Los Alamos National Laboratory
Copper Water Quality Criteria Fact Sheet

OBJECTIVE:
Obtain New Mexico Water Quality Control Commission approval for determining copper water quality criteria utilizing U.S. Environmental Protection Agency 2007 biotic ligand model

LOCATION:
Surface water both within and in the vicinity of Los Alamos National Laboratory

APPROACH:
Build an equation using water chemistry parameters to accurately update copper criteria for surface water

OUTCOME:
Align copper criteria for monitoring at LANL with EPA criteria for protection of aquatic life

BACKGROUND

Copper is an abundant, naturally occurring element found in the earth's crust and surface waters. It enters surface waters through natural sources (e.g., rock weathering, volcanic activity) and anthropogenic sources (e.g., legacy laboratory operations, mining, pesticides, urban runoff). Copper is an essential micronutrient at low concentrations to virtually all plants and animals. At elevated concentrations, copper can be toxic to aquatic life. Copper toxicity levels can vary widely across different waterbodies because local water chemistry affects the bioavailability of copper to aquatic life. Two water quality criteria are specified for most constituents, including copper: (1) acute toxicity (short-term exposure), and (2) chronic toxicity (long-term exposure).

IMPACT OF PROPOSED CHANGE

The proposed site-specific water quality criteria (SSWQC) equations enable more accurate determination of copper toxicity levels. This approach will eliminate copper exceedances in sampling events that are not toxic levels to aquatic life and increase effective use of public resources.

REGULATORY CRITERIA

New Mexico applies Environmental Protection Agency's (EPA) 1996 copper criteria in surface waters across the state. However, the state also allows interested parties to develop specific standards to address the local environment. The criteria use equations that consider the influence of water hardness on copper bioavailability. For example, copper bioavailability decreases as hardness increases, due to competitive interactions between copper and the constituents that impact hardness (e.g., calcium and magnesium) for uptake into an aquatic organism. Hardness-based criteria are potentially under-protective (i.e., not stringent enough) or over-protective (i.e., too stringent), depending on site-specific water chemistry.

In 2007, EPA published recommended criteria using the biotic ligand model (BLM). The BLM replaces EPA's previously recommended hardness-based equation by incorporating additional parameters that can affect copper bioavailability and toxicity to aquatic life. EPA considers the copper BLM to represent the best available science for setting copper criteria.

New Mexico's water quality standards allow for the SSWQC to use EPA's copper BLM. The physical and chemical characteristics (i.e., BLM parameters) of Pajarito Plateau surface waters have been extensively monitored (over 500 samples from nine different watersheds) at a variety of locations for over a decade, making it a suitable setting for use of BLM-based copper SSWQC.

PROPOSAL FOR PUBLIC INPUT

BLM-based SSWQC for copper are being proposed for Pajarito Plateau surface waters in the vicinity of Los Alamos National Laboratory. The proposed SSWQC are based on a multiple-linear regression equation that reduces the complexity of the BLM model into a three-parameter equation with the inputs of pH, dissolved organic carbon (DOC), and hardness. These three parameters have the most significant overall effects on copper toxicity due to their influence on copper bioavailability (see ***Figure 1***).

BIOAVAILABILITY

is a measure of the fraction of the copper in water that will be able to have a toxic effect on organisms living in that water. Water chemistry affects copper bioavailability.

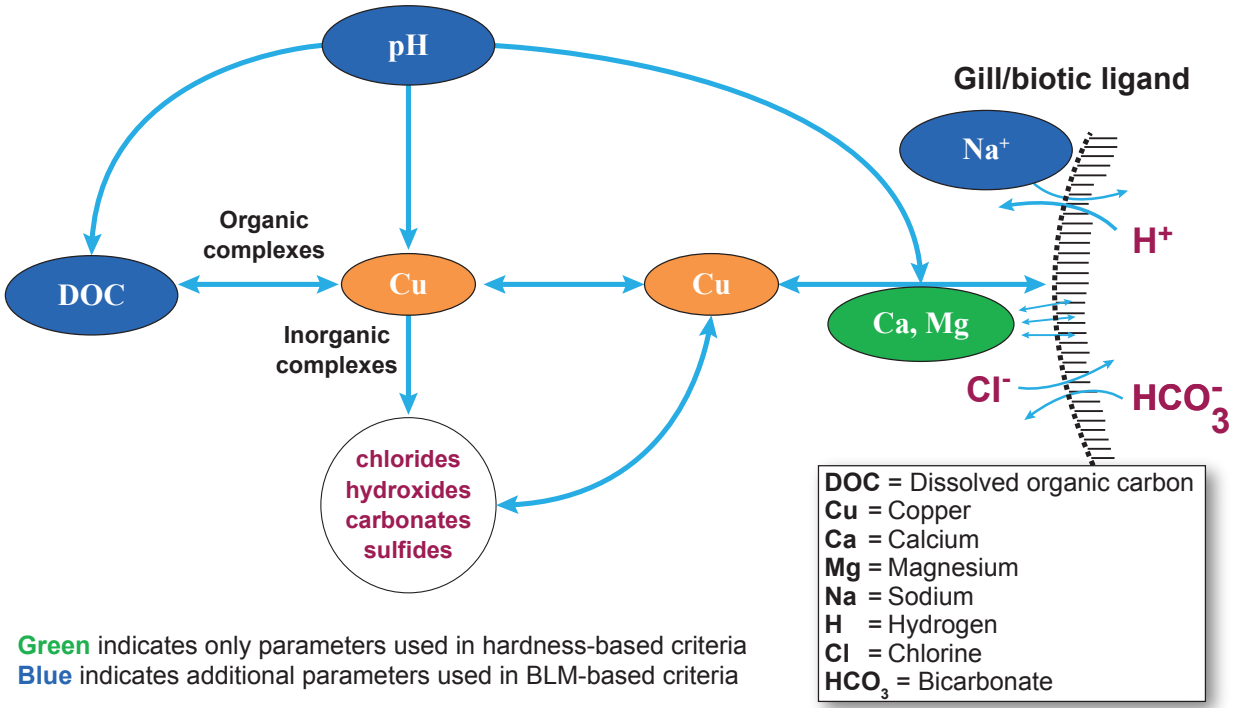

Figure 1. *Copper BLM schematic depicting the influence of water chemistry parameters on copper bioavailability.*

PROPOSED EQUATIONS

$$SSWQC_{acute} = e^{(-22.912 + 1.017*\log_e(DOC) + 0.045*\log_e(hardness) + 5.176*pH - 0.261*pH^2)}$$

$$SSWQC_{chronic} = e^{(-23.382 + 1.017*\log_e(DOC) + 0.045*\log_e(hardness) + 5.174*pH - 0.261*pH^2)}$$

The equation inputs are DOC (mg/L), hardness (mg/L $CaCO_3$), and pH (in standard units).

The SSWQC equations would apply to Pajarito Plateau surface waters from the western headwaters to the Rio Grande (excluding the Rio Grande) and from Guaje Canyon in the north to El Rito de Frijoles in the south (see ***Figure 2***).

The SSWQC equations accurately generate EPA's BLM-based criteria, which provides for the protection and maintenance of aquatic life on the Pajarito Plateau. The proposed SSWQC do not involve new discharges or sources of copper to the Pajarito Plateau and will remain protective of downstream aquatic life in the Rio Grande. The SSWQC Demonstration Report contains additional information regarding the proposed SSWQC.

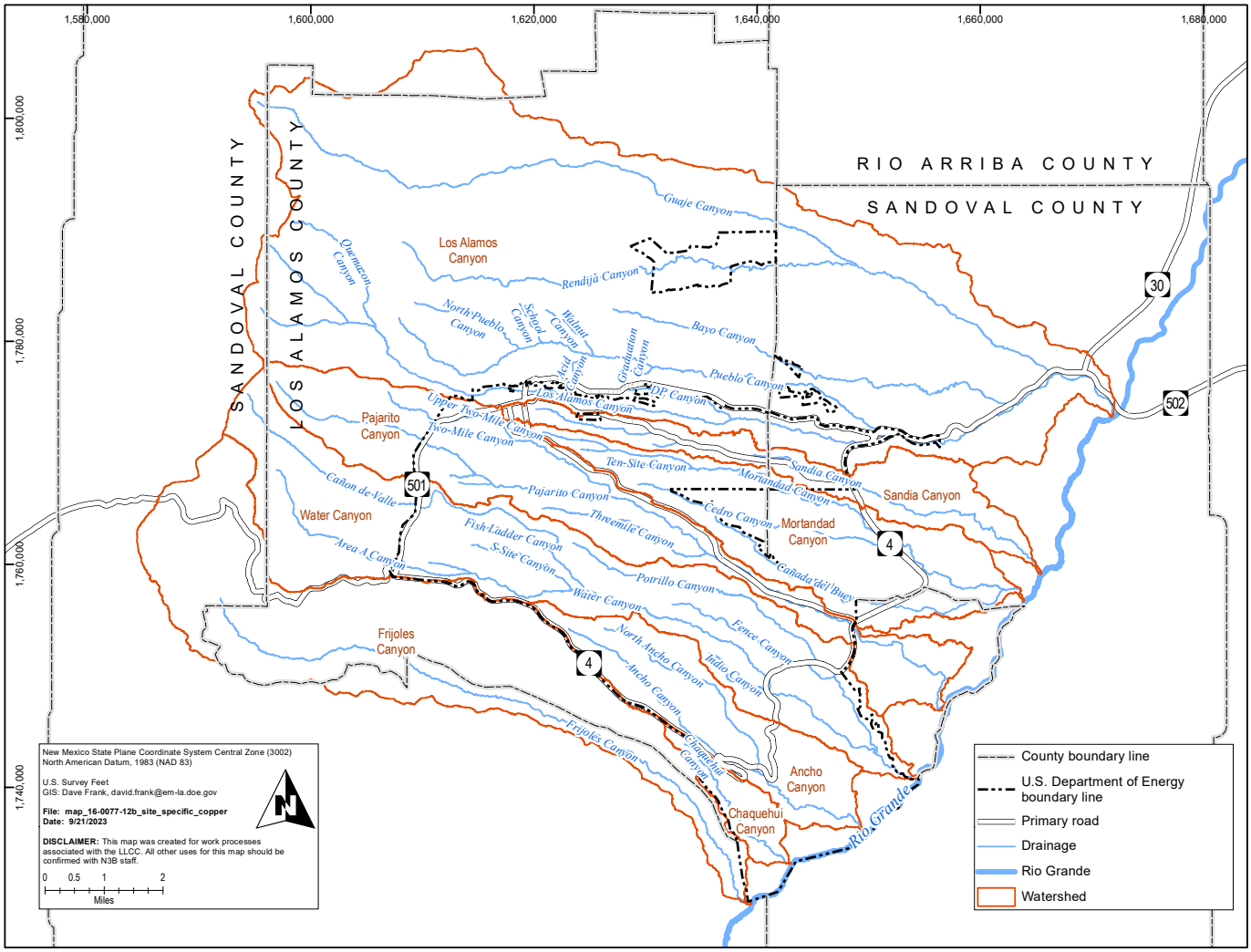

Figure 2. *Surface waters of the Pajarito Plateau proposed for copper SSWQC (note: Rio Grande is not part of the proposal)*

ACTIONS TAKEN

Draft Demonstration Report

- ✓ Presentation and justification of copper SSWQC using BLM pursuant to New Mexico Administrative Code § 20.6.4.10

Agency Review

- ✓ New Mexico Environment Department (NMED) and EPA review and comment on draft Demonstration Report

NEXT STEPS

Stakeholder & Public Review

- ☐ Public review of and comment on the draft Demonstration Report
- ☐ Development of the final Demonstration Report

Petition & Rulemaking

- ☐ Develop the petition for copper SSWQC based on: (a) conclusions presented in the final Demonstration Report; (b) NMED and EPA comments; and (c) comments from the public, the National Forest Service, National Park Service, Pueblos, and others

ADDITIONAL RESOURCES

EPA. 2007. Aquatic Life Ambient Freshwater Quality Criteria- Copper- 2007 revision. Office of Water 4305T. EPA-822-F-07-001. February 2007

EPA. 2018. Questions and Answers on the Establishment of Site-Specific Freshwater Criteria using the Copper Biotic Ligand Model. EPA Region 3. June 2018

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