



WQS Triennial Review – Issue Paper:

Comparison of Current Idaho Aquatic Life Criteria for Ammonia and EPA §304(a) Recommended Criteria

Introduction

Under section 304(a) of the Clean Water Act, the US Environmental Protection Agency (EPA) is to develop and publish water quality criteria that reflect the latest scientific knowledge on the effects of a constituent concentration on animal and human health. These criteria are published as recommendations to states and authorized tribes for use in setting their water quality standards. While EPA provides scientific recommendations to protect aquatic life and recreation uses, these do not substitute for the Clean Water Act or EPA's regulations, nor are they regulations themselves. As a practical matter, EPA uses recommended §304(a) criteria as one factor for determining whether to approve a state's water quality standards. Revisions to Idaho water quality standards must be approved by EPA before they are applicable for Clean Water Act purposes. States must consider adopting new or updated Clean Water Act §304(a) criteria recommendations as part of their triennial review as described under 40 CFR 131.50(a).

EPA produced new §304(a) ammonia recommendations in 2013 that the Department of Environmental Quality (DEQ) formally considered in the 2017 Triennial Review and will revisit in 2020. This paper reviews the current Idaho surface water quality ammonia criteria for aquatic life use designations (IDAPA 58.01.02.250), in comparison with updated EPA §304(a) ammonia criteria recommendations.

Please note that throughout this paper the term 'ammonia criteria' refers to the equation used to calculate the ammonia criterion, where temperature and pH parameters are known..

History of Ammonia Criteria

EPA originally published freshwater ammonia criteria recommendations in 1976, which were later updated in 1985. EPA's '1999 Update of Ambient Water Quality Criteria for Ammonia' considered pH, temperature and the effects of ammonia to fish life stages. The 1999 update expressed ammonia as total ammonia nitrogen (mg TAN/L), whereas the prior 1985 update expressed the criterion as unionized ammonia (NH₃). Additionally, the chronic ammonia criterion changed to a 30-day averaging period (rolling average), as opposed to the 4-day averaging period recommended in the 1985 update. Consequently, Idaho adopted these recommended numeric criteria for freshwater ammonia on March 15, 2002, and EPA approved Idaho's adoption of the criteria in November 2002 (IDAPA 58.01.02.250).

In 2003, EPA became aware of new toxicity studies indicating the relative sensitivity of freshwater mussels to ammonia and began to update the 1999 criteria to reflect this new information. The 2009 EPA draft update to the ammonia criteria included freshwater mussel sensitivity, bifurcated criteria for waters with mussels present or absent, and discussed new

toxicity data for freshwater snails which indicates that gill-bearing snails are sensitive to ammonia (EPA 2009) (Table 1).

Table 1. Comparison of 1999 and Draft Updated 2009 Ammonia Criteria.

	Draft 2009 Ammonia Criteria*	1999 Ammonia Criteria*
Acute	2.9 mg N/L mussels present 5.0 mg N/L mussels absent	5.6 mg N/L salmon present
Chronic	0.26 mg N/L mussels present 1.8 mg N/L mussels absent	1.2 mg N/L fish early life stages present
*at pH 8 and 25°C		

In April 2013, EPA finalized the updated ammonia criteria, which incorporated the draft 2009 ammonia criteria and supersede EPA's previously recommended 1999 criteria. The 2013 final ammonia aquatic life criteria reflect the latest scientific information on freshwater mussel and snail sensitivities to ammonia. Additional toxicity testing of ammonia on freshwater, gill-breathing snail species validates the draft 2009 ammonia update. EPA now recommends applying a single acute and single chronic criterion to all waters, rather than different criteria based on the presence or absence of mussels. Because sensitive mollusks are present in nearly all fresh waters of the contiguous U.S., the latest criteria apply to all fresh water bodies to protect the aquatic community as a whole (EPA 2013b).

Comparison of 1999 to 2013 Ammonia Aquatic Life Criteria

The EPA 1999 recommended aquatic life criteria for ammonia were based on the most sensitive endpoints known at the time: salmonids, where present (acute), and the reproductive effects on the benthic invertebrate *Hyaella* (chronic). The 2013 criteria updates account for data from additional sensitive freshwater mussel species in the family *Unionidae*. These updates include additional data from other freshwater mollusk taxa confirming that non-pulmonate (gill-bearing) snails are also sensitive to the effects of ammonia (EPA 2013a). The relationship with temperature and pH that was established in the 1999 ammonia criteria still hold with the parameter's current analysis.

Changes to 2013 Criteria

In 2018, EPA corrected a minor typesetting error in the 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia document. To correctly calculate the ammonia criterion maximum concentration (CMC) where *Oncorhynchus* species are absent, the missing parentheses were placed into the equation. This error did not affect any of the criterion value results presented in the document.

Current Rule

Ammonia Surface Water Quality Criteria for Aquatic Life Use Designations (IDAPA 58.01.02.250)

02. Cold Water. Waters designated for cold water aquatic life are not to vary from the following characteristics due to human activities:

...

d. Ammonia. The following criteria are not to be exceeded dependent upon the temperature, T (degrees C), and pH of the water body:

i. Acute Criterion (Criterion Maximum Concentration (CMC)). The one (1) hour average concentration of total ammonia nitrogen (in mg N/L) is not to exceed, more than once every three (3) years, the value calculated using the following equation:

$$CMC = \frac{0.275}{1 + 10^{7.204 - pH}} + \frac{39.0}{1 + 10^{pH - 7.204}}$$

ii. Chronic Criterion (Criterion Continuous Concentration (CCC)).

(1) The thirty (30) day average concentration of total ammonia nitrogen (in mg N/L) is not to exceed, more than once every three (3) years, the value calculated using the following equations:

(a) When fish early life stages are likely present:

$$CCC = \left(\frac{0.0577}{1 + 10^{7.688 - pH}} + \frac{2.487}{1 + 10^{pH - 7.688}} \right) \bullet \text{MIN}(2.85, 1.45 \cdot 10^{0.028(25-T)})$$

(b) When fish early life stages are likely absent:

$$CCC = \left(\frac{0.0577}{1 + 10^{7.688 - pH}} + \frac{2.487}{1 + 10^{pH - 7.688}} \right) \bullet 1.45 \cdot 10^{0.028(25-T)}$$

(2) The highest four-day (4) average within the thirty-day (30) period should not exceed two point five (2.5) times the CCC.

(3) Because the Department presumes that many waters in the state may have both spring-spawning and fall-spawning species of fish present, early life stages of fish may be present throughout much of the year. Accordingly, the Department will apply the CCC for when fish early life stages are present at all times of the year unless:

(a) Time frames during the year are identified when early life stages are unlikely to be present, and

(b) The Department is provided all readily available information supporting this finding such as the fish species distributions, spawning periods, nursery periods, and the duration of early life stages found in the water body; and

(c) The Department determines early life stages are likely absent.

03. Seasonal Cold Water. Between the summer solstice and autumn equinox, waters designated for seasonal cold water aquatic life are not to vary from the following characteristics due to human activities. For the period from autumn equinox to summer solstice the cold water criteria will apply:

...

d. Ammonia. Concentrations of ammonia are not to exceed the criteria defined at Subsection 250.02.d

04. Warm Water. Waters designated for warm water aquatic life are not to vary from the following characteristics due to human activities:

...

d. Ammonia. The following criteria are to be met dependent upon the temperature, T (degrees C), and pH of the water body:

i. Acute Criterion (Criterion Maximum Concentration (CMC)). The one (1) hour average concentration of total ammonia nitrogen (in mg N/L) is not to exceed, more than once every three (3) years, the value calculated using the following equation:

$$CMC = \frac{0.411}{1 + 10^{7.204 - pH}} + \frac{58.4}{1 + 10^{pH - 7.204}}$$

ii. Chronic Criterion (Criterion Continuous Concentration (CCC)). Concentrations of ammonia are not to exceed the criteria defined at Subsection 250.02.d.ii.

Discussion

Idaho has not yet addressed guidance from the most recent EPA recommended ammonia criteria. The last revision to ammonia in Idaho WQS was in 2002, based on EPA's 1999 ammonia criteria. The EPA 2013 recommended criteria for ammonia have updated criteria magnitudes and are more stringent than previously recommended 1999 criteria magnitudes; however, duration and frequency components of the 1999, 2009 and 2013 criteria are the same.

The National Recommended Criteria for Ammonia in Fresh Water

EPA's 2013 recommendations are presented below in Table 2 as an example, utilizing the equation for ammonia criteria, while assuming a pH of 7.0 and temperature of 20° C. This example displays an acute criterion magnitude of 17 mg TAN/L and a chronic criterion

magnitude of 1.9 mg TAN/L at pH 7 and 20°C, with the stipulation that the chronic criterion cannot exceed 4.8 mg TAN/L as a 4-day average. All recommended criteria magnitudes are not to be exceeded more than once in three years on average. Available ammonia data indicate that, except where unusually sensitive species are on-site, freshwater aquatic life will be protected if these criteria are met.

Table 2. Deriving Ammonia Criteria, Utilizing EPA's 2013 Recommended Equation for Ammonia

2013 Final Aquatic Life Criteria for Ammonia (Magnitude, Frequency, and Duration) (mg TAN/L) pH 7.0, T=20°C	
Acute (1-hour average)	17
Chronic (30-day rolling average)	1.9*
*Not to exceed 2.5 times the CCC as a 4-day average within the 30-days, i.e. 4.8 mg TAN/L at pH 7 and 20°C, more than once in three years on average.	
Criteria frequency: Not to be exceeded more than once in three years on average.	

Acute Criterion Calculations

[The one-hour average concentration of total ammonia nitrogen (mg TAN/L) is not to exceed, more than once every three years on average, the acute criterion magnitude (CMC).]

$$CMC = MIN \left(\left(\frac{0.275}{1 + 10^{7.204 - pH}} + \frac{39.0}{1 + 10^{pH - 7.204}} \right), \left(0.7249 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \times (23.12 \times 10^{0.036 \times (20 - T)}) \right) \right)$$

Chronic Criterion Calculations

[The thirty-day rolling average concentration of total ammonia nitrogen (mg TAN/L) is not to exceed, more than once every three years on average, the chronic criterion magnitude (CCC).]

$$CCC = 0.8876 \times \left(\frac{0.0278}{1 + 10^{7.688 - pH}} + \frac{1.1994}{1 + 10^{pH - 7.688}} \right) \times (2.126 \times 10^{0.028 \times (20 - MAX(T, 7))})$$

Currently, Idaho's WQS vary with presence and life-stage of aquatic species and pH; only the chronic criteria calculation includes temperature. After considering the most recent scientific knowledge concerning the impact of ammonia exposure to mollusks, freshwater mussels, freshwater non-pulmonate snails, and other sensitive invertebrate taxon, EPA determined these factors should be included in the most current ammonia dataset to accurately protect for aquatic life, and also that bifurcated criterion based on mussel presence or absence was no longer recommended. 2013 EPA-recommended equations for determining ammonia produce a single acute and chronic criterion, which are more stringent than current Idaho WQS, see Table 3 example below.

Table 3. Example of EPA §304(a) Recommended Criteria and Idaho WQS Comparison. [Note: In this example, criteria magnitudes for ammonia are expressed as total ammonia nitrogen (mg TAN/L) at pH 7 and 20 °C.]

Criteria Version	Criterion Duration	
	CMC ^a (1-hour average, mg TAN/L)	CCC ^a —When Fish Early Life Stages Present (30-day average ^b , mg TAN/L)
Idaho WQS (based on 1999 EPA criterion)	24	4.5 ^c
EPA §304(a) (based on final 2013 criterion)	17	1.9 ^c

a. See definitions of Acute Criteria (CMC) and Chronic Criteria (CCC) (IDAPA 58.01.02.010).

b. Rolling average for 2013 EPA criteria.

c. Not to exceed 2.5 times the criterion continuous concentration as a 4-day average within a 30-day period.

Criteria frequency: Not to be exceeded more than once in 3 years on average.

References

- EPA (US Environmental Protection Agency). 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia. Washington, DC: EPA-822-R-99-014, 147 pp.
- EPA (US Environmental Protection Agency). 2000. Biological Assessment of the Idaho Water Quality Standards for Numeric Water Quality Criteria for Toxic Pollutants. Seattle, WA: EPA, 208 pp.

EPA (US Environmental Protection Agency). 2009. Draft 2009 Update of Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater. Washington, DC: EPA-822-F-09-055, 2 pp.

EPA (US Environmental Protection Agency). 2013a. Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater 3013. Washington, DC: EPA-822-R-18-002, 242 pp.

EPA (US Environmental Protection Agency). 2013b. Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater Final 2013 [PowerPoint slides]. Retrieved from <https://www.epa.gov/wqc/aquatic-life-criteria-ammonia>