Water Quality Standards Unit
Water Quality Standards Triennial Review 2019-2020

Reference and Recommendations

for

Chloride plus Sulfate

Section 303(c)(1) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA's) implementing regulations at 40 CFR 131.20 require that states, from time to time, but at least once every three years, hold public hearings to review applicable water quality standards and, as appropriate, modify and adopt water quality standards. In order to more effectively work toward this requirement, the Water Protection Program's Water Quality Standards (WQS) Unit has compiled this Reference and Recommendations document. The purpose of this document is to inform discussions and provide recommendations within the Program and with stakeholders during the WQS rulemaking process.

What are Chloride and Sulfate and How Do They Enter the Water?

Chloride and sulfate are dissolved ions, which are both components of total dissolved solids (TDS). Chlorine is a naturally abundant element that is very reactive, forming chloride compounds found in ambient conditions. Anthropogenic sources of chloride include road salt, runoff from urban and agricultural areas, discharges from municipal wastewater plants and industrial plants, and oil and gas well drilling[1]. Sulfate results from the oxidation of elemental sulfur, sulfide minerals, or organic sulfur. Because sulfur is a naturally abundant element, sulfate is found in ambient conditions. Anthropogenic sources of sulfate include sulfur-containing fossil fuels, detergents, industrial effluents, sulfuric acid for steel and metal industries, feedstock or reagent in manufacturing processes, fertilizers, and fungicides and algicides [2].

Impacts of Chloride and Sulfate on Water Quality

Chloride and sulfate can cause environmental problems individually or collectively with other dissolved solids. TDS at high concentrations can cause stressful and sometimes toxic conditions for aquatic life many different ways[3]:

- Affects the flow of water in and out of an organism's cells
- Limits growth and may lead to death
- Reduces water clarity, contributing to a decrease in photosynthesis and an increase in water temperature
- Affects pH levels
- Dehydrates skin
- Causes laxative effects

Chloride in high concentrations can be toxic to aquatic life, wildlife, vegetation, and can cause hypertension in humans. Chloride can cause stratification, impeding the mixing of parameters such as dissolved oxygen and nutrients, and also cause anoxic conditions at the bottom layers of

[1] https://www.epa.gov/sites/production/files/2018-08/documents/chloride-aquatic-life-criteria-1988.pdf
[2] https://www.epa.gov/sites/production/files/2014-09/documents/support_cc1_sulfate_dwreport.pdf
[3] http://www.ei.lehigh.edu/envirosci/watershed/wq/wqbackground/tdsbg.html

water bodies. At concentrations above 250 mg/L, chloride can cause taste and odor issues in drinking water. Application of road salt to increasing amounts of impervious surfaces have led to higher concentrations of chlorides and TDS in waters across the state. Sulfate can cause negative aesthetic effects, such as taste and smell, in drinking water. Sulfate can also cause adverse health effects in humans and animals, such as laxative effects, but these effects are usually temporary with rapid recovery.

Rulemaking History in Missouri

A combined sulfate plus chloride criteria was developed in 1981 after several requests had been received to discharge sulfate and chloride, and there was no guidance available at the time to determine a safe level for these parameters. The limited literature on the toxicity of dissolved solids suggested that fish may be stressed when TDS exceeds 5,000 mg/L. When sulfate and chloride, components of TDS, are limited to 1,000 mg/L, TDS should normally not exceed 2,000 mg/L, and thus provide a margin of safety. This reasoning was used to develop 10 CSR 20-7.031(4)(L) Sulfate and chloride limit for protection of aquatic life. It stated that the concentration of chloride plus sulfate shall not exceed 1,000 mg/L for streams with a 7Q10 low flow of less than 1 cfs. It allowed up to a 20% increase of chloride plus sulfate concentration above ambient levels at the 60Q2 low flow for Class P1 waters and streams with a 7Q10 low flow greater than 1 cfs. The proposed limit had initially put the flow condition as "20% above ambient level" at the 7Q10 low flow. However, it was decided that this flow condition was too restrictive, and was changed to the 60Q2 low flow. 10 CSR 20-7.031(4)(L)3. stated, "If higher concentrations can be demonstrated through bioassays or studies not to be detrimental to indigenous aquatic life, then an appropriate higher concentration shall be allowed." This acknowledged that toxicity information on dissolved solids was limited and that these numerical criteria may have been more stringent than necessary in some cases.

During the 1994-1996 Rulemaking, the low flow value used to estimate natural background sulfate and chloride concentrations at 10 CSR 20-7.031(4)(L)2. was revised from the 60Q2 to the 60Q10. This revision was made to provide improved protection of aquatic life through the application of a more conservative stream design flow. EPA also approved newly proposed chloride criteria, published in the March 30, 1994 Water Quality Standards, which set chronic chloride criteria at 230 mg/L and acute chloride criteria at 860 mg/L for the protection of aquatic life.

In the 2005 Rulemaking, 10 CSR 20-7.031(4)(L)3. was removed and replaced with what is now 10 CSR 20-7.031(5)(S) Site-Specific Criteria Development for the Protection and Propagation of Fish, Shellfish, and Wildlife.

New chloride and sulfate criteria were proposed and submitted to EPA on December 10, 2012. The proposed chloride criteria and sulfate criteria revisions were hardness and sulfate/chloride dependent equations, based on equations developed and adopted by the State of Iowa. EPA disapproved the proposed criteria, stating that there were no modifications to Iowa's criteria and no report or general statement explaining or defending the revised criteria without the application of newer scientific studies. The proposed WQS revisions also removed the restrictions on combined concentrations of chloride and sulfate from the WQS and replaced it with a reference

to the proposed sulfate and chloride criteria, which were described in Table A. This proposed language was also disapproved by EPA.

U.S. Environmental Protection Agency's Recommendations
The Clean Water Act requires EPA to develop criteria for ambient water quality that accurately reflect the latest scientific knowledge on the impacts of pollutants on human health and the environment. These criteria are recommendations that state governments may use directly or use as guidance in developing their own. The EPA publishes a compilation of national recommended water quality criteria along with their scientific justification for each: https://www.epa.gov/wqc/national-recommended-water-quality-criteria.

There is currently no national recommendation for Sulfate plus Chloride.

Recommended Revisions to 10 CSR 20-7.031
The following are recommendations from the Water Protection Program's WQS Unit and are meant to be used as a starting point for discussion. References to sulfate and chloride can be found in 10 CSR 20-7.031(5)(L), as well as numeric value for sulfate and chloride individually at Table A1. The Department is currently only recommending revisions to chloride plus sulfate. This rulemaking will take an interim step at addressing issues with the chloride plus sulfate criterion by eliminating the stream flow-based approach.

The WQS Unit recommends the revised rule text:
10 CSR 20-7.031(5)(L) [*Sulfate and*] **Chloride plus** [*Chloride*] **Sulfate** Limit for Protection of Aquatic Life.

> [*1. Streams with 7Q10 low flow of less than one cubic foot per second (1 cfs).*] The concentration of chloride plus sulfate shall not exceed one thousand milligrams per liter (1,000 mg/L). Table A1 includes additional chloride criteria.
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> [*2. Streams with 7Q10 low flow of more than one cubic foot per second (1 cfs) and Class P1, L1, L2, and L3 waters. The total chloride plus sulfate concentration shall not exceed the estimated natural background concentration by more than twenty percent (20%) at the 60Q10 low flow.*]

Implementation of Recommended Revisions to 10 CSR 20-7.031
It is important to examine how the recommended WQS revisions will be implemented. The WQS Unit strives to be collaborative with our colleagues throughout the Water Protection Program; therefore, discussing how changes to WQS will impact their processes is key. Also, the first interaction that many members of the regulated community have with a WQS revision is often through an implementation action such as permitting.

<u>Permitting</u>
Effluent limit calculations for chloride plus sulfate will be easier with the revised WQS. Language determining 20% above natural background concentration of a stream at the 60Q10 low flow will be replaced with a limit of 1,000 mg/L, which would remove the need for calculating natural background concentration or low flows when conducting effluent limit

calculations. Limited water quality data restricts the ability to establish their site-specific values. Where a facility is new or expanded, Antidegradation Implementation Procedures will apply.

Financial Impacts

Several financial analyses are required to be completed during the WQS rulemaking process. First, an environmental and economic impact evaluation must be conducted on a subbasin basis for any proposed WQS revision of 25% or more per Section 644.058, RSMo. Then, a Regulatory Impact Report (RIR) must be prepared for rulemakings that set environmental standards or conditions. The RIR will be open to public comment. Finally, fiscal notes must be created for both public and private entities if the aggregate cost associated with the rulemaking exceeds $500.

Assessment

No changes are expected for assessment of chloride plus sulfate criteria.

Resources

For further information about Missouri's WQS, please visit our webpage: https://dnr.mo.gov/env/wpp/wqstandards/index.html. Updates on this WQS rulemaking can be found on our Water Protection Program Rule Development webpage: https://dnr.mo.gov/env/wpp/rules/wpp-rule-dev.htm. For specific questions about Missouri's WQS, you may contact the staff listed below or send an email to wqs@dnr.mo.gov.

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