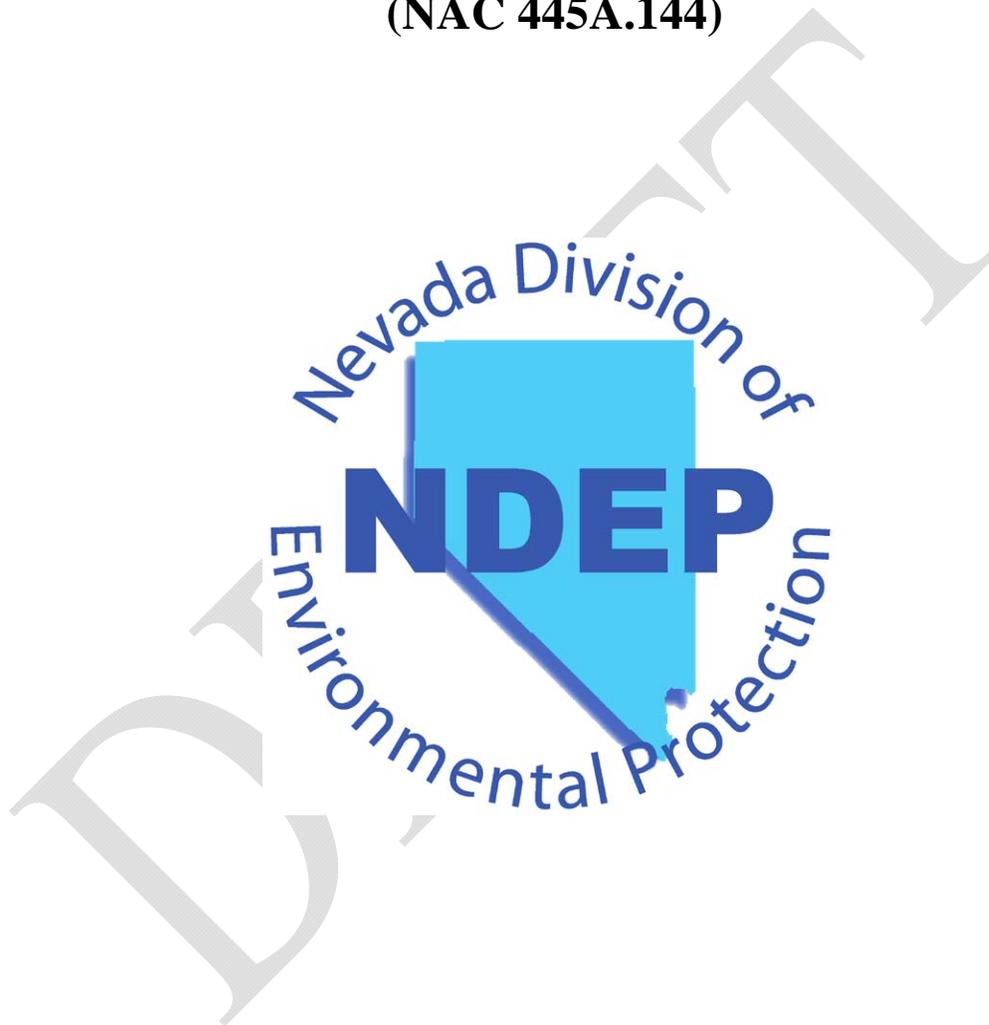


**RATIONALE FOR PROPOSED REVISION TO  
AQUATIC LIFE WATER QUALITY CRITERIA  
FOR MOLYBDENUM  
(NAC 445A.144)**



**Bureau of Water Quality Planning  
July 2008**

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## **Appendix A**

Aquatic Life Water Quality Criteria for Molybdenum  
(Tetra Tech, Inc., July 9, 2008)

# **RATIONALE FOR PROPOSED REVISION TO AQUATIC LIFE WATER QUALITY CRITERIA FOR MOLYBDENUM (NAC 445A.144)**

## **Introduction**

The current State of Nevada molybdenum (Mo) water quality standard for protection of aquatic life is 19 µg/L (0.019 mg/L). This standard was adopted based on recommendations made by the California State Water Resources Control Board (CSWRCB) in the report, *Regulation of Agricultural Drainage to the San Joaquin River*, (1988). The relevance and applicability of the molybdenum standard to Nevada surface waters has been frequently questioned. The U.S. Environmental Protection Agency (EPA) has not developed or published national water quality criteria for molybdenum for protection of aquatic life. This is most likely due to the relatively low toxicity and rare occurrence of molybdenum in most areas of the U.S.

The Nevada Division of Environmental Protection – Bureau of Water Quality Planning (NDEP-BWQP) contracted with Tetra Tech, Inc. to assess the existing statewide molybdenum aquatic life standard and to determine whether more recent and relevant toxicological data had been published. Based on the compiled data, an evaluation was made to determine if adequate data existed to substantiate the existing molybdenum aquatic life standard or to support derivation of revised criteria consistent with EPA methods.

The molybdenum criterion recommended by the CSWRCB was calculated based on toxicity data published in 1978 and 1980 on the long term effects of molybdenum on rainbow trout, narrow-mouthed toad, and *Daphnia magna* (an aquatic macroinvertebrate), and an ambient national background level of molybdenum in surface waters. A 19 µg/L molybdenum criterion value was derived by taking the log mean of the three adverse effects levels for the above mentioned species and the average level of molybdenum in surface waters of the U.S. The average national surface water concentration of 0.68 µg/L reported in *Study and Interpretation of the Chemical Characteristics of Natural Waters* (Hem, 1985) was used. Including the national background level strongly biased the calculation. The use of a surface water

background concentration is not consistent with EPA accepted criteria development methods, nor is it toxicologically-based. The CSWRCB noted in the 1988 report that the calculated molybdenum criterion should be considered preliminary subject to revision as new toxicity data became available.

Assessment of the 19 µg/L molybdenum aquatic life threshold indicated that the criterion was developed using limited toxicity data and non-standard criteria development methods. The aquatic life toxicological data that was assembled for molybdenum by Tetra Tech, Inc. did not support the CSWRCB recommended criteria. Development of revised molybdenum aquatic life water quality criteria based on sound toxicological data and supporting information that would be scientifically defensible and applicable to Nevada surface waters was determined to be appropriate.

### **Criteria Development Summary**

The standard protocol for use in deriving aquatic life water quality criteria is EPA's *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses* (Stephan et al. 1985). Most of the current EPA aquatic life criteria for metals have been developed in accordance with this guidance. The minimum data requirements ("8 Family Rule") for developing criteria as well as the procedures for calculating criteria based upon those data are outlined in the guidance document. Additionally, the guidance discusses the types of toxicity tests appropriate for generating data to be used in criteria development.

To derive criterion for protection of aquatic life and their uses, the EPA guidance document requires that toxicity tests results for at least one representative species from the following eight families be available:

- Member of the family Salmonidae
- Member of another family in class Osteichthyes
- A third family in phylum Chordata
- A planktonic crustacean

- A benthic crustacean
- An insect
- A family in a phylum other than Arthropoda or Chordata
- A family in any order of insect or any phylum not already represented

Toxicological data for the above eight families are the minimum data set required for calculation of numerical criterion values.

An extensive literature search was conducted by Tetra Tech, Inc. to gather all available and relevant molybdenum toxicity data for freshwater aquatic life. Following compilation of the available toxicity data, the suitability of the data for use in criteria development was evaluated. This evaluation focused on (1) the quality of the experimental methods used; (2) the documentation presented to support the reported toxicity values; and (3) the suitability of the selected experimental organisms to represent species which occur in Nevada.

Acute data from 15 species and chronic data from 5 species were determined to be suitable for development of molybdenum water quality criteria for protection of aquatic life in Nevada surface waters. Acute toxicity data for species ranged from 28.9 mg Mo/L to >10,000 mg Mo/L, while chronic toxicity values ranged from 1.7 mg Mo/L to 866 mg Mo/L. Sufficient acute toxicity data were available to meet the EPA recommended minimum data requirements (“8 Family Rule”) for aquatic life criteria development. The draft molybdenum acute criterion was calculated following the methods set forth in EPA criteria development guidance.

There was not sufficient chronic molybdenum toxicity data from a diversity of species to develop a chronic criterion in the same manner as the acute criterion. When the chronic database lacks sufficient data (does not meet the “8 Family Rule”), an acute-to-chronic ratio (ACR) is an alternative means of deriving chronic criteria by relating acute toxicity values to chronic toxicity values (Stephan et al. 1985). ACR values for at least three species in three different families should be available for final ACR calculation. Furthermore, the EPA guidance indicates that ACR values should be calculated from acute and chronic toxicity data generated in the same laboratory. Tetra Tech, Inc. determined that sufficient molybdenum aquatic life

chronic data was available to establish a relationship between the acute and chronic toxicity for four different aquatic life species. The draft molybdenum chronic criterion was calculated using an acute-to-chronic ratio.

Draft molybdenum aquatic life criteria of 6.16 mg Mo/L (acute) and 1.65 mg Mo/L (chronic) were calculated by Tetra Tech, Inc., based on the molybdenum toxicity data that was compiled and determined to be suitable for criterion derivation. The criteria were developed based on total molybdenum toxicity concentrations and should be evaluated as such. These values will be a protective water quality standard if the 4-day average Mo concentration does not exceed 1.65 mg/l and the 1-hour concentration does not exceed 6.16 mg/l more than once every 3 years.

The calculated aquatic life criteria (AQLC) values are lower than concentrations of molybdenum reported in the scientific literature and laboratory studies to have short-term and/or long-term toxicological effects to fish and benthic macroinvertebrate communities. Aquatic life acute and chronic molybdenum toxicity data are compared to the proposed criteria values in Figures 1 and 2, respectively. The assembled toxicity data did not indicate an apparent relationship between molybdenum toxicity and water hardness. For some metals (e.g. cadmium, copper), water hardness (mg/L as CaCO<sub>3</sub>) is known to affect the toxicity of the metals to aquatic organisms. Also, the available toxicological studies did not indicate that bioaccumulation and biomagnification of molybdenum caused additional toxic hazards to aquatic life.

Figure 1. Molybdenum acute toxicity values.

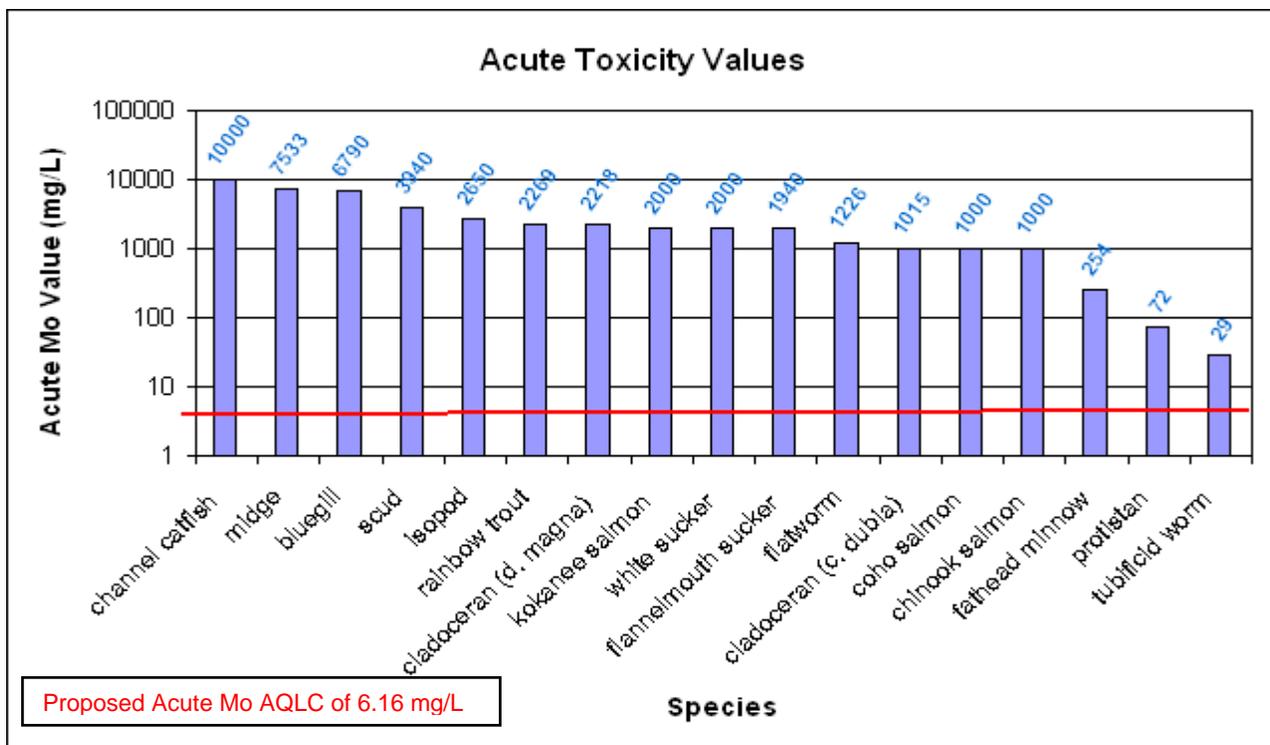
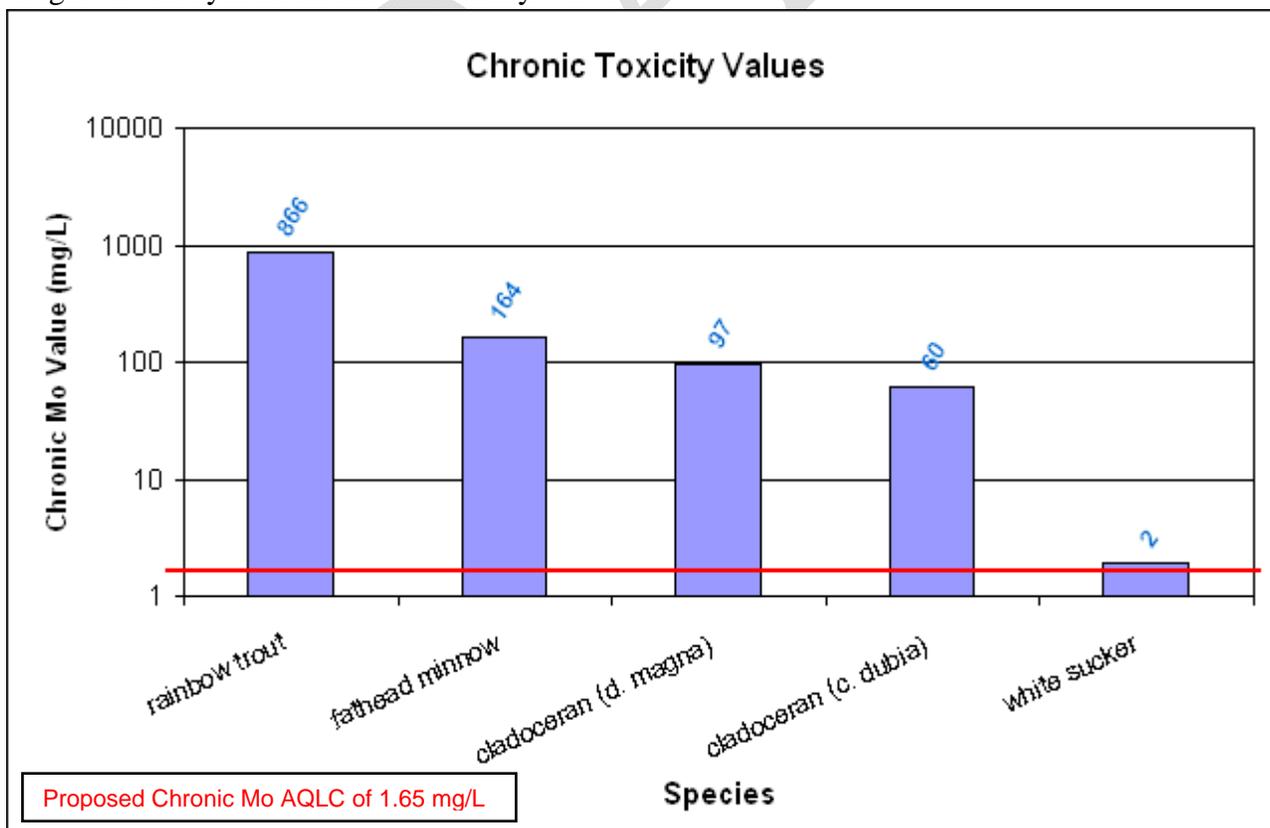


Figure 2. Molybdenum chronic toxicity values.



## **Overview Tetra Tech, Inc. Report**

The draft project report prepared by Tetra Tech, Inc. for NDEP-BWQP is included as Appendix A. The report provides detailed discussion of the following:

- The appropriateness of the current State of Nevada molybdenum water quality standard for protection of aquatic life;
- Data sources reviewed to gather available and relevant molybdenum toxicity data;
- Evaluation of available molybdenum acute and chronic toxicity data for use in criteria development;
- Assessment of toxicity test results to meet EPA recommended minimum data requirements (“8 Family Rule”);
- Determination of acute and chronic species mean toxicity values;
- Criteria development approach and methodology;
- Calculation of draft acute and chronic aquatic life criteria; and
- Evaluation of the draft molybdenum aquatic life criteria values.

## **LITERATURE CITED**

- California State Water Resources Control Board (CSWRCB). 1988. Regulation of Agricultural Drainage to the San Joaquin River. Technical Committee Report. Appendix D. Pages 121-124.
- Hem, J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Waters, Third Edition. Water Supply Paper 2254. U.S. Department of the Interior, U.S. Geological Survey, Alexandria, VA.
- Stephan et al. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses. U.S. EPA, 822-R-85-100. Office of Research and Development, Duluth, MN.

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## **APPENDIX A**

Project Report: Aquatic Life Water Quality Criteria For Molybdenum  
(Tetra Tech, Inc., July 9, 2008)

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