95. Three footnotes to the table describe how the SMAVs and GMAVs from the original sources were adjusted based on the ratio of LC50 results of the INHS and New England Bioassay testing done for this rulemaking at 10°C and 25°C.

a. Footnote 1 for Fingernail clam, Musculium sp, states, “Adjusted to 10 degrees C by multiplying by 1.75 based on Sphaerium results.” Prop. at 95. The 1.75 ratio appears to be from the INHS Report data on Fingernail clam, Sphaerium simile for the 96-hour LC50 of 2920 mg/L Cl at 10°C divided by LC50 of 1673 mg/L Cl at 25°C from the INHS Report. Prop. at 214. Is that correct? Please indicate what the original SMAV and GMAV of Musculium sp. were, the source, and why they were added to the original list from Stephan 2009.

b. Footnote 2 for Daphnia states, "Adjusted to 10 degrees C based on [Ceriodaphnia] dubia results, by multiplying times 1.3." Prop. at 95. The TSD states that the 1.3 ratio is "the acute toxicity of Ceriodaphnia dubia at 10°C compared to the 25°C results." Prop. at 94. The 1.3 ratio does not appear to be the 48-hour LC50 of 2197 mg/L Cl at 10°C divided by the LC50 of 1165 mg/L Cl at 25°C from the November 13, 2017 New England Bioassay Report (2197/1165 = 1.89). Please describe how the ratio 1.3 was derived. If a different ratio is appropriate, please show how it would affect the calculated values in Table 1.

c. For the Footnote 2 adjustments, Mr. Huff explains, "Adjustments were also made to all three daphnia species based on the results from our work with the Ceriodaphnia dubia." Huff PFT at 10. While Daphnia and Ceriodaphnia are in the same family, they are from different genera. Please cite to some established protocol, from USEPA or elsewhere that prescribes the adjustment of the GMAV of one genera based on another genera. If not, would you please further elaborate on the appropriateness of this approach?

Normalizing Acute Values Based on Hardness and Sulfate.

35. In Stephan 2009a,c, the GMAVs and SMAVs were normalized to hardness and sulfate. Stephan 2009c lists the hardness and sulfate concentrations in the test material for each species. Normalized Acute Values (NAV) were calculated by normalizing the Acute Values (AV) to hardness and sulfate concentrations using the following equation:

$$NAV = (AV)\ (Hardness)^{0.205797}\ (Sulfate)^{-0.07452}.$$

The Acute Values were normalized to hardness of 300 mg/L and sulfate of 65 mg/L. The effect of normalizing acute values in this way results in higher Acute Values. Stephan 2009 at 1. As such, the values in the TSD Table 1 originating from the Stephan 2009c list are the Normalized Acute Values.

The new values in TSD Table 1 that were obtained from the INHS and NEB tests do not appear to be normalized to hardness and sulfate for the following species. While hardness values are provided for the test waters, total sulfate concentrations are not specifically mentioned in the test reports.

- Mayfiles, Neocloeaon triangulifer GMAV 1920 mg/L (100 mg/L as $CaCO_3$)
- Cladoceran, Ceriodaphnia dubia GMAV 2197 mg/L Cl (86 or 88 mg/L as $CaCO_3$)
- Fingernail clam, Sphaerium simile GMAV 2920 mg/L Cl (100 mg/L Hardness as $CaCO_3$)
- Amphipod, Hyalella azteca, Burlington strain SMAV 2185 mg/L Cl (100 mg/L hardness as $CaCO_3$)

a. Please comment on revising TSD Table 1 to use the Normalized Acute Values of the four species listed above based on the hardness and sulfate concentrations reported for the test waters and normalizing the data to 300 mg/L hardness and 65 mg/L sulfate for consistency with the existing Stephan 2009 values.

b. Please comment on how using the normalized acute values might change the ranks and the calculation of the Final Acute Value and Final Chronic Value, CMC and CCC presented in TSD Table 2?

36. Using the Normalized Acute Values for all species in the list, Stephan 2009a calculated a Final Acute Value of 1364 mg/L Cl and a CMC (acute criterion) of 682 mg/L Cl and a CCC (chronic criterion) of 421.5 mg/L Cl at hardness of 300 mg/L and sulfate of 65 mg/L. Stephan 2009a at 8, 14. The calculation followed the equation in USEPA 1985 Guidelines at 16. Since the CMC was normalized for hardness of 300 mg/L and sulfate of 65 mg/L, Stephan 2009 also calculated the non-normalized CMC and CCC to be used in equations dependent on site-specific hardness and sulfate:

CMC (Acute Criterion)
682.0 mg/L at hardness 300 mg/L $CaCO_3$ and 65 mg/L Sulfate
$287.8 \text{ mg/L} \times (\text{Hardness in mg/L as } CaCO_3)^{0.205797} \times (\text{Sulfate mg/L})^{-0.07452}$

CCC (Chronic Criterion)
421.5 mg/L Cl at hardness 300 mg/L $CaCO_3$ and 65 mg/L Sulfate
$177.87 \text{ mg/L} \times (\text{Hardness in mg/L as } CaCO_3)^{0.205797} \times (\text{Sulfate mg/L})^{-0.07452}$

Stephan 2009a at 8, 14.

As noted above, these equations became part of the Iowa chloride water quality standard. The statewide default values actually used in Iowa Adm. Code are hardness of 200 mg/L as $CaCO_3$ and a sulfate concentration of 63 mg/L. 567 Iowa Adm. Code 61.3(3) Table 1, Footnote (m).

a. Please comment on recalculating the CMC and CCC presented in TSD Table 2 based on normalized and non-normalized values as done by Stephan 2009a and use of the equation.

b. Please comment on what statewide default values for hardness and sulfate might be used in Illinois when site-specific information is not available.

b. Please comment on the resulting values and equation format and how they compare to the original proposal.

Other Acute Toxicity Testing on Mayflies at Various Temperatures with Linear Regression Analysis.

37. Although the new test values for Neocloeon (Mayflies) from INHS included in TSD Table 1 added a new genera to the body of work relied upon in Stephan 2009, mayflies

were also tested by the Stroud Water Research Center, Jackson and Funk (2019), as cited by Mr. Klocek.[3] Klocek PFT at 3, Att. 2. Mr. Klocek noted that four species of mayflies representing three different families and four different genera were tested for salinity toxicity at a range of temperatures from 5°C to 25°C: Neocloeon (Family Baetidae), Leptophlebia (Family Leptophlebiidae), Maccafertium (Family Heptageniidae), and Procloeon (Family Baetidae). Klocek PFT, Att. 2.

The Jackson and Funk (2019) acute toxicity tests examined acute (96 hour LC50) responses to elevated sodium chloride (NaCl) concentrations at 5, 7.5, 10, 12.5, 15, 20, and 25°C. The test waters were characterized by hardness of 93-100 mg/L as $CaCO_3$ and sulfate concentrations of 1.0-17.6 mg/L. Klocek PFT, Att. 2, Table 1. The results are summarized in Jackson and Funk (2019) Att. 2 in Table 2 with acute values measured in NaCl. Mr. Klocek indicated that the NaCl concentrations could be converted to chloride concentrations by multiplying by 0.607, which is the ratio of atomic mass of Na to Cl [35.453/(35.453+22.990) = 0.60662]. Klocek PFT at 3. At 10°C, the acute values (96 hour LC50) ranged from 3295 mg/L to 6336 mg/L chloride across the four genera tested. Klocek PFT, Att. 2, Table 2. The lowest of these values 3295 mg/L, before being normalized for hardness and sulfate, would rank as a GMAV between 6 and 5 in TSD Table 1.

a. Please comment on providing a table similar to Table 2 of Jackson and Funk (2019) showing species, genera, temperatures, and electrical conductivity with the 96-hour LC50 acute values converted to chloride concentrations. Please also comment on including the normalized acute values as done in Stephan 2009 for hardness and sulfate.

b. Please comment on why the acute values from these 4 new genera of mayflies from Jackson and Funk (2019) were not added to TSD Table 1 along with the acute value provided by INHS.

c. Please comment on the effect of adding the 10°C data for the Neocloeon genera from Jackson and Funk (2019) to the INHS 2017 data would have on the calculation of the SMAV and the GMAV used in TSD Table 1.

d. Please comment on any effect of adding the 10°C data for all four genera would have on the TSD's calculation of the Final Acute Value and Criterion Maximum Concentration (Acute Criterion).

TSD Table 2: Recalculation Values

38. TSD Table 2 is entitled "Recalculation Values for Chicago Sanitary and Ship Canal". Prop. at 97. Is this title correct? If not, is the table addressing values for all Illinois waters?

[3] Jackson JK, Funk DH. 2019. Temperature affects acute mayfly responses to elevated salinity: implications for toxicity of road de-icing salts. Phil. Trans. R. Soc. B 374: 20180081. http://dx.doi.org/10.1098/rstb.2018.0081

39. TSD Table 2 contains the calculations behind the derivation of the proposed winter acute and chronic standards. Prop. at 97. The formulas use the GMAV and rank of the species listed in Table 1 of the TSD (Prop. at 95).

Table 2 lists the four most sensitive species identified in TSD Table 1, along with terms to be used in the calculation to derive the Final Acute Value: GMAV, Cumulative Probability, $(ln\ \text{GMAV})^2$, *ln* GMAV, and the square root of the Cumulative Probability ($P^{½}$), and the summation of each. The column of $(ln\ \text{GMAV})^2$ and column of *ln* GMAV both appear to have slipped one cell up in the spreadsheet, such that values in the last two rows are repeated and the correctly calculated value for the first row is missing. This in turn affects the subsequent calculations.

Please review the values in Table 2 and make and submit the necessary revisions.

40. Due to the limitations of the text editor, the format of the mathematical terms in Table 2 doesn't seem to appear as intended. Based on the USEPA 1985 Guidelines, please comment on whether the equations below appear as intended. USEPA 1985 at 16.

$$P = \sum_{R=1\text{-}4} (R / (N + 1))$$

$$S^2 = \frac{[\sum ((\ln GMAV)^2)] - [(\sum \ln GMAV)^2 \div 4]}{[\sum (P)] - [(\sum(\sqrt{P}))^2 \div 4]}$$

$$L = [\sum (\ln GMAV) - S (\sum (\sqrt{P}))] \div 4$$

$$A = S (\sqrt{0.05}) + L$$

$$FAV = e^A$$

$$CCM = FAV \div 2$$

$$CCC = FCV = FAV \div ACR$$

where

P	Cumulative Probability of Ranks 1-4 for N values
R	Rank
N	Total number of all mean values ranked
e	Natural Logarithm Base
GMAV	Genus Mean Acute Value
FAV	Final Acute Value
FCV	Final Chronic Value
ACR	Acute-Chronic Ratio
CMC	Criterion Maximum Concentration (Acute Criterion)

CCC Criterion Continuous Concentration (Chronic Criterion)

Acute-Chronic Ratio.

41. The 1988 USEPA criteria document calculates the Final Acute-Chronic Ratio as the geometric mean of the three available Genus Mean Acute-Chronic Ratios: Rainbow Trout (Salmo garidneri) of 7.308, Fathead minnow (Pimepholes promelos) of 15.17, and Cladoceran (Daphnia pulex) of 3.951. The result was 7.594. Prop. at 54-55.

    In contrast, Stephan 2009 states, "[T]he fathead minnow should not be used in calculations [for the Final Acute-Chronic Ratio] because the acute and chronic tests using the fathead minnow were performed in different dilution waters…" Stephan 2009a at 7. Stephan 2009a instead used only the geometric mean of the Genus Mean Acute-Chronic Ratios for Daphnia (ambigua 4.148, magna 1.974, pulex 3.952) to calculate a Final Acute-Chronic Ratio of 3.187. Stephan 2009 at 7.

    TSD Table 2 used a similar Acute-Chronic Ratio of 3.178 to calculate the Final Chronic Value = Final Acute Value/Acute-Chronic Ratio. Prop. at 98. The TSD explained, "The chronic derivation is not as straight forward [as the derivation of the winter acute chloride standard], as no chronic effects were observed using the standard USEPA toxicity test protocol, making derivation of a chronic standard subject to more best professional judgement. Using the USEPA Acute:Chronic ratio of 3.178 was therefore a conservative approach, which yielded a chronic water quality criterion of 640 mg/L . . . In summary, using the acute-to-chronic ratio, as described in the previous section results in a conservative chronic water quality criterion, which will be protective of the most sensitive species." Prop. at 98.

    Roger Klocek's PFT and Stephan 2009a refers to the Acute-Chronic Ratio of 3.187. Klocek PFT at 4; Stephan 2009a at 7.

    a. Instead of 3.178, did you mean to use 3.187 in your calculations?

    b. Please comment on how this would alter the results for Final Chronic Value.

Derivation of an Alternative Final Chronic Value.

42. Stephan 2009a described an alternative approach to deriving the Final Chronic Value "justified on the basis of the 'good science" clause in section CII.B of the 1985 Guidelines." Stephan 2009at at 9. "The FACR of 3.187 derived above was derived from all of the acceptable ACRs [Acute-Chronic Ratio] for invertebrates. The only acceptable ACR for a vertebrate is 7.308. A predicted GMCV [Genus Mean Chronic Value] can be calculated from each GMAV by using 3.187 as the invertebrate ACR and using 7.308 as the vertebrate ACR." Stephan 2009 at 9. "[T]he FCV [Final Chronic Value] can be calculated directly from the predicted GMCVs. This approach calculates and uses a predicted chronic value for each genus for which an acute value is available and probably does a better job of taking into account the chronic sensitivities of both vertebrates and invertebrates to chloride." Stephan 2009a at 9.

The 2010 Stroud Expert Report further explained this alternative approach, stating:

> "Iowa worked with the [US]EPA to develop their chloride criteria. Iowa instituted three major changes from the 1988 [US]EPA Criteria…The third major change was in the way they calculated the criterion chronic concentration (CCC). Rather than use the ACR [Acute-Chronic Ratio] method used by the [US]EPA in 1988, they used the ACR and genus mean acute value (GMAV) to calculate a predicted genus mean chronic value (pGMCV). Then they used the pGMCV to calculate a final chronic value (FCV) using observed values of hardness and sulfate." 2010 Stroud Expert Report at 10.

> "Rather than use the ACR from four species [rainbow trout vertebrate ACR 7.308, and 3 species of Daphnia geometric mean invertebrate ACR 3.187] to calculate the CCC (Iowa DNR 2009), this approach relied on the predicted GMCV from 20 genera (Stephan 2009a). This method still relied on the ACR, but changed how it was used (Stephan 2009a). In addition, the predicted GMCV did not represent new research, but were derived from the existing GMAVs and ACRs. Stephan (2009a) divided the GMAV for each species by the ACR to calculate a genus mean chronic value (GMCV). The GMCVs were then used to calculate a FCV using the same equations that were used to calculate the FAV…Using two ACRs had a substantial effect on the CCC value when compared to a single geometric mean ACR." 2010 Stroud Expert Report at 13.

As such, the ranking based on GMAV is different than the ranking based on predicted GMCV since a different Acute-Chronic Ratio is applied to the GMAVs depending on whether the genus is invertebrate of vertebrate. Therefore, the four most sensitive genare are different in Stephan 2009a for the calculation of the Final Acute Value based on GMAV and the Final Chronic Value based on the predicted GMCVs that utilize both the vertebrate and invertebrate Acute-Chronic Ratios. In the Stephan 2009a list, the 4 most sensitive ranked genera based on GMAV were 4. Lampsilis, 3. Daphnia, 2. Ceriodaphnia, and 1. Sphaerium; while the 4 most senstive ranked genus based on predicted GMCV were 4. Daphnia, 3. Pseudacris (Chorus Frog), 2. Ceriodaphnia, 1. Sphaerium. The TSD Tables 1 and 2 list, the 4 most sensitive genera based on GMAV as 4. Sphaerium, 3. Lampsilis, 2. Ceriodaphnia, 1. Neocloeaon. However, for the calculation of an alternative Final Chronic Value, it appears the 4 most sensitive genera based on predicted GMCV using the invertebrate ACR 3.187 and vertebrate ACR 7.308 would be 4. Lampsilis, 3. Ceriodaphnia, 2. Pseudacris, and 1. Neocloeaon.

a. Please comment on how the four most sensitive species would be different in the TSD Table 1 and 2 list based on the GMAVs for the calculation of the Final Acute value vs. the predicted GMCVs for the calculation of the Final Chronic Value using the alternative method.

b. Please comment on recalculating the CCC (Final Chronic Value) based on the predicted GMCVs as used in the Stephan 2009a Derivation of an Alternative Final Chronic Value and described by the 2019 Stroud Expert Report instead of simply using the Acute-Chronic Ratio of 3.187 in the FCV equation of FCV = FAC ÷ ACR? Prop. at 97.

Technical Feasibility and Economic Reasonableness

43. As noted in the Statement of Reasons, the Board is required to take into account the "technical feasibility and economic reasonableness of measuring or reducing the particular type of pollution." *See* 415 ILCS 5/27(a). Would you please address the technical feasibility and economic reasonableness of the proposal?

Chloride Best Management Practices and Offsets

44. In R08-9(D), Mr. Huff testified regarding a chloride offset program with the Illinois Toll Highway Authority. The Board's First Notice opinion noted,

> "Speaking of his experience with the construction of the Elgin-O'Hare extension, Mr. Huff testified regarding negotiations between the tollway and USEPA and IEPA on a chloride offset program that has received all the appropriate permits. In order to achieve the offsets for the increased lane miles, the BMP plan involved the local communities and funding brine tanks, training, and calibration of equipment. Mr. Huff testified that a similar approach over the past seven years has already shown progress in the DuPage River and Salt Creek. As for the future of the ALUB waters, Mr. Huff believes that the BMPs will lead to fewer exceedances of the 500 mg/L chloride level, perhaps as much as by 80 to 90% over the next five to ten years. 12/17/13 Tr. at 193-197." R08-9(D), slip op. at 78 (September 18, 2014).

a. Please provide further elaboration on these efforts.

b. Were local communities able to apply to the Illinois Toll Highway Authority for funding to purchase new equipment to reduce salt usage in their communities to offset increased salt usage by the tollway where the same watersheds were affected?

c. How much funding were the communities able to acquire for these offset agreements, how were the amounts determined, and how was it allocated among BMP measures?

d. Can you name some of the Illinois communities have these type of offset agreements?

e. Were these agreements or resulting BMP initiatives made part of their MS4 permits?

f. Do you know if there are similar offset agreements in other states?

g. What other sources of funding are communities able to use for implementing chloride BMPs?

45. Regarding the implementation of BMPs for deicing, Mr. Huff notes, "it has become apparent that there is no basis to believe BMPs by themselves will result in achieving a 500 mg/L not-to-exceed winter standard." Huff PFT at 2.

a. Please comment on whether all municipalities and other entities discharging to urban waterways have developed and implemented BMPs to reduce deicing salt usage.

b. If not, would it be premature to draw broad conclusions on the effectiveness of BMPs to reduce salt usage to meet the chloride standard?

46. The Jackson and Funk (2019) Report states:

> "It is important to note that salinity toxicity is known to vary among salts…so our toxicities for elevated salinity that is predominately NaCl must be used with caution when referring to other de-icing and anti-icing salts such as MgCL2, CaCl2, KCL or calcium magnesium acetate…" Klocek PFT, Att. 2.

a. Please comment on whether other salts besides NaCl tend to be more or less toxic to aquatic life?

b. Do you know if any of the chloride BMPs currently being prescribed consider the toxicity of other salts? If not, should they?

47. Mr. Huff, referring to a Connecticut Department of Transportation Study notes that, "[a] 19 percent increase in nonfatal injuries and a 33 percent increase in total accidents were observed with the sand-salt mixture compared to just salt." Huff PFT at 2 (citing Prop., Att. 4).

a. Are Illinois roadway authorities considering alternatives other than sand-salt mixture to reduce salt usage in urban areas?

b. If so, please describe the alternative options being considered to reduce salt usage for deicing, and comment on the effectiveness of such alternatives in terms of mobility and safety. Also, submit any studies conducted to evaluate the effectiveness of alternatives to sand-salt mixture.

c. Please clarify whether it is your opinion that "highway de-icing practices cannot be simply changed" or is it the consensus of roadway authorities in the State. Huff PFT at 1.

Response to Ms. Barghusen's Testimony

48. Ms. Barghusen asserts that the species mean acute value (SMAV) of 2764.4 Cl-/L for Lampsilis siliquoidea used in Mr. Huff's proposal "is not consistent with current data for the most sensitive life stages of Lampsilis siliquoidea or the most sensitive life stages of other sensitive mussels of the genus Lampsilis." Barghusen PFT at 4. Please clarify whether the SMAV used in the proposal needs to be revised considering the more recent studies cited by Ms. Barghusen. If not, please explain the rationale for the use of SMAV used in the proposal over a revised SMAV.

49. Please comment on Ms. Barghusen's concern regarding the lack of studies to demonstrate that the proposed standard affords adequate protection to "chloride sensitive glochidia of the Fat Mucket (Lampsilis siliquoidea), Plain Pocketbook (Lampsiliscardium), Wavy-rayed lampmussel (Lampilis fasciola), and Northern riffleshell (Epiblasma torulosa rangiana) because their chloride toxicity has not been tested at 10°C." Barghusen PFT at 5.