

**Iowa Department of Natural Resources
Environmental Protection Commission**

ITEM

16

DECISION

TOPIC

**Final Rule – Chapter 61 Water Quality Standards- Chloride,
Sulfate and Total Dissolved Solids and Chapter 62, “Effluent and
Pretreatment Standards: Other Effluent Limitations or Prohibitions”**

The Commission is requested to approve a final rule to amend the state’s water quality standards (WQS).

The rule amendments, if approved, would:

- Establish numerical water quality criteria for chloride for the protection of aquatic life uses.
- Establish numerical water quality criteria for sulfate for the protection of aquatic life uses.
- Update the effective date of references to the “Supporting Document for Iowa Water Quality Management Plans” found in 567 IAC Chapters 61 and 62 to reflect the removal of the total dissolved solids site-specific approach and revision of the sulfate ion guideline value.
- Revise the default hardness level used for hardness-dependent chemical criteria from 100 mg/l (as CaCO₃) to 200 mg/l.

Seven public hearings were held with notice of the hearings sent to various individuals, organizations, associations and interest groups, and to statewide news network organizations. Comments were received from approximately 16 persons and organizations. No comments were received that resulted in any substantial changes to the proposed amendments (see attached Responsiveness Summary for more details).

Charles C. Corell, Chief
Water Quality Bureau
Environmental Services Division

August 19, 2009

ENVIRONMENTAL PROTECTION COMMISSION[567]

Adopted and Filed

Pursuant to the authority of Iowa Code sections 455B.105 and 455B.173, the Environmental Protection Commission hereby amends Chapter 61, "Water Quality Standards," and Chapter 62, "Effluent and Pretreatment Standards: Other Effluent Limitations or Prohibitions," Iowa Administrative Code.

The Notice of Intended Action was published in the Iowa Administrative Bulletin on June 17, 2009 as **ARC 7853B**. Seven public hearings were held with notice of the hearings sent to various individuals, organizations, associations and interest groups, and to statewide news network organizations. Comments were received from approximately 16 persons and organizations. No comments were received that resulted in any substantial changes to the proposed amendments. A responsiveness summary addressing the comments can be obtained from the Department of Natural Resources.

The final rules adopt changes to the Commission's Water Quality Standards (WQS) as summarized below:

- Establish numerical water quality criteria for chloride for the protection of aquatic life uses.
- Establish numerical water quality criteria for sulfate for the protection of aquatic life uses.

- Update the effective date of references to the “Supporting Document for Iowa Water Quality Management Plans” found in 567 IAC Chapters 61 and 62 to reflect the removal of the total dissolved solids site-specific approach and revision of the sulfate ion guideline value.
- Revise the default hardness level used for hardness-dependent chemical criteria from 100 mg/l (as CaCO₃) to 200 mg/l.

Additional information on Iowa’s Water Quality Standards and the Department’s rules can be found on the Department’s Web site at

<http://www.iowadnr.com/water/standards/index.html>.

These amendments may have an impact upon small businesses.

These amendments are intended to implement Iowa Code chapter 455B, division III, part 1, and will become effective November 11, 2009.

The following amendments are adopted.

ITEM 1. Amend 567—Chapter 61 and 62 by striking the phrase “as revised on June 16, 2004” wherever it occurs and inserting the effective date of these amendments in lieu thereof.

ITEM 2. Amend paragraph 61.3(2)“g.”

g. Cations and anions guideline values to protect livestock watering ~~Acceptable levels of total dissolved solids (TDS) and constituent cations and anions will be established on a site specific basis. The implementation approach for establishing the site specific levels may be found in the~~ “Supporting Document for Iowa Water Quality Management Plans,” Chapter IV, July 1976, as revised on November 11, 2009.

ITEM 3. Amend subrule 61.3(3), TABLE 1. Criteria for Chemical Constituents, parameters for copper, lead, nickel and zinc,

as follows:

Parameter		Use Designations						C	HH
		B(CW1)	B(CW2)	B(WW-1)	B(WW-2)	B(WW-3)	B(LW)		
Cadmium	Chronic	1	--	0.27 <u>0.45</u> ^(h)	0.27 <u>0.45</u> ^(h)	0.27 <u>0.45</u> ^(h)	1	--	--
	Acute	4	--	2.13 <u>4.32</u> ^(h)	2.13 <u>4.32</u> ^(h)	2.13 <u>4.32</u> ^(h)	4	--	--
	Human Health + -- Fish	--	--	--	--	--	--	--	168 ^(e)
	MCL	--	--	--	--	--	--	5	--
Chloride	<u>Chronic</u>	<u>389</u> ^{(m)*}	<u>389</u> ^{(m)*}	<u>389</u> ^{(m)*}	<u>389</u> ^{(m)*}	<u>389</u> ^{(m)*}	<u>389</u> ^{(m)*}	--	--
	<u>Acute</u>	<u>629</u> ^{(m)*}	<u>629</u> ^{(m)*}	<u>629</u> ^{(m)*}	<u>629</u> ^{(m)*}	<u>629</u> ^{(m)*}	<u>629</u> ^{(m)*}	--	--
	MCL	--	--	--	--	--	--	250*	--
Copper	Chronic	20	--	9.3 <u>16.9</u> ⁽ⁱ⁾	9.3 <u>16.9</u> ⁽ⁱ⁾	9.3 <u>16.9</u> ⁽ⁱ⁾	10	--	--
	Acute	30	--	14 <u>26.9</u> ⁽ⁱ⁾	14 <u>26.9</u> ⁽ⁱ⁾	14 <u>26.9</u> ⁽ⁱ⁾	20	--	--
	Human Health + -- Fish	--	--	--	--	--	--	--	1000 ^(e)
	Human Health + -- F & W	--	--	--	--	--	--	--	1300 ^(f)
Lead	Chronic	3	--	3.2 <u>7.7</u> ^(j)	3.2 <u>7.7</u> ^(j)	3.2 <u>7.7</u> ^(j)	3	--	--
	Acute	80	--	81.7 <u>197</u> ^(j)	81.7 <u>197</u> ^(j)	81.7 <u>197</u> ^(j)	80	--	--
	MCL	--	--	--	--	--	--	50	--
Nickel	Chronic	350	--	52 <u>93</u> ^(k)	52 <u>93</u> ^(k)	52 <u>93</u> ^(k)	150	--	--
	Acute	3250	--	470 <u>843</u> ^(k)	470 <u>843</u> ^(k)	470 <u>843</u> ^(k)	1400	--	--
	Human Health + -- Fish	--	--	--	--	--	--	--	4600 ^(e)
	Human Health + -- F & W	--	--	--	--	--	--	--	610 ^(f)

Zinc	Chronic	200	--	120 <u>215</u> ^(l)	120 <u>215</u> ^(l)	120 <u>215</u> ^(l)	100	--	--
	Acute	220	--	120 <u>215</u> ^(l)	120 <u>215</u> ^(l)	120 <u>215</u> ^(l)	110	--	--
	Human Health + -- Fish	--	--	--	--	--	--	--	26 ^{*(e)}
	Human Health + -- F & W	--	--	--	--	--	--	--	7.4 ^{*(f)}

* units expressed as milligrams/liter

ITEM 5. Amend subrule 61.3(3), TABLE 1. Criteria for Chemical Constituents, footnotes (h) to (l), as follows:

ITEM 6. Amend subrule 61.3(3), TABLE 1. Criteria for Chemical Constituents, by adopting the following new footnote (m):

(m) Acute and chronic criteria listed in main table are based on a hardness of 200 mg/l (as CaCO₃ (mg/l)) and sulfate concentration of 63 mg/l. Numerical criteria (µg/l) for chloride is a function of hardness (CaCO₃ (mg/l)) and sulfate (mg/l)) using the equation for each use according to **the following table:**

	B(CW1), B(CW2), B(WW-1), B(WW-2), B(WW-3), B(LW)
Acute	$287.8(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$
Chronic	$177.87(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$

(h) Class B(WW-1), B(WW-2), and B(WW-3) criteria listed in main table are based on a hardness of ~~100~~ **200** mg/l (as CaCO₃ (mg/l)). Numerical criteria (µg/l) for cadmium are a function of hardness (as CaCO₃ (mg/l)) using the equation for each use according to the following table:

	B(WW-1)	B(WW-2)	B(WW-3)
Acute	$e^{[1.0166\text{Ln}(\text{Hardness}) - 3.924]}$	$e^{[1.0166\text{Ln}(\text{Hardness}) - 3.924]}$	$e^{[1.0166\text{Ln}(\text{Hardness}) - 3.924]}$
Chronic	$e^{[0.7409\text{Ln}(\text{Hardness}) - 4.719]}$	$e^{[0.7409\text{Ln}(\text{Hardness}) - 4.719]}$	$e^{[0.7409\text{Ln}(\text{Hardness}) - 4.719]}$

(i) Class B(WW-1), B(WW-2), and B(WW-3) criteria listed in main table are based on a hardness of ~~100~~ **200** mg/l (as CaCO₃ (mg/l)). Numerical criteria (µg/l) for copper are a function of hardness (CaCO₃ (mg/l)) using the equation for each use according to the following table:

	B(WW-1)	B(WW-2)	B(WW-3)
Acute	$e^{[0.9422\text{Ln}(\text{Hardness}) - 1.700]}$	$e^{[0.9422\text{Ln}(\text{Hardness}) - 1.700]}$	$e^{[0.9422\text{Ln}(\text{Hardness}) - 1.700]}$
Chronic	$e^{[0.8545\text{Ln}(\text{Hardness}) - 1.702]}$	$e^{[0.8545\text{Ln}(\text{Hardness}) - 1.702]}$	$e^{[0.8545\text{Ln}(\text{Hardness}) - 1.702]}$

(j) Class B(WW-1), B(WW-2), and B(WW-3) criteria listed in main table are based on a hardness of ~~100~~ **200** mg/l (as CaCO₃ (mg/l)). Numerical criteria (µg/l) for lead are a function of hardness (CaCO₃ (mg/l)) using the equation for each use according to the following table:

	B(WW-1)	B(WW-2)	B(WW-3)
Acute	$e^{[1.2731\text{Ln}(\text{Hardness}) - 1.46]}$	$e^{[1.2731\text{Ln}(\text{Hardness}) - 1.46]}$	$e^{[1.2731\text{Ln}(\text{Hardness}) - 1.46]}$
Chronic	$e^{[1.2731\text{Ln}(\text{Hardness}) - 4.705]}$	$e^{[1.2731\text{Ln}(\text{Hardness}) - 4.705]}$	$e^{[1.2731\text{Ln}(\text{Hardness}) - 4.705]}$

(k) Class B(WW-1), B(WW-2), and B(WW-3) criteria listed in main table are based on a hardness of ~~100~~ **200** mg/l (as CaCO₃ (mg/l)). Numerical criteria (µg/l) for nickel are a function of hardness (CaCO₃ (mg/l)) using the equation for each use according to the following table:

	B(WW-1)	B(WW-2)	B(WW-3)
Acute	$e^{[0.846\text{Ln}(\text{Hardness}) + 2.255]}$	$e^{[0.846\text{Ln}(\text{Hardness}) + 2.255]}$	$e^{[0.846\text{Ln}(\text{Hardness}) + 2.255]}$
Chronic	$e^{[0.846\text{Ln}(\text{Hardness}) + 0.0584]}$	$e^{[0.846\text{Ln}(\text{Hardness}) + 0.0584]}$	$e^{[0.846\text{Ln}(\text{Hardness}) + 0.0584]}$

(l) Class B(WW-1), B(WW-2), and B(WW-3) criteria listed in main table are based on a hardness of ~~100~~ **200** mg/l (as CaCO₃ (mg/l)). Numerical criteria (µg/l) for zinc are a function of hardness (CaCO₃ (mg/l)) using the equation for each use according to the following table:

	B(WW-1)	B(WW-2)	B(WW-3)
Acute	$e^{[0.8473\text{Ln}(\text{Hardness}) + 0.884]}$	$e^{[0.8473\text{Ln}(\text{Hardness}) + 0.884]}$	$e^{[0.8473\text{Ln}(\text{Hardness}) + 0.884]}$
Chronic	$e^{[0.8473\text{Ln}(\text{Hardness}) + 0.884]}$	$e^{[0.8473\text{Ln}(\text{Hardness}) + 0.884]}$	$e^{[0.8473\text{Ln}(\text{Hardness}) + 0.884]}$

ITEM 7. Amend subrule 61.3(3) by adopting the following new Table 4:

TABLE 4 Aquatic Life Criteria for Sulfate for Class B Waters

(all values expressed in milligrams per liter)

Hardness mg/L as CaCO ₃	Chloride		
	Cl ⁻ < 5 mg/L	5 <= Cl ⁻ < 25	25 <= Cl ⁻ < =500
H < 100 mg/L	500	500	500
100 <= H <= 500	500	$[-57.478 + 5.79$ $(\text{hardness}) + 54.163$ $(\text{chloride})] * 0.65$	$[1276.7 + 5.508$ $(\text{hardness}) - 1.457$ $(\text{chloride})] * 0.65$
H > 500	500	2,000	2,000

Date

Richard A. Leopold, Director

F. Total Dissolved Solids: Total Dissolved Solids (TDS) numerical criteria will be determined by applying a site specific approach for the protection of Iowa's surface waters and their specified uses. The site specific approach would first consider a guideline value of 1000 mg/l (TDS) as a threshold in stream level at which negative impacts to the uses of the receiving stream may begin to occur. (Note, for some unusual situations where sensitive in stream uses occur or where uses are sensitive to the ion composition of the TDS, a more restrictive guideline value may be warranted.) Sources of TDS potentially elevating a receiving stream above 1000 mg/l (TDS) would be required, upon application for a discharge permit or permit renewal, to clearly demonstrate that their discharge will not result in toxicity to the receiving stream.

The following represents the site specific requirements to demonstrate compliance with the narrative criteria and defined uses noted in the Water Quality Standards.

1. ~~Passage of a Whole Effluent Toxicity Test~~—Each source discharging TDS that may potentially elevate a receiving stream above 1000 mg/l (TDS) will be required to complete and pass an acute or an acute and chronic Whole Effluent Toxicity (WET) test with the results submitted to the Department with the application for discharge permit or permit renewal. The WET test shall be conducted using EPA approved test procedures.
- ~~For dischargers directly entering a Class B designated water body, acute and chronic WET tests will be conducted using a mixed combination of effluent and receiving stream water. For the acute WET test, the mixed combinations will be in the proportion of the effluent flow to 2.5 % of the natural one day, ten year low flow (1Q10) or protected flow or the results of a site specific zone of initial dilution stream study. For the chronic WET test, the mixed combinations will be in the proportion of the effluent flow to 25 % of the natural seven day, ten year low flow (7Q10) or protected flow or the results of a site specific mixing zone stream study.~~

- ~~For dischargers directly entering a water body classified only as a General Water of the state, an acute WET test will be conducted using 100% of the effluent flow.~~
- 2. ~~Submit a chemical analysis of the WET test water for selected cations and anions, including Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate and Iron. Also to be included is the Total Dissolved Solids contained in the test sample. The concentration for specific ions will be evaluated to determine if exceedances occur to defined uses. Potential threshold levels where impacts to uses may occur are noted in the following Table.~~
- 3.

F. Cation and Anion Guideline Values for Livestock Watering: The protection of the defined uses requires application of the ion guidelines as ‘end-of-pipe’ limits in general waters. In designated waters, the guideline values would be met at the boundary of the mixing zone.

Recommended Water Quality Guidelines
for
Protecting Defined Uses

Ions	Recommended Guidelines Values* (mg/l)
Calcium	1000
Chloride	1500
Magnesium	800
Sodium	800
Sulfate	1000 <u>2000</u>
Nitrate+Nitrite-N	100

* Based on the guidelines for livestock watering.

RESPONSIVENESS SUMMARY

Chloride, Sulfate and Total Dissolved Solids Revisions

**Prepared by the
Iowa Department of Natural Resources
August 24, 2009**

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Introduction

This is a summary of the comments received in response to proposed revisions to the Environmental Protection Commission's (EPC's) water quality standards (WQS). The proposed changes were published in the Notice of Intended Action **ARC 7853B** on June 17, 2009. This document provides a discussion of the issues raised by the comments as well as recommendations for final EPC action on the proposed changes.

Summary of Rule/Rule Changes:

- Establish numerical water quality criteria for chloride for the protection of aquatic life uses.
- Establish numerical water quality criteria for sulfate for the protection of aquatic life uses.
- Update the effective date of references to the "Supporting Document for Iowa Water Quality Management Plans" found in 567 IAC Chapters 61 and 62 to reflect the replacement of the total dissolved solids site-specific approach with numerical criteria for chloride and sulfate, and revision of the sulfate ion guideline value.
- Revise the default hardness level used for hardness-dependent chemical criteria from 100 mg/l (as CaCO₃) to 200 mg/l.

Iowa Code sections 455B.171 to 455B.183 establish requirements for the protection and management of surface water quality. The Environmental Protection Commission, with the assistance of the department, promulgates administrative regulations on water quality. Iowa's water quality standards are written into regulation at 567 IAC Chapter 61.

In 2004, the Iowa Department of Natural Resources (DNR) moved forward with a proposed chloride standard. Concerns were raised that the proposed chloride standard was not scientifically defensible for use in Iowa. Consequently, a chloride standard was not approved, and an interim strategy using total dissolved solids as an indicator regarding water quality was put in place while the Department worked through the issues surrounding the chloride standard.

Recently, the research and analysis related to toxicity of total dissolved solids, chloride and sulfate have been completed by the Department in conjunction with the U. S. Environmental Protection Agency. The purpose of the research and analysis was to update and develop criteria for these parameters to better protect aquatic life based on new scientific information.

The DNR worked with the U.S. Environmental Protection Agency to ensure that the research compiled met certain scientific standards. Gaps were identified in the research and resulted in new toxicity tests being performed in 2008 and 2009.

With the availability of new research and toxicity data, the information is now available to propose numeric criteria for chloride and sulfate to better protect river, stream and lake

aquatic life uses and remove the current interim approach for total dissolved solids criteria.

Seven public hearings were held: Orange City and Spencer on July 7, 2009; Des Moines on July 9, 2009; Dubuque and Iowa City on July 13, 2009; Atlantic on July 15, 2009; and Clear Lake on July 16, 2009. Notice of the hearings was sent to interest groups and statewide news network organizations. Written comments were received through August 14, 2009. The hearings were lightly attended and oral public comments were recorded only at the Des Moines public hearing.

Approximately 16 persons or groups provided written comments on the proposed WQS revisions (The commentators' names are listed in Appendix A). The responsiveness summary attempts to address all of the comments received. The department did not list every comment received, but rather merged similar comments into major issue areas. The questions and comments were sorted into common topics and the department's response is written under each topic section. The department did attempt to address every question or comment received.

As a general summary, most comments received were supportive of this rule making effort. Concerns remain as to the economic impacts and implementation methods that may arise from having to comply with these new criteria. Also, there are concerns that TDS should remain in the rule in some shape or form to address perceived pollution issues. The responsiveness summary will address these concerns in more detail below.

Recommendations

Based on comments from the public, DNR recommends no major revisions to the proposed rule and that the EPC adopt a final rule as drafted in the Notice of Intended Action with the revised language for paragraph 61.3(2)“g.” providing legal clarification.

Issue 1: Should Total Dissolved Solids (TDS) remain in the water quality standards?

Public Comments

- We do not support the removal entirely of the TDS criteria and site specific approach. We believe that a 1,000 mg/l TDS threshold and site specific approach should remain in the WQS for protection of general uses.
- We are concerned that without some reference to the site-specific guidelines (in the Basin Plan Support Document) and a threshold that triggers a review in the WQS, this review may not be implemented
- We believe there should still be criteria for total dissolved solids. Although chloride and sulfate are the most critical components of TDS, there are still other components of concern. A TDS standard would address these concerns.
- TDS aquatic life criteria should not deviate much from the background levels
- How the proposed chloride and sulfate criteria protective of the ecological system and other beneficial uses?
- We believe that if chloride and sulfate standards are to be adopted, total dissolved standards should be eliminated based on the available science.
- Keeping TDS criteria would cause unnecessary inefficiencies, burdensome restrictions and duplication costs – all without enhancing the safeguards protecting Iowa’s water.
- The proposed chloride and sulfate numerical criteria will provide adequate aquatic life protection from the most common toxic dissolved solids found in Iowa waters.

DNR Response:

The current site-specific TDS approach uses the Whole Effluent Toxicity (WET) test results to develop a numeric effluent limitation for TDS, a particular pollutant. WET testing is designed to measure the toxicity of the whole effluent including synergistic and antagonistic interactions of pollutants. It is not designed to measure the toxicity of a single pollutant in a sample. The justification of the replacement of site-specific TDS approach with specific numerical criteria for chloride and sulfate is stated below.

(1) Implementation Issues

Since the adoption of the site-specific TDS approach, there are several issues with the implementation process:

1. Chronic testing with Ceriodaphnia has shown inconsistent testing results for the same discharge. The chronic testing would pass at 100% effluent concentration and fail at a lower TDS concentration (higher dilution).
2. A facility does not know at the time it collects an effluent sample what the concentrations of various pollutants are in that sample as the Department requires the toxicity test to start no later than 36 hours after sample collection. However, the lab typically does not have the analytical results for that sample prior to starting the toxicity test. This has resulted in a number of cases where the toxicity test is completed only to find that the concentration of TDS in the test sample was significantly less than the highest TDS concentration measured in the discharge.

In these cases, the toxicity test results cannot be used to establish a permit limit. There have been other cases where the concentration of ammonia or chlorine was high enough that the measured toxicity was likely due to one of these pollutants rather than TDS.

3. There are currently no laboratories certified by the State of Iowa to perform chronic toxicity testing. There are only 5 laboratories certified by the State of Iowa to perform acute toxicity testing and only one of these is located in Iowa.
4. The lack of laboratory capability has resulted in facilities having to schedule a test with the laboratory as much as 3-6 months before the test will actually be performed. This is especially problematic for a controlled discharge lagoon that cannot know whether conditions will be right for discharge 3-6 months in advance. Controlled discharge lagoons only discharge every 6 months.
5. The current approach can cause difficulties for new facilities and for facilities that operate seasonally (e.g. parks, campgrounds, children's camps). If the first toxicity test does not produce valid or useful data there is a considerable delay before another test can be performed.
6. We often require facilities to change their operations such as increasing the number of cycles in order to collect the highest sample TDS concentration to be used to establish a TDS limit. The condition at which the samples are collected does not represent the normal operating conditions.
7. Variability among WET testing results is significant.

(2) Lack of Scientific Support

Total dissolved solids (TDS) is a term used to describe the combination of all dissolved inorganic or organic ions or molecules in water, and often consists of a complex mixture of cations such as sodium, calcium, magnesium, and anions including chloride and sulfate. While these ions are natural compounds that are present in most freshwater systems, at elevated concentrations they are potentially toxic to aquatic life. Currently, there are no federal water quality criteria for TDS for the protection of aquatic life.

After the adoption of the 2004 site-specific TDS approach, IDNR conducted extensive literature search on TDS and its ions effect. The TDS concentration that causes adverse effects varies substantially with the ion composition. For example, the TDS lethal concentration that causes 50% mortality for an invertebrate species (*Ceriodaphnia dubia*) during 48-hour tests ranges from 390 mg/l to over 4,000 mg/l depending on the ion composition.

Mount et al. (1997) states that the toxicity of fresh waters with high dissolved solids has been shown to be dependent on the species ionic composition of the water. Integrative parameters such as conductivity, TDS, or salinity are not robust predictors of toxicity for a range of water qualities. Therefore, as indirect measures of the presence of inorganic dissolved solids such as chloride, bicarbonate, nitrate, sulfate, phosphate, sodium, magnesium, calcium, potassium and iron, specific conductance, TDS, and salinity have only been used as indicators of water pollution, and not as the basis for ambient water quality criteria. As such, there are no federal water quality criteria for specific conductance, TDS or salinity for the protection of aquatic life. Among the various

individual ionic constituents in surface water, potassium, bicarbonate, sodium, magnesium, chloride and sulfate are most significant in terms of toxicity (Mount et al. 1997). For example, EPA has a recommended Clean Water Act 304(a) criterion for chloride (U.S. EPA, 1988), and at least two states (Illinois and Minnesota) have developed aquatic life criteria for sulfate.

McCulloch et al. (1993) states that depending on the discharge situation, effluent toxicity due solely to TDS may be less of a regulatory problem, due to rapid dilution below toxic levels and the absence of human health or biomagnification concerns. Chapman et al. (2000) studied TDS toxicity with two mine effluents to early life stages of rainbow trout and chironomid larvae. Chapman et al. (2000) indicated that the toxicity related to the ions in TDS is due to the specific combination and concentration of ions and is not predictable from TDS concentrations. Weber-Scannell and Duffy (2007) states that it is recommended that different limits for individual ions, rather than TDS, be used for salmonid species.

The IDNR research into existing ion concentrations in Iowa waters found that of the common substances comprising the major portion of total dissolved solids, toxicity is always associated with either sulfate or chloride. Sodium, calcium, magnesium and carbonates make up the other ions in the majority, but these are not sufficiently toxic to create the need for individual water quality standards. Simply put, if sulfate and chloride, alone or in combination, meet the proposed standards, toxicity from the other major ions comprising “total dissolved solids” is insignificant. Therefore, TDS concentration provides no additional useful information. The existing standard is cumbersome and results in restrictions where none should exist. For example, if the sulfate water quality standard for a water body was calculated to be 2,000 mg/L under a certain level of hardness and chloride (340 mg/L and 50 mg/L, respectively), the total dissolved solids concentration of that solution would be greater than 2,100 mg/L without adding the sodium that is associated with the sulfate and chloride. Obviously, a TDS standard of 1,000 mg/L is incapable of indicating the concentrations of dissolved substances that are harmful to aquatic life in this example. In another example, where chloride is 5 mg/L and hardness is 90 mg/L, the sulfate standard is 500 mg/L. Here, a 1,000 mg/L TDS standard may be under protective.

(3) Monitoring Study on Chloride, TDS and Sulfate

In 2005, the Iowa Water Pollution Control Association, wastewater facilities from across Iowa, the Iowa DNR – Water Quality Bureau, and the Iowa DNR – Water Monitoring and Assessment Program conducted a cooperative study to monitor point source outfalls and receiving streams mainly for total dissolved solids and chloride.

This study was conducted to accurately and objectively assess the ion and total dissolved solid (TDS) concentrations in the outfalls of point source facilities across Iowa, upstream of outfalls, and downstream of outfalls. Sampling for this study occurred under low-flow conditions, when the impact of point source outfalls on receiving streams is the greatest.

This data collection effort was initiated in order to satisfy a recommendation from the Iowa Environmental Protection Commission to IDNR to prepare an economic analysis as part of the development of TDS and chloride standards.

The effluent monitoring data show that chloride and sulfate are the anions could potentially contribute to high effluent TDS levels. The ambient monitoring data indicate that point source contributions of TDS, chloride and sulfate could be diluted quickly downstream of the discharge after mixing. There is no significant impact on overall surface water quality downstream of the discharges. However, numerical criteria for specific ions such as chloride and sulfate are necessary to prevent near-field toxicity.

(4) State of Illinois Adopted Rules Replacing TDS with Sulfate

State of Illinois had a general use standard of 1000 mg/l for TDS, a sulfate standard of 500 mg/l, and a chloride standard of 500 mg/l for aquatic life protection. Illinois EPA adopted a water quality standard rule to replace the TDS standard with numerical sulfate standard early 2009, which has been approved by U.S. EPA (Illinois EPA, 2006). Illinois EPA states that the chloride standard of 500 mg/l is thought to be protective of aquatic life toxicity. No change is proposed for the chloride standard. The Illinois EPA states that the existing TDS standard has always been ungainly since it is really based on a worst-case combination of minerals being present and the specific constituents of the mineral contents of water are better regulated individually. The Illinois EPA recommended that the TDS standard be deleted from the Board regulations. In its justification, it states that:

“While sulfate was being evaluated, it became increasingly obvious that TDS is a very inappropriate parameter for use in water quality standards. TDS is the sum of all dissolved substances in water and is dominated by the common ions of sulfate, chloride, sodium, calcium, carbonate and magnesium in various proportions. Our investigations into sulfate toxicity reinforced the notion that it makes little sense to have a standard that covers all these substances together when the toxicity of each constituent is really what is important. For example, a TDS concentration of 2,000 mg/L with chloride as the primary anion constituent is acutely toxic to aquatic life, but the same TDS concentration composed primarily of sulfate is nontoxic. With toxicity-based sulfate and chloride standards in force, there should be no need of a TDS standard that is incapable of predicting the threshold of adverse effects to aquatic life. The Illinois EPA is, therefore, proposing that the TDS water quality standard be deleted from the Board regulations.”

As the literature review indicates, integrative parameters such as TDS, conductivity and salinity are not robust predictors of toxicity for a range of water qualities. Since individual ions contribute to the TDS toxicity, specific ion criteria are better indicators than TDS for water quality protection.

Because of the better understanding of major ion toxicity, IDNR is proposing to delete the existing TDS standard (a threshold of 1,000 mg/l) from the current regulations, and to replace it with specific ion standards.

The proposed chloride and sulfate criteria are for aquatic life protection. IDNR will continue to implement the ion guideline values adopted in 2004 for livestock watering and other beneficial uses.

(5) Protection of Other Beneficial Uses and Ecological Systems

Concerns were raised as to why background levels of TDS and ions are not taken into consideration for developing ion criteria. Section 131.11(a)(1) of the federal regulation requires States to adopt water quality criteria to protect the designated uses. The State criteria must be based on sound scientific rationale. Currently, the best approach for developing numerical chemical criteria is based on adequate scientific toxicity testing data instead of background concentrations. When there is not enough toxicity data available, certain criteria could be developed based on background levels. For example, some States adopted minimum dissolved oxygen criterion as a certain percentage of saturation. However, background pollutants levels are relevant when water quality based limits are developed or during the implementation of the numerical standards to permits. The background pollutant levels could be used to determine the water body's assimilative capacity, it can also be used to determine if the water quality is better than the water quality standard. Thus, an antidegradation review may be required to maintain the existing water quality. Background concentrations could be an important component when biocriteria are developed in the future.

The toxicity testing data are usually collected in laboratory controlled conditions using reconstituted dilution water with low organic carbon contents. Since the acute testing data are usually based on the protection of 50% of the tested species population, the final criterion is divided by two to obtain a criterion value that is protective of all species. This procedure generally results in a more conservative acute criterion. Because of the process for developing numerical criteria, the criteria values are generally more conservative. Also, two chloride criteria values are developed, acute criterion and chronic criterion. The acute criterion is to protect short term adverse effect and the chronic criterion is to protect long term effect. In ambient conditions, the site-specific conditions are usually different than the laboratory conditions at which the toxicity testing was conducted. Several factors could mitigate chloride and TDS toxicity, such as hardness and other cations. Most laboratory toxicity testing is conducted at a hardness of 100 mg/l as CaCO₃, the mean hardness level in Iowa surface waters are 300 mg/l as CaCO₃. EPA allows states to develop site-specific criteria based on different procedures such as water-effect ratios (the toxicity data based ambient water vs. lab water). Thus, the numerical criteria developed based on laboratory reconstituted water are generally more conservative and will ensure that the ecological system is protected. Also, to meet the minimum toxicity data requirement, the EPA 1985 Guidance document requires at least 8 family species included in the toxicity database. The eight-family rule is to ensure that a balanced diversity of species will be protected in surface waters. In order to develop scientific based chloride criteria for aquatic life protection, IDNR made concerted effort to obtain the most up-to-date toxicity information by working with EPA Duluth Laboratory staff. As a result, the toxicity database was expanded from 12 species in the EPA 1988 304(a) criteria document to 29 species as used in the proposed chloride

criteria. Illinois EPA also worked with EPA Duluth Lab to obtain the most up-to-date sulfate toxicity information. As a result, toxicity data for 11 species were used to derive the sulfate criteria. In addition, antidegradation review will ensure the existing water quality is maintained and protected.

Furthermore, the derivation of water quality based limits is based on 10-year critical low flows that occur every ten years. This is another conservative factor to ensure the ecological system is protected from point source discharges. IDNR monitoring data collection project indicates that at low flow conditions, TDS and chloride concentrations in the discharges will be quickly diluted below the point sources discharges.

TDS and ions are natural compounds. Point source discharges from both municipal and industrial facilities in the State is usually the result of the concentrated ground water from reverse osmosis, cooling water or ion exchange. Based on the several conservative factors mentioned above, the water quality based limits will be protective of Iowa’s natural ecological system.

The proposed chloride and sulfate criteria are derived based on aquatic life toxicity and they are for aquatic life protection purposes. During 2004 TDS rule making, IDNR adopted ion specific guideline values for the protection of livestock watering. These guideline values remain the same except for IDNR is revising the sulfate guideline value from 1,000 mg/l to 2,000 mg/l based on literature review and State of Illinois research on the subject. State of Illinois has recently adopted a sulfate value of 2,000 mg/l for livestock watering. In its justification, it states:

“Based on consideration of recent literature as well as Dr. Meerdink’s professional experiences, the Agency concludes that 2,000 mg/L sulfate is a protective standard for livestock in Illinois.” “A chronic standard of 2,000 mg/L is considered protective of livestock watering, as surface waters supporting this concentration will not lead to adverse effects on livestock or economic effects to livestock operations.”

As mentioned above, the proposed chloride and sulfate criteria are for aquatic life protection. Currently, IDNR does not have any numerical criteria for chloride and sulfate for aquatic life protection. This is a process toward establishing numerical criteria for all parameters that could have the potential to interfere with the designated uses. Regarding other uses such as livestock watering, the ion guideline values will remain the same and they are listed in the following table.

Recommended Water Quality Guidelines
for
Protecting Defined Uses

Ions	Recommended Guidelines Values* (mg/l)
Calcium	1000
Chloride	1500

Magnesium	800
Sodium	800
Sulfate	2000(a)
Nitrate+Nitrite-N	100

(a) IDNR is proposing to revise the value from 1,000 mg/l to 2,000 mg/l

* Based on the guidelines for livestock watering.

The protection of the defined uses requires application of the ion guidelines as ‘end-of-pipe’ limits in general waters. In designated waters, the guideline values would be met at the boundary of the mixing zone.

It is important to note that after the 2006 “fishable and swimmable” rule, the majority of Iowa waters are designated. Thus, the aquatic life criteria for chloride and sulfate will most likely be governing in the majority cases.

It is also important to note that IDNR is adding numerical criteria for two parameters, chloride and sulfate for aquatic life protection, for which no aquatic life numerical criteria exist today. IDNR is not changing existing criteria for the protection of other uses (except for sulfate guideline value for livestock watering).

With the final adoption of the proposed chloride and sulfate numerical criteria, the applications of the above ion guideline values, and the general criteria (“such waters shall be free from substances attributable to wastewater discharges or agricultural practices in concentrations or combinations which are acutely toxic to human, animal, or plant life.”), the beneficial uses and the ecological systems of Iowa waters will be protected.

Issue 2: How were the new criteria developed?

Public Comments

- EPA has established criteria for chloride as 860 mg/L for acute levels and 230 mg/L for chronic levels. Iowa DNR has abandoned these criteria in favor of an equation. We are not convinced that the equation is sound. It appears that the equation may be the product of some isolated samples and then extrapolated from those isolated samples. There may be some assumptions that were used that were not justified. We hope your responsiveness summary will better explain how the equations were developed.

DNR Response:

Since the most recent EPA national criteria for chloride were published in 1988, the derivation of the national criteria was based on toxicity data available before 1987. In order to develop chloride criteria based on the best information available, the Iowa Department of Natural Resources started a review of the chloride criteria by looking at the most up-to-date toxicity information available. As part of the effort, IDNR working together with the EPA-Duluth, Office of Research and Development (ORD), performed a literature search to update and recalculate the 1988 acute and chronic chloride criteria

based upon new toxicity data deemed acceptable following the 1985 EPA Guidelines (U.S. EPA, 1985). Gaps were identified in the research and resulted in new toxicity tests being performed in 2008 and 2009.

The literature review revealed acceptable data for several new species, which were not part of the EPA 1988 chloride criteria document. One particular study, conducted by Wurtz and Bridges (1961), including two of the four species suspected of being most sensitive to chloride (a planorbid snail, *Gyraulus circumstriatus*, and the fingernail clam, *Sphaerium tenue*). The toxicity testing data for fingernail clam (the most sensitive species) by Wurtz and Bridges (1961) was never published in peer reviewed journals (the paper was included in Proceedings of the Pennsylvania Academy of Science), and the toxicity testing was conducted in the 60's. A second study (Khangarot 1991) included acute chloride toxicity data for the tubificid worm (*Tubifex tubifex*), which indicated that this species might also be highly sensitive to chloride, but the data were determined unacceptable for inclusion in the recalculation based on several factors. Given the importance of the Wurtz and Bridges (1961) data, the Khangarot (1991) data, and the lack of verification by other laboratories, it was determined that more toxicity data would be warranted to independently determine if those species are indeed sensitive to chloride.

EPA contracted with the Great Lakes Environmental Center (GLEC) in Columbus, OH and the Illinois Natural History Survey (INHS) at Champaign, IL to perform the additional toxicity testing. The acute toxicity of chloride to four freshwater invertebrate species: water flea (*Ceriodaphnia dubia*), fingernail clam (*Sphaerium simile*), planorbid snail (*Gyraulus parvus*), and tubificid worm (*Tubifex tubifex*), was determined under different levels of water hardness (all four species) and sulfate concentrations (*C. dubia* only). Tests with *C. dubia* acclimated and tested under different levels of total water hardness and sulfate were performed simultaneously by two different laboratories. The toxicity results from the two laboratories were comparable. The final toxicity testing results for the four freshwater invertebrate species are published in the report "Acute Toxicity of Chloride To Select Freshwater Invertebrates, September 26, 2008".

Both laboratory tests showed that hardness has a significant effect on chloride toxicity (for three of the four species tested). Conversely, sulfate exerted only a small (inverse) effect on chloride toxicity. The new toxicity testing results from the two independent laboratories confirmed earlier studies that water chemistry parameters such as hardness play an important role in chloride toxicity effect to aquatic life.

It is important to point out that the effect of water chemistry such as hardness on pollutant toxicity has been well documented in research papers and several existing national criteria development. For example, the hardness value affects the following metal criteria, cadmium, copper, lead, nickel and zinc. As a result, the EPA 304(a) criteria for these metals are hardness dependent equations. As the water hardness increases, the toxicity of these metals decreases. That is one of the reasons that the EPA 1985 Guidance Document specifically identified procedures to derive hardness dependent criteria equations. As the EPA 1985 Guidance Document indicates, when enough data are available to show that acute toxicity to two or more species is similarly related to

water quality characteristics, the relationships should be taken into account. The derivation of the proposed hardness dependent chloride and sulfate acute criteria equations is consistent with the 1985 EPA guidance procedure.

As a result of the literature review and new toxicity testing, the acute toxicity database for chloride is expanded from 12 species in the original chloride toxicity database of the EPA 1988 chloride criteria document to a total of 29 species. The proposed acute chloride criterion was calculated using the 1985 EPA Guidance procedure based on the newly expanded database.

As the EPA 1985 Guidance indicates that depending on the data availability, the chronic criteria might be calculated in the same manner as the acute criteria or by dividing the final acute value by the acute-chronic ratio. The acute-chronic ratio method is used to derive the proposed chronic chloride criteria. As the name implies, the acute-chronic ratio (ACR) is a way of relating acute and chronic toxicities since there are often not enough chronic toxicity data available to derive the chronic criteria directly from chronic toxicity testing results. For chloride, the ACRs are available for four invertebrates and one fish species (rainbow trout). The chronic chloride criteria considered both the ACRs for invertebrates and fish. The only acceptable ACR for fish is the ACR of 7.308 for rainbow trout. The ACR for fathead minnow was not acceptable based on the EPA 1985 Guidance procedure, because different dilution waters were used in the acute and chronic tests.

The examination of all the available ACRs indicates that vertebrates have a higher ACR, on the average, than invertebrates. In other words, there is a trend in the ACRs among invertebrates and vertebrates species. In order to take into account for the trend in ACRs, the chronic chloride criterion used an alternative approach from the 1985 Guidance. Based on the alternative approach, the vertebrate ACRs and the invertebrate ACR are used, respectively, with the Genus Mean Acute Values (GMAVs) to calculate a predicted Genus Mean Chronic Value for each genus, and then a Final Chronic Value (FCV) were calculated directly from the predicted Chronic Values. This approach calculates and uses a predicted chronic value for each genus for which an acute value is available and does a better job of taking into account the chronic sensitivities of both vertebrates and invertebrates to chloride. It results in more protective chronic chloride criteria than using the traditional 1985 Guidance procedure (that uses a geometric mean of ACRs of both invertebrates and vertebrates).

In addition, the proposed chloride criteria equation is implemented using the 10th percentile hardness based on Iowa's statewide ambient monitoring data as the default value, which results in more conservative chloride criteria than using the median or mean hardness values. Furthermore, the proposed chloride criteria will be implemented in water quality based permit limits at the critical low stream flow conditions, 7Q10 and 1Q10 flows that only occur every ten years.

Thus, IDNR believes that the proposed chloride criteria are developed based on collaborative effort with EPA experts, based on sound science data and methodology. They are protective of the aquatic life uses as intended.

Issue 3: The mean or median hardness value should be used instead of the 10th percentile

Public Comments

- The proposed hardness defaults are too conservative
- The mean or median would increase the hardness value substantially
- Other states use the mean or median
- Using the mean or median will alleviate some of the need (and therefore implementation costs) to perform site-specific variance or chloride limitation procedure
- An approach where the receiving waters are expected to be either “hard” or “soft” initially should be employed to save money.

DNR Response:

IDNR made concerted effort to develop chloride and sulfate criteria by taking into account for the water chemistry effect, which result in a criterion equation. The advantage of the criterion equation comparing with fixed State-wide numerical values is that site-specific water chemistry conditions can be considered to develop water quality based limits that are not only protective of the local natural resources, but also preventing unnecessary expenditures by facilities. Thus, to better use the chloride and sulfate criteria, water chemistry data from site-specific measurements are preferred in lieu of default water chemistry conditions.

When site-specific data are not available, statewide background levels of hardness, chloride and sulfate may be used to implement the proposed chloride and sulfate criteria equations. To derive the default water chemistry data, IDNR staff studied the available ambient statewide monitoring data from 2000 to 2007. It was recommended to use the 10th percentile value of the hardness and the corresponding sulfate concentration for the implementation of the chloride criteria, and the 10th percentile hardness value and the corresponding chloride concentration for the implementation of the sulfate criteria. The selection of using the 10th percentile value instead of the mean hardness as the default hardness level is a risk management decision to ensures that the default chloride and sulfate criteria are protective of aquatic life uses statewide among a wide range of situations when site-specific data are not available. The use of the 10th percentile hardness value is conservative because of the uncertainty and lack of local water quality data for both the discharge and the receiving waters. Thus, it will ensure that the default criteria are protective of aquatic life uses in statewide conditions most of the time.

Facilities are encouraged to collect site-specific water chemistry data for both discharge water and the receiving waters and submit the data to IDNR. If the site-specific data are deemed acceptable, they will be used to develop water quality based limits instead in lieu of default water chemistry data.

Issue 4: Why has the sulfate guideline value increased from 1,000 mg/l to 2,000 mg/l?

DNR Response:

Much of the research on livestock watering for sulfate relied on the State of Illinois study since Illinois EPA recently revised its general criteria for sulfate from 500 mg/l to 2,000 mg/l for livestock watering, which has been approved by EPA. In addition, the Illinois EPA adopted the final rule that deletes the TDS general use water quality standard of 1000 mg/l, and replacing it with numerical criteria for chloride and sulfate. Before the adoption of the sulfate criterion of 2,000 mg/l for livestock watering, State of Illinois conducted extensive literature review of the adverse effects of sulfate on livestock for the last several years. Based on the research, the Agency concludes the protection of livestock watering will be achieved through the proposed standard of 2,000 mg/l sulfate over a 30-day average at locations where livestock watering occurs.

The following includes the excerpt for the justification of sulfate livestock watering value from State of Illinois rule making process.

“The threshold concentration at which sulfate-water will adversely affect livestock is difficult to quantify due to the complexity of sulfate and the limited amount of reputable research. However, recent studies suggest that surface water concentrations in excess of 2,000 mg/L sulfate may be detrimental to livestock operations. Loneragan et al. (2001) found that chronic exposure to 2,360 mg/L sulfate-water decreased carcass characteristics of cattle, signifying that chronic exposure to these concentrations may result in economic losses to livestock operations. Braul and Kirychuk (2001) found that exposure to water with 2,500 mg/L sulfate results in poor conception of cattle. Patterson et al. (2002) found that concentrations near 2,600 mg/L sulfate result in weight loss and decreased body condition of cattle. As sulfate concentrations approach 3,000 mg/L cattle drink less water and become more prone to polioencephalomalacia (PEM), a neurological disorder which leads to anorexia, blindness, seizures, and eventually death (Patterson et al. 2002). It is apparent that the severity of adverse effects on cattle quickly accelerates at concentrations between ~2,300-3,000 mg/L sulfate, therefore, warranting a more conservative standard.

Due to a limited number of studies, assorted endpoints, and questionable validity of outdated studies, a mathematical derivation for sulfate toxicity to livestock is not practical. However, by observing recent studies, it is evident that a standard of 2,000 mg/L sulfate would adequately protect livestock from reductions in food consumption, water consumption, and growth. To verify the suitability of this proposed standard, Dr. Gavin Meerdink from the Department of Veterinary Medicine at University of Illinois Champaign-Urbana was contacted. Dr. Meerdink was informed of our plans of implementing 2,000 mg/L sulfate as a chronic, 30-day average standard. Dr. Meerdink stated that sulfur compounds within the ruminant are a complicated issue, as much variability can be attributed the sulfur content of feed as well as the ability of rumen microbes to convert sulfur compounds into sulfides. Although limited animal taxa are represented in the literature, Dr. Meerdink acknowledged that cattle are a suitable study

organism, as sulfur compounds in monogastric animals (pigs, rats, etc.) are much less of an issue. In summary, Dr. Meerdink stated that a 2,000 mg/L sulfate standard would adequately protect livestock. He related that unacclimated animals may exhibit diarrhea for several days immediately after initial exposure but will suffer no economically significant weight loss or other adverse condition. In his experience, livestock will soon adapt to the higher sulfate water and the temporary symptoms will disappear. Dr. Meerdink also stated that he would feel uncomfortable setting a standard at concentrations significantly higher than 2,000 mg/L sulfate.

Based on consideration of recent literature as well as Dr. Meerdink's professional experiences, the Agency concludes that 2,000 mg/L sulfate is a protective standard for livestock in Illinois. Although cathartic effects may occur to unacclimated animals consuming 2,000 mg sulfate/L water, referenced data suggests that chronic exposure to this concentration will not result in economic impacts such as reduced growth. Further, cathartic effects are likely to diminish or disappear over time. Given that sulfate ingested by animals would produce adverse impacts over a long period of time, the 2,000 mg/L standard for sulfate is proposed as an average concentration over at least a 30-day period."

Based on the similarities between Iowa and Illinois Surface Water Quality, IDNR is proposing the same sulfate value of 2,000 mg/l for the protection of livestock watering uses. IDNR will continue to implement the sulfate criterion for livestock watering in the same manner as other ion guideline values under the 7Q10 critical low stream flow conditions. Since water quality based limits are developed to protect all downstream uses and most of Iowa waters are designated, the proposed sulfate aquatic life criteria will most likely be governing over the revised livestock watering guideline value for sulfate.

Issue 5: How will this affect well water discharge permits?

DNR Response: The well water discharge general permit is currently progressing through a separate rule making process. The department is aware of this situation and will work through any implementation issues for chloride and sulfate as a part of the general permit rule making effort.

Issue 6: Mixing zones are not supported by the Sierra Club

DNR Response: This rule making effort proposes to revise chemical criteria for chloride, add new sulfate criteria, and remove the TDS site-specific approach. No revisions to Iowa's mixing zone provisions are proposed in this rule making effort.

Issue 7: What is the expected compliance path for non-compliant discharges of sulfate and/or chloride? How will economic hardship be considered?

Public Comments

-IDNR should consider economic impacts in the application of the chloride standards and provide adequate compliance durations.

-Variances may be needed to address certain situations where discharges cannot reasonably comply.

DNR Response: The proposed criteria for chloride and sulfate will likely result in new permit limits for a relatively large portion of all NPDES permitted discharges and several cannot comply or will likely struggle to comply with the expected permit limitations. The question is how facilities that violate the new chloride and sulfate permit limits will eventually achieve compliance. The following outline represents the generalized implementation path expected for these situations with compliance evaluated after each step:

- I. Calculate site-specific permit limitations and examine other implementation options (e.g. alternative discharge locations, zero discharge, mixing zone studies, or flow variable limitations)
- II. Identify and implement voluntary source reduction efforts
- III. Identify and implement mandatory source reduction efforts
- IV. Evaluate options for treatment for chloride and/or sulfate
- V. Evaluate options for a variance

Mechanical Treatment Options

Based on the research of this issue in other states, it is clear there is no easy treatment solution for the removal of chloride. The treatment options are few and the ones that are available are typically cost prohibitive when considered for publicly owned treatment works. For example, the Santa Clarita Valley Joint Sewerage System, CA (service population 125,000) estimated that the cost of constructing advanced chloride removal and brine disposal facilities would cost at minimum \$350 million, which would be paid for by ratepayers in the service area, resulting in a 400% increase in sewer rates.

The option identified in the case of Santa Clarita is the effective, yet generally cost prohibitive, treatment option of microfiltration combined with reverse osmosis. Reverse osmosis is a technique whereby a solution is forced through a semipermeable membrane under pressure; used to generate drinkable water from sea water, or to separate chemical compounds. Some of Iowa's drinking water treatment facilities employ such technology for drinking water treatment and laboratories use it to produce pure water. While this technology can remove chloride and sulfate (and a whole host of other pollutants) from the "product" water, it also produces a "reject" stream (also called the "concentrate" stream). This reject stream contains all of the filtered pollutants, now concentrated into a brine, with very limited options for disposal or reuse due to the large volumes of it that would be created through wastewater treatment. While this treatment method can effectively remove chloride and sulfate, it is not currently viewed as a viable treatment

option for most dischargers to surface waters, particularly for areas such as Iowa where disposal of the reject stream by evaporation or discharge to the ocean or a brackish water body are not currently feasible.

Source Reduction

The lack of cost effective treatment techniques available to remove chloride or sulfate and the presence of between 252 and 520 facilities in the state suspected not to comply with their future chloride and sulfate permit limits creates a dilemma for compliance statewide. This was a common theme found in the research of other states; however, other solutions are available to help facilities combat chloride and sulfate pollution issues. The most common process used by states across the country to reduce chloride and sulfate levels in wastewater effluent is to utilize an array of source reduction options, primarily associated with water softening.

Source reduction is accomplished in several ways, including but not limited to:

- Modified operation of home water softeners by maximizing salt usage
- Removal of home water softeners
- Exchange tank home water softeners
- Soften water where needed aka “feed softened water”
- Removal or replacement of centralized ion exchange
- Best management practices where solid salt is used to prevent it from being washed down the drain (e.g. kosher slaughter house and IDOT truck washing operations)
- Removal of chlorine contributions to the waste stream or effluent (e.g. chlorine bleach, disinfection processes via chlorination)

Options such as minimizing home water softener use, removal of water softeners, and using softened water at points where necessary can actually save money immediately or in the long run depending on how these options are implemented. Exchange tank softening is more expensive than traditional home water softening. Generally speaking, there is not an expected direct or high cost for BMPs to keep solid salt out of sewer drains. Removal or replacement of centralized ion exchange water softening for municipalities can be costly and is considered a last resort if it is identified as the main source of the chloride or sulfate in the effluent entering Iowa’s surface waters. The sources of chloride may vary dramatically from town to town or industry to industry depending on several factors including, but not limited to:

Municipalities:

- The use of home water softening
- Drinking water treatment plant backwash
- Industrial contributors
- Centralized ion-exchange softening
- Source water

Industries:

- Industry type (e.g. ethanol, power plants, car washes, food processors, etc.)

- Processes that utilize salt
- Source water
- Use of softened water
- Closed loop or open loop cooling water
- Brine recovery

Since there are several different factors that are site-specific and can be different from facility to facility and with the multitude of source reduction options that may either save money or may require expenditures, it is difficult, if not impossible, to estimate overall costs or savings statewide with any degree of accuracy.

Site-Specific Monitoring

A unique aspect to the proposed chloride criteria is that its toxicity is dependent on hardness and sulfate (and conversely, sulfate toxicity is dependent on hardness and chloride). In general, the harder the water, the less toxic chloride and sulfate is to aquatic life. Conservative statewide default values will be used in the initial calculation of chloride and sulfate permit limits.

If a facility cannot comply or struggles to comply with chloride numeric permit limits, then it may explore the option of establishing revised chloride limitations based on site-specific hardness and sulfate concentrations of the effluent and receiving stream. Site-specific permit limits will ensure the appropriate benchmarks are in place for determining compliance. This is anticipated to be a course of action widely used as a first step towards compliance.

Currently, the department's site-specific data collection guidance requires two years of data at a frequency of once per week for each parameter. In the case of chloride, both hardness and sulfate wastewater effluent and ambient upstream samples can be collected for a total of four samples per week.

According to the University of Iowa Hygienic Laboratory both hardness and sulfate samples analyzed in a certified laboratory typically cost \$18 per sample. This potential cost per facility is calculated as follows:

$(4 \text{ samples} * \$18) * 104 \text{ weeks} = \mathbf{\$7,488}$ for site-specific sampling costs per facility

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APPENDIX A: COMMENTATORS

The following is a list of the individuals and organizations that commented on the proposed rule changes during the public comment period. The commentators are grouped into similar categories and are listed in no particular order.

City/Community Officials

None

Organizations

Greg	Bell	Exide Batteries
Marian	Gelb	Iowa Environmental Council
Klint	Gingerich	Gingerich Well & Pump Service
Joseph	Harrison	Water Quality Association
John	Kulper	Wendling Quarries Inc.
Jim	McElvogue	Iowa Water Pollution Control Association
Morton	Satin	Salt Institute
Monte	Shaw	Iowa Renewable Fuels Association
Greg	Schildberg	Schildberg Construction Company
Greg	Sindt	Bolton & Menk, Inc.
Wally	Taylor	Sierra Club
Steve	Veysey	Hawkeye Fly Fishing Association
Rich	White	Iowa Limestone Producers Association

Private Citizens:

Mary	McBee
Debbie	Neustadt
Lew	Olson