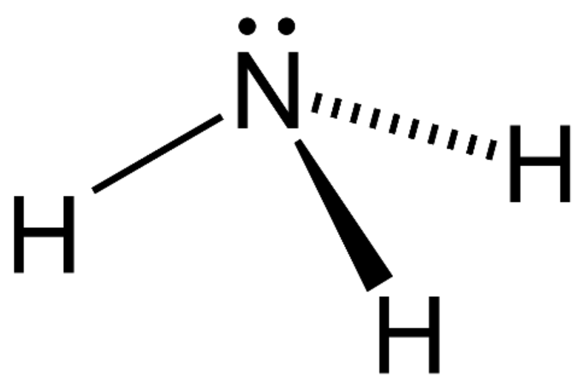
Ammonia Toxicity Assessment Method



November 2025, Final
WQDWQPBWQA-04
Version 1.0

Prepared by:
Montana Department of Environmental Quality
Water Quality Division
Water Quality Planning Bureau
Monitoring and Assessment Section

SUGGESTED CITATION

Montana Department of Environmental Quality (DEQ). 2025. Ammonia Toxicity Assessment Method. Helena, MT: Montana Department of Environmental Quality. Document WQDWQPBWQA-04.

CONTRIBUTORS

Ryan Koehnlein
Darrin Kron
Ella Bushnell

REVISION HISTORY

Revision No.	Date	Modified By	Sections Modified	Description of Changes

TABLE OF CONTENTS

List of Figures

List of Tables

Acronyms

ARM	Administrative Rules of Montana
CALM	Consolidated Assessment Listing Method
CCC	Criterion Continuous Concentration
CMC	Criterion Maximum Concentration
CWAIC	Clean Water Act Information Center
DEQ	Montana Department of Environmental Quality
DO	dissolved oxygen
DQA	data quality assessment
EQuIS	MT-eWQX Enterprise database
H_2SO_4	sulfuric acid
HDPE	high-density polyethylene
µg/L	micrograms per liter
mg/L	milligrams per liter
mL	milliliter
MCA	Montana Code Annotated
N	nitrogen
NH_3	ammonia
NH_4	ammonium
NH_3-N+NH_4-N	total ammonia as nitrogen
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
SAP	sampling and analysis plan
SOP	standard operating procedure
TMDL	total maximum daily load
WARD	Water Quality Assessment and Reporting Documentation System

1.0 Introduction

This document details the Montana Department of Environmental Quality (DEQ) ammonia toxicity assessment method for all state surface waters. The Beneficial Use Assessment Method for Montana's Surface Waters describes the overall process to conduct a beneficial use assessment for a waterbody (Makarowski 2020). This assessment method document is a guidance document and not a state rule or regulation.

1.1 Background Information

Total ammonia is the concentration of nitrogen (N) expressed as NH_3 and NH_4 and is one of the many forms of nitrogen found in waterbodies. When ammonia is present in surface waters at high enough levels, aquatic organisms have difficulty excreting the toxicant, leading to toxic buildup in tissues and blood, and potentially death (EPA 2013). The toxicity of ammonia depends on the waterbody's pH and temperature; therefore, ammonia criteria fluctuate depending on these influencing conditions (EPA 1986). As water temperature and pH increase, ammonia toxicity increases.

Ammonia concentration in surface waters tends to be lower during summer than during winter. This is due to the higher rate of plant uptake in the summer and decreased ammonia solubility at higher water temperatures (Maryland Department of Natural Resources 2003). Yet, ammonia is more toxic during the summertime when aquatic plants can drive pH higher and water temperature is generally higher. Ammonia is naturally found in surface water from decaying organic matter and can be found in water systems with fine silt substrates where there is decomposition of organic matter. While these natural sources are typically very low, it is possible that in the right conditions they can produce harmful concentrations of ammonia nitrogen.

Ammonia can be introduced into surface water in different ways but is usually associated with nitrogen rich concentrated organic or industrial waste in which dissolved oxygen is severely depleted. It can directly enter surface water through municipal effluent discharges or animal feeding operations. It can also enter the water system indirectly though runoff of agricultural lands, nitrogen fixation, and air deposition. Other sources of contamination that can eventually reach surface water are septic seepages or landfill leachate that may enter groundwater. **Section 5.2** lists sources that are commonly associated with ammonia impairment listings in Montana.

2.0 Montana Ammonia Water Quality Standards

Montana's water quality standards are developed to protect water resources, identify polluted waters or healthy waters in need of protection, and establish limits for discharges from regulated facilities.

2.1 Overview

Numeric ammonia standards only apply to the aquatic life beneficial use and are located in the Circular DEQ-7 (DEQ 2010). Aquatic life standards encompass both acute (criterion maximum concentration, or CMC) and chronic (criterion continuous concentration, or CCC) exposure. These standards vary based on the presence of salmonids, temperature, and pH concentrations. Montana's beneficial use classifications will be used for determining when the salmonid and early life stages analyses are applied (ARM

17.30.607-613, 621-629). Waters classified with a 1 or a 2 (i.e., A-1, B-1, B-2, C-1, C-2) are cold water or marginal cold water streams expected to support salmonid fishes, whereas waters classified with a 3 (i.e., B-3, C-3) are warm water streams expected to support non-salmonid fishes (Makarowski 2020). Assessors will follow these classifications to implement the ammonia assessment. However, if an assessor determines there are cold water species present in a warm water classified waterbody and verifies findings with Montana Fish Wildlife and Parks, they will assess for cold water species and supply the supporting fishery data to DEQ water quality Standards Section.

For use class A-Closed, ARM 17.30.621(3)(h) does not reference DEQ-7 and instead says no increases of toxic parameters above naturally occurring concentrations are allowed. Water quality modeling or upstream/downstream monitoring may be used to indicate if anthropogenic sources increase ammonia concentrations above naturally occurring concentrations for A-Closed waters. Water quality models should only be based on data collected on that assessment unit or a reference waterbody and should be compared to historic data where available.

2.2 Acute Criteria

The one-hour average concentration of total ammonia nitrogen (in mg/L) does not exceed the CMC (acute criterion) calculated using the following equations:

Where salmonid fish are present:

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

Or where salmonid fish are not present:

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

More stringent acute standards apply for assessment units where salmonid fish are expected to be present. Salmonid fish are expected to be present in surface waters with a use class of A-1, B-1, B-2, C-1, and C-2. Salmonid fish are **not** expected to be present in surface waters with a use class of B-3 or C-3.

2.3 Chronic Criteria

The chronic criterion (criterion continuous concentration) has two parts:

1. The thirty-day average concentration of total ammonia nitrogen (in mg/L) does not exceed the CCC (chronic criterion) calculated using the following equations:

When fish early life stages[1] are present:

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

When fish early life stages[1] are absent:

$$\mathrm{CCC} = \left(\frac{0.0577}{1 + 10^{7.688 - \mathrm{pH}}} + \frac{2.487}{1 + 10^{\mathrm{pH} - 7.688}} \right) \times 1.45 \times 10^{0.028 \times (25 - \mathrm{MAX}(T,7))}$$

[1] Includes all embryonic and larval stages and all juvenile forms of fish to 30-days following hatching.

The chronic criterion is tailored to protect early life stages of fish when they are present (**Appendix A**). Because of the temporal variability of the early life stages for different salmonid fish species found in surface waters with the use class A-1, B-1, B-2, C-1, or C-2, the early life stage standards should be applied year-round for these waters. For surface waters with the use class B-3 or C-3, the early life stages present standards are applied from March 15th through September 30th.

2. The highest four-day average within the thirty-day periods should not exceed 2.5 times the chronic criteria.

2.4 Exceedance Frequency

For ammonia assessment, the acute criteria and 2.5x the chronic criteria will apply **both** a 10% exceedance rate and no more than one exceedance in a three-year timeframe to be protective of aquatic life. If either fail, aquatic life is not supported by ammonia conditions. The 30-day average chronic criteria will only apply the no more than one exceedance in a three-year timeframe. Assessment decisions based on these exceedance frequencies are provided in **Section 5.1**.

3.0 Sampling and Data Quality Considerations for Ammonia Assessment

Waterbody condition must be evaluated based on all existing and readily available data and information (§75-5-702, MCA; 40 CFR 130.7(b)(5)). This section describes several considerations for developing monitoring designs and assessing data quality when performing ammonia assessments.

3.1 Data Currency

Data collected within the past ten years are considered current and may be used in making assessment decisions (Makarowski 2020). Data may be excluded even if they are less than ten years old if conditions or sources are known to have changed. Best professional judgement will be used to be protective of aquatic life. The assessor should document the specific changes, identify data currency alternatives, and determine and describe which years of data are appropriate to include in the assessment process.

3.2 Sample Collection, Analysis, and Units

Samples are collected on-site in 250 mL high density polyethylene (HDPE) vessels then are to be preserved as soon as possible with sulfuric acid (H_2SO_4). Preserved samples are to be stored at <6°C until delivery to the lab for analysis. The samples have a hold time of 28 days. Alternatively, samples may be immediately cooled until frozen on the day of the sampling without using a preservation additive. If frozen, the holding time is extended to 45 days. Ammonia samples are typically analyzed according to EPA 350.1, which is referred to as the Phenate method. The process uses steam distillation to isolate the ammonia, followed by a colorimetric chemical reaction. The concentration of ammonia is found through spectrophotometry or through Ion Selective Electrode (EPA 1993). The Quality Assurance Project Plan for Water Quality Planning Bureau Environmental Data Operations states the required reporting limits (DEQ 2022). Ammonia is best recorded in milligrams per liter (mg/L) since the water quality standard for ammonia is also provided in mg/L.

Ambient water temperature and pH **must** be measured at the same time that ammonia is collected to accurately calculate ammonia standards. Temperature should be measured in or converted to Celsius for the calculation of standards. See DEQ handheld and *in situ* water quality meter standard operation procedures (SOPs) for further guidance concerning temperature and pH measurements.

Montana's definition of ammonia to be compared to the standard is total ammonia. For new data collection, the preferred method is to analyze total ammonia as nitrogen (EPA 350.1). When evaluating existing data, care must be taken to ensure the correct form of ammonia is being reported and compared. Where total recoverable ammonia as N data is available, it may be compared directly to the standard during assessment if generated by a comparable analytical method to EPA 350.1. Dissolved ammonia may be evaluated against the standard but should only be used if the datum represents an exceedance. If only dissolved ammonia is available and it is less than the standard, there is insufficient data to complete the assessment.

3.3 Sampling Timeframe and Temporal Requirements

Ammonia samples can be collected throughout the year but should prioritize the time of year that toxicity levels are higher or when sources are the most prevalent (**Section 1.1**). Ammonia loading from adjacent landscapes can be higher during wet weather and should be considered when scheduling sampling for the purpose of this method. Spawning and rearing timeframes should also be considered for warm water classifications (**Appendix A**).

For all water bodies, data collected at any time of year can be used to evaluate acute criteria and 2.5x the chronic criteria. To evaluate the chronic 30-day criteria, data collected at any time of year can be used to calculate a 30-day average, but it is required to have at least one 30-day average fall within the timeframe of July 1st through September 30th to capture conditions when ammonia is expected to be the most toxic.

However, to delist, it is required to have about half of the calculated 30-day averages fall within the timeframe of July 1st through September 30th and the other half collected between November 1st and April 30th (to capture conditions when ammonia concentrations are expected to be the highest). Additionally, for a delisting on a B-3 or C-3 stream, minimum data requirements for the acute and 2.5x the chronic criteria must be fully met within the timeframe when early life stages are present, March 15th through September 30th.

3.4 Sampling Locations and Spatial Independence

Guidance for selecting sampling locations is intended to help ensure spatial independence of data.

3.4.1 Assessment Unit Selection

Ammonia assessment decisions are made by individual assessment unit. Guidance for determining assessment unit delineations can be found in DEQ's Beneficial Use Assessment Method (Makarowski 2020). An assessment unit may be an entire waterbody or segment of a waterbody (e.g., headwaters to a tributary). DEQ or other entities may prioritize monitoring of waters that have been previously identified as impaired or waters at higher risk of ammonia impairment due to human activities, point sources, agricultural use, or other factors. All readily available data must be included for assessment for any unit that is part of a 303(d)-assessment project.

3.4.2 Assessment Reaches

The assessment analysis may take place over the entire assessment unit or over an assessment reach. An assessment reach is a sub-segment of an assessment unit, which may be justified if one or more significant shifts in type and intensity of potential ammonia sources and sinks exist such that clear breaks could be made to designate homogenous reaches (Suplee and Sada 2016). For example, if a relatively unimpacted upstream reach can be isolated and its condition is substantially different from other downstream parts of the assessment unit, the assessment unit may be split into two reaches for assessment purposes. The following guidelines should be used when sub-segmenting an assessment unit:

- If one reach indicates impairment, the entire assessment unit receives the impairment determination.
- Each reach has the same general data requirements (e.g., dataset minimums) as the parent assessment unit would have had if it hadn’t been divided.
- It is better to lump than to split reaches to avoid excessive sub-segmentation and the consequential administrative and sampling requirements that result.
- An assessor must decide whether to sample potential reach breaks in an assessment unit before data collection; this will help ensure that reach breaks are based on considerations of land use and sources.

3.4.3 Total Number of Sites and Site Locations

This section provides guidance for developing monitoring plans for ammonia assessments; however, all readily available data must be used at the time of assessment. For ammonia, assessment determinations are made using data pooled for the entire assessment unit or reach, not individual sites. Best professional judgement may be applied to determine how many sites are needed to adequately represent the range of potential human sources influencing the assessment unit. It is preferable to incorporate data collected at multiple sites to better capture variability in ammonia concentrations throughout the assessment unit. If only one site is planned for monitoring, it must be located at the most at-risk location after evaluation of potential sources. Sites may also bracket potential sources to aid in locating sources (e.g., agricultural runoff, wastewater treatment outfalls, and dams). The number and locations of sites should represent the entire assessment unit or reach.

3.4.4 Spatial Independence

Sites should be spatially independent of each other. Spatial independence relies on best professional judgment, particularly when combining data from multiple sources and projects. The following guidance for achieving spatial independence for ammonia testing is similar to other pollutant specific assessment methods (Drygas 2012; Suplee and Sada 2016):

a. Select sites that are at least one stream mile apart unless there is a flowing tributary that confluences with the segment, or a discrete source is located between the two sites.
b. Monitor below areas where tributaries or ditches mix with the assessment unit.
c. Consider land use to help identify potential impacts on ammonia concentrations.

3.5 Data Quality

This assessment method is subject to DEQ Water Quality Division’s established policies and procedures for quality assurance (QA) and quality control (QC), beneficial use assessment, and data management. Data quality requirements apply to all data used for making assessment decisions, whether collected internally or externally. DEQ will require that QA systems are applied to data that are used during 303(d) assessments. Sampling plans or a DEQ approved equivalent are required for data use (Makarowski 2020) and should address potential sources of ammonia and sampling locations at a project level.

3.5.1 Quality Control: Field Duplicates and Field Blanks

Field duplicates are samples collected as close as possible to the time and location where the original sample was collected at the site. They should be collected by the same person using the same collection method outlined in the sampling and analysis plan (SAP), but they are stored in separate bottles and analyzed independently. Any ammonia sampling design intended for assessing water quality standards should incorporate field duplicates. Additionally, the frequency of duplicate sampling should be documented in a QAPP or SAP. Typically, field duplicates are collected at a minimum frequency of 10% of total samples.

Selection of timing and sites for field blank collection is generally up to the judgement of the project manager but should include significant storage time in the sample cooler to represent the handling process. Field blanks should not occur at the last site or day of a longer trip, so they also experience transportation and field storage management practices that other samples are exposed to. Field blanks are samples collected and handled following the same methods as routine samples except laboratory-grade deionized or distilled water is used rather than ambient water. Field blanks represent total ambient conditions during sampling and laboratory processing to identify possible sources of contamination (EPA 2009). Any ammonia sampling design intended for assessing water quality standards should incorporate field blanks and the frequency should be documented in a QAPP or SAP. Typically, at least one field blank is analyzed along with each batch of routine samples.

3.5.2 Data Quality Assessment Overview

Data quality assessment (DQA) is the scientific and statistical evaluation of data to determine whether data obtained from monitoring operations are of the right type, quality, and quantity to support water quality assessments (EPA 2002a). Assessors use DEQ's Water Quality Assessment and Reporting Documentation (WARD) System to document the DQA outcome (pass or fail) for each parameter group being assessed per beneficial use. All data quality indicators must be met to pass the DQA. If a single indicator is not met, the DQA fails for that parameter group. An assessor may override a pass or fail for the DQA, but they must accompany this override with adequate justification. In these cases, a manager or QA officer would need to approve the override.

Additional data quality screening may be necessary before the dataset is ready to support attainment decisions (EPA 2000, EPA 2002b), for example:

- Ensuring detection levels are sufficiently low to support project decision making: Non-detects are used in the data analysis and the value of the detection can be used for statistical methods if it is below the standard. Non-detects above the standard should be excluded from analysis.
- Evaluating database flags and justification and documentation of non-used data.
- Evaluating QC samples (i.e., field duplicates and field blanks)
- Verifying that holding time and incubation times were adhered to
- Reviewing QA/QC reports
- Investigating errors in collection or analysis
- Addressing missing data
- Reviewing deviations from SOPs and SAPs

Once DEQ determines the data meet basic documentation requirements, the data are ready to be analyzed to support water quality standards attainment decisions.

3.6 Minimum Data Requirements

This guidance should not be interpreted to limit data collection. Each project's monitoring objectives and resources should be considered when designing a monitoring plan. Acute and chronic standards assessments are completed independently. Both criteria do not have to be evaluated to produce an impaired assessment outcome. Both criteria must be evaluated to produce a delisting. A sample is defined as temporally paired ammonia, pH, and temperature data at a spatially independent site and date.

3.6.1 Acute Criteria

In order for ammonia to be listed or remain listed as a cause of impairment, a minimum of eight independent samples are needed for an assessment unit or reach to assess the acute criteria. More rigorous data collection may be unnecessary if there are already a minimum of three exceedances in data sets of three to seven samples spread over 10 years or if two samples within a 3-year timeframe exceed the acute criteria. In these situations where minimum data requirements are not met but there is a large exceedance rate, the attainment decision will be to list or to remain listed and a data quality assessment override in the WARD database can be justified.

A sample size of at least eleven independent samples is necessary for the acute criteria analysis if point sources are present or to delist an assessment unit that is currently listed for ammonia.

3.6.2 Chronic Criteria

30-Day Average:
At least three samples within a 30-day period, spaced at least six days apart, are needed to calculate the chronic 30-day criteria. At least two 30-day periods are needed to evaluate the chronic criteria. For de-listings, at least two years must be represented by a chronic criteria evaluation. Average monthly calculations are used to evaluate the chronic 30-day average criteria. Guidance on how to calculate a monthly average can be found in **Section 4.1.1**.

2.5x the Chronic Criteria:
If acute criteria and/or chronic 30-day criteria minimum data requirements are met, any sample may represent a 4-day average to compare to 2.5x the chronic criteria. Typically, the assessor will have just one sample from a single site in any given 4-day period, so a single sample may be used to represent the 4-day average. In the event that there are multiple samples from the same site during a 4-day period, then the results will be averaged together.

A minimum of eight 4-day averages is needed for an assessment unit or reach to assess 2.5x the chronic criteria. A sample size of at least eleven 4-day averages is necessary if point sources are present or to delist a waterbody that is currently listed for ammonia.

4.0 DATA ANALYSIS TO SUPPORT ATTAINMENT DECISIONS

4.1 PREPARING DATA FOR ASSESSMENT

Preparing data for assessment should take into consideration minimum data requirements that are described in **Section 3.6**. It is important for the assessor to evaluate data quality for every available result and document any data that cannot be used. Additionally, temporal requirements (**Section 3.3**) as well as beneficial use class of the waterbody being assessed (**Section 1.0**) should be carefully reviewed before calculating ammonia water quality standards and performing a beneficial use assessment.
Total and total recoverable ammonia as nitrogen concentration (mg/L) are the only data types that are to be applied directly to the Montana ammonia water quality standards. Dissolved ammonia as nitrogen may be reviewed to see if concentrations are above the standard but can't be used to determine if standards are met. Temperature and pH data collected at the same site and time are needed to calculate ammonia standards.

4.1.1 Calculating Monthly Averages

Average ammonia calculated by calendar month is used to evaluate the chronic 30-day average criteria. Each monthly dataset that meets minimum data requirements (**Section 3.6**) should go through a three-step process to derive a monthly average. Following this process for each month of available data ensures that all collection timeframes are represented equally, and no timeframe has stronger representation than another due to monitoring variability.

Because the formulas to calculate the chronic criterion are non-linear in pH and temperature, the monthly standard must be calculated by the average of separate evaluations of the formulas reflective of the fluctuations of pH and temperature within the averaging period. It is not appropriate to apply the formula to average monthly pH and temperature.

Step 1: Calculate daily averages for an assessment unit or reach.

Step 2: Calculate a weekly average from the daily averages. If partial weeks at the beginning or end of the month are present, combine results with the first or last full week of the month respectively, then calculate weekly averages.

Step 3: To derive a final monthly average, all the weekly averages are averaged for the calendar month. This monthly average can then be compared against the monthly average numeric standard and used for assessment decision process provided in **Section 5.1**.

DEQ is not trying to create an amalgamation paradox[1] by using averages of averages. Rather, we are trying to produce equal representation of time across a month when there could be dissimilarly timed sampling events.

4.2 ASSESSMENT PROCESS

The following steps should be followed when organizing and preparing data for assessment to determine attainment of ammonia standards in Montana's surface water (**Section 2.0**).

[1] Amalgamation paradox, also called Simpsons paradox is an effect that occurs when the marginal association between two categorical variables is qualitatively different from the partial association between the same two variables after controlling for one or more other variables (Carlson 2019).

1. Compile all the ammonia, pH, and temperature data for an assessment unit or reach (**Sections 3.1 and 3.4**).
2. Perform data quality assessment to identify the usable dataset for the assessment unit or reach (**Section 3.5.2**).

Acute Criteria

3. Group ammonia samples and associated pH measurements by year (**Section 3.2**).
4. Determine which acute standard calculation to use based on the presence/absence of salmonids (**Section 2.0**).
    a. Salmonids present in cold/marginal cold waters with an A-1, B-1, B-2, C-1, and C-2 use class. Salmonids not present in warm waters with a B-3 and C-3 use class.
5. Calculate the acute standard for each ammonia sample using the associated pH measurement.
6. Compare each ammonia sample to the sample's calculated acute standard. Do not use ammonia samples that do not have an associated pH measurement.
7. If greater than 10% of samples exceed their calculated standard **or** if more than one sample within any three-year period exceeds its calculated standard, the acute criteria fail.

Chronic Criteria

8. Group ammonia samples with associated pH and temperature measurements by calendar month (**Section 3.2**).
9. Determine which chronic standard calculation to use based on the presence/absence of early life stages (**Section 2.0**).
    a. Early life stages present **year-round** for cold/marginal cold waters with an A-1, B-1, B-2, C-1, and C-2 use class. Early life stages present from **March 15th – September 30th** for warm waters with a B-3 and C-3 use class.
10. Calculate the chronic standard for each ammonia sample.
11. Evaluate 2.5x Chronic Criteria:
    a. Evaluate all individual samples (from the acute criteria evaluation) against 2.5x the individual sample's chronic criteria calculated in Step 9. Do not use samples that do not have associated pH and temperature measurement.
        i. If multiple samples from a single site are collected within 4 days of each other, average the sample values and each sample's calculated chronic standard. Compare the 4-day ammonia average to 2.5x the 4-day average chronic criteria.
    b. If greater than 10% of samples exceed their calculated standards **or** if more than one sample within any three-year period exceeds its calculated standard, the 2.5x chronic criteria fails.
12. Evaluate the Chronic 30-Day Average Criteria:
    a. Follow the steps in **Section 4.1.1** to calculate monthly ammonia averages for calendar months that meet minimum data requirements (**Section 3.6**).
    b. If a month has enough data to calculate a monthly ammonia average, follow the same steps in **Section 4.1.1** to calculate that month's average chronic standard. The monthly chronic standard is calculated using each individual sample's calculated chronic standard. *Do not pool temperature and pH conditions to calculate the monthly chronic standard.*
    c. Compare each monthly ammonia average to the monthly chronic standard. Do not use ammonia samples that do not have an associated pH and temperature measurement.

d. In order to complete an assessment of the chronic 30-day average criteria, there must be at least two calculated monthly averages. Review listing/delisting and temporal requirements in **Section 3.3**.
e. If more than one monthly average in any three-year timeframe exceeds the monthly chronic standard, the chronic 30-day average criteria fail.

Both the chronic 30-day average criteria and 2.5x chronic criteria must pass for the chronic criteria to pass. If minimum data requirements are not met for the chronic 30-day average criteria or 2.5x chronic criteria, there is insufficient information to assess the chronic criteria. If either the chronic 30-day average criteria or 2.5x chronic criteria fails, the chronic criteria fail.

5.0 Assessment Decisions and Documentation

Once the data have been evaluated following the procedure in **Section 4.2**, an assessment decision can be made. When assessment confirms that an assessment unit is not attaining water quality standards, the assessment decision is either to “list” the waterbody-cause combination if it is a newly discovered impairment, or to “keep listed” if the waterbody-cause combination is already listed. When assessment confirms that a waterbody is attaining water quality standards for a parameter, the assessment decision is either “do not list” if the waterbody-parameter combination is not already listed, or “delist” if the waterbody-cause combination was listed previously.

5.1 Assessment Decision Framework

Beneficial use determinations based on acute and chronic criteria analyses for ammonia are as follows:

List/Keep Listed:

- If any chronic or acute criteria analyses fail, ammonia is identified as a cause of impairment.

Do Not List:

- If all chronic and acute criteria analyses pass, ammonia is not identified as a cause of impairment.

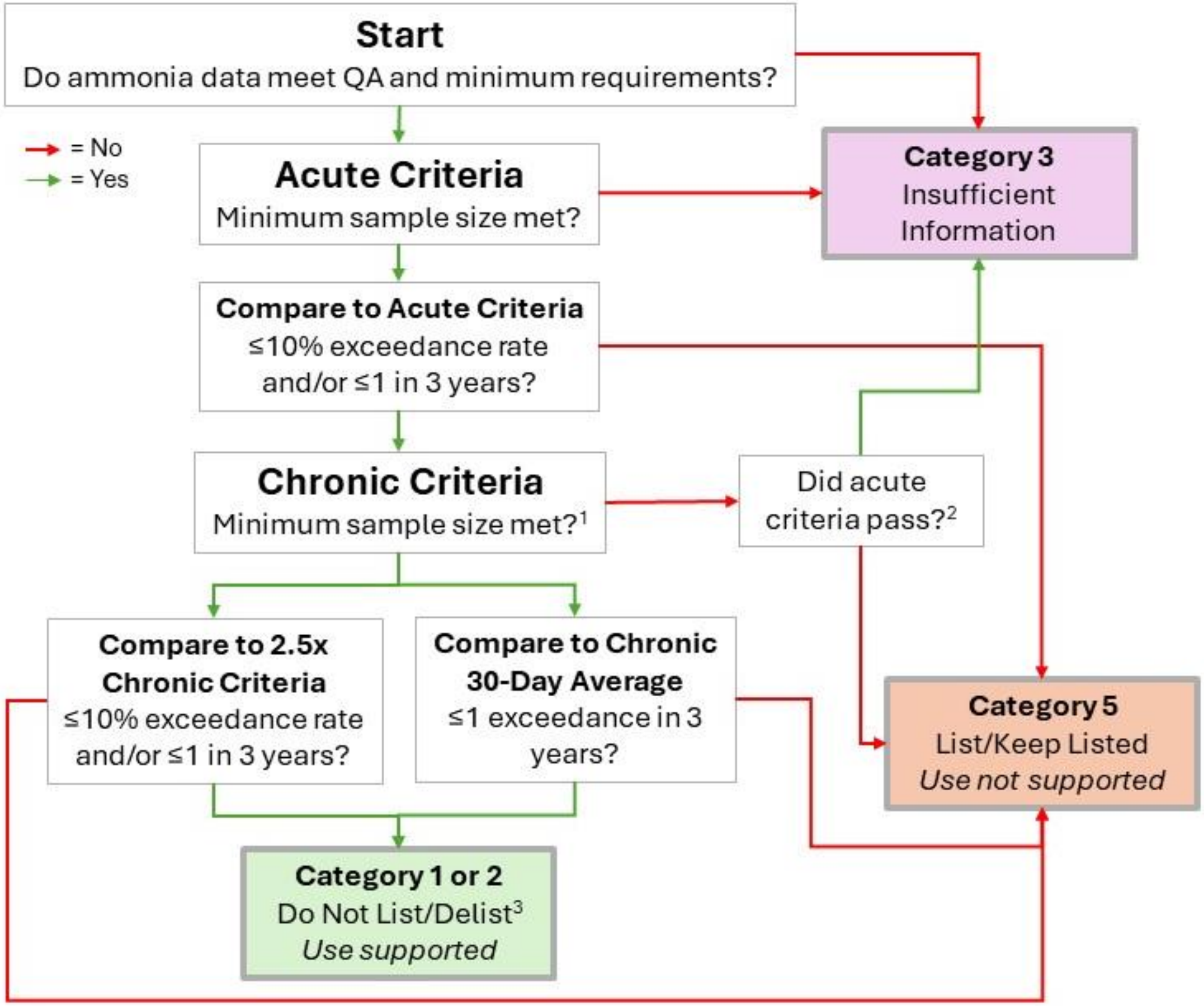
Delist:

- All chronic and acute criteria analyses are necessary, and all must pass to delist ammonia as a cause of impairment. Delisting requires more rigorous data collection, see **Sections 3.3 and 3.6.**

Insufficient Information:

- If only the acute analysis can be completed and passes, there is insufficient information to make an impairment listing determination.

Figure 1. Ammonia Beneficial Use Decision Framework Process



[1]Both the chronic 30-day average criteria and 2.5x chronic criteria must meet minimum data requirements and pass for the chronic criteria to pass
[2]If only the acute criteria can be evaluated and passes, there is insufficient information to make an impairment listing determination
[3]In order to delist ammonia, all acute and chronic criteria must be evaluated, and all must pass

Table 1. Assessment Method Decision Framework

Cold Water Sampling: Salmonid Fishes (A-1, B-1, B-2, C-1, and C-2)[1]					Warm Water Sampling: Non – Salmonid Fishes (C-3, B-3, and I)				
Criteria	*Minimum Data Requirements*	*Temporal Requirements*	*Calculations*	*List*	*Criteria*	*Minimum Data Requirements*	*Temporal Requirements*	*Calculations*	*List*
Acute Criteria	8 independent samples 11 independent samples to delist	Year -round	Compare to Acute Criterion Maximum Concentration for salmonid waters.	>10% exceedance and/or >1 exceedance in 3 years.	Acute Criteria	8 independent samples 11 independent samples to delist	List/Keep Listed/Do Not List: Year-round Delist: March 15-September 30	Compare to Acute Criterion Maximum Concentration for non-salmonid waters.	>10% exceedance and/or >1 exceedance in 3 years.
30-Day Average Chronic Criteria	At least 3 samples within any calendar month, spaced at least six days apart to calculate the 30-day average. Two 30-day averages to assess. N = 6	List/Keep Listed/Do not List: recommended 1 monthly average between July 1 - Sept. 30. Delist: must have about half of monthly averages between July 1 - Sept 30 about half between Nov 1 and April 30	Calculate the 30-day average of the available dataset. Compare to 30-day average Chronic Criterion Continuous Concentration.	>1 exceedance in 3 years.	30-Day Average Chronic Criteria	At least 3 samples within any calendar month, spaced at least six days apart to calculate the 30-day average. Two 30-day averages to assess. N = 6	List/Keep Listed/Do not List: recommended 1 monthly average between July 1 - Sept. 30. Delist: must have about half of monthly averages between July 1 - Sept 30 and about half between Nov 1 and April 30	Calculate the 30-day average of the available dataset. Compare to 30-day average Chronic Criterion Continuous Concentration.	>1 exceedance in 3 years.
2.5x Chronic Criteria	8 4-day averages 11 4-day averages to delist Any independent sample may represent a four-day average.	Year -round	Highest 4-day average within the 30-day available dataset must not exceed 2.5 times the CCC.	>10% exceedance and/or >1 exceedance in 3 years.	2.5x Chronic Criteria	8 4-day averages 11 4-day averages to delist Any independent sample may represent a four-day average.	List/Keep Listed/Do Not List: Year-round Delist: March 15-September 30	Highest 4-day average within the 30-day available dataset must not exceed 2.5 times the CCC.	>10% exceedance and/or >1 exceedance in 3 years.

[1]See **Section 2.1** for A-closed waters' assessment process

5.2 Source Assessment and Supplemental Information

Probable sources of impairment are the activities, facilities, or conditions that generate pollutants that prevent waters from meeting water quality standards. The following sources are the most likely to be associated with ammonia impairment listings in Montana; additional selections are available in the Water Quality Assessment and Reporting Documentation (WARD) system if needed:

- Impoundments
- Municipal waste treatment outfalls
- Septic sewage
- Industrial point sources
- Agricultural and urban runoff
- Manure application
- Animal feeding operations
- Landfill leachate
- Atmospheric sources
- Riparian vegetation loss
- Fish hatcheries
- Natural sources
- Urban runoff

If water quality data are available that prove, or a TMDL identifies, a probable source is contributing ammonia, the assessor should check the Source Confirmed box in WARD. If probable sources are present in the watershed but are not confirmed, the assessor should check the Source Not Confirmed box. The assessor may also include a brief description of sources in the overall condition of the waterbody summary in WARD.

5.3 Reporting Assessment Decisions and Review with Management

The assessor must document all data and decisions made pertaining to beneficial use support determinations for assessment units. Waterbodies identified as impaired due to ammonia are included in Montana's biennial Water Quality Integrated Report and list of impaired waters. Assessment decisions are reviewed by the Monitoring and Assessment Section Supervisor and may be reviewed by the QA Officer, managers, or staff from other DEQ programs.

6.0 Public Information

Ammonia data collected by DEQ is stored in DEQ's MT-eWQX Enterprise (EQuIS) database and is uploaded weekly to the Water Quality Portal (EPA, USGS, NWQMC, 2023). Assessment outcomes for individual assessment units, including data summaries, impairment determinations, and beneficial use support determinations, are documented via Montana DEQ's CWAIC (available at www.cwaic.mt.gov).

7.0 References

California Environmental Protection Agency: State Water Resources Control Board. 2004. Functional Equivalent Document: Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Sacramento, CA: California Environmental Protection Agency.

Carlson, B.W. 2019. Simpson's Paradox. Encyclopedia Brittanica. Encyclopedia Brittanica Inc. https://www.britannica.com/topic/Simpsons-paradox

Drygas, Jonathan. 2012. The Montana Department of Environmental Quality Metals Assessment Method. Helena, MT: Montana Dept. of Environmental Quality.

Makarowski, K. 2020. Beneficial Use Assessment Method for Montana's Surface Waters. Helena, MT: Montana Department of Environmental Quality. Document WQPBWQM-001, Version 4.0.

Maryland Department of Natural Resources, 2003. Literature Review: Nitrogen Sequestration in Headwater Streams

Montana Department of Environmental Quality, Water Quality Planning Bureau, Water Quality Standards and Modeling Section. 2019. DEQ-7 Montana Numeric Water Quality Standards. Helena, MT: Montana Dept. of Environmental Quality.

Montana Department of Environmental Quality, Water Quality Planning Bureau. 2022. Quality Assurance Project Plan for Water Quality Planning Bureau Environmental Data Operations. WQDWQPBQAP-01, Version 1.0. Helena, MT: Montana Dept. of Environmental Quality.

National Water Quality Monitoring Council (NWQMC). 2023. Water Quality Portal. Available at: https://www.waterqualitydata.us/.

Suplee, M.W., and R. Sada, 2016. Assessment Methodology for Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels. Helena, MT: Montana Dept. of Environmental Quality.

U.S. Environmental Protection Agency (EPA). 1986. Quality Criteria for Water ("Gold Book"): Office of Water Regulations and Standards, EPA-440/5-86-001

U.S. Environmental Protection Agency (EPA). 1993. Determination of Ammonia Nitrogen by Semi-Automated Colorimetry. Available at https://www.epa.gov/sites/default/files/2015-06/documents/epa-350.1.pdf.

U.S Environmental Protection Agency (EPA). 2000. Guidance for Data Quality Assessment: Practical methods for Data Analysis. EPA QA/G-9

U.S. Environmental Protection Agency (EPA), Office of Wetlands, Oceans, and Watersheds. 2002a. Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices. Available at Consolidated Assessment and Listing Methodology (epa.gov)

U.S. Environmental Protection Agency (EPA). 2002b. Guidance on Choosing a Sampling Design for Environmental Data Collection for use in Developing a Quality Assurance Project Plan. Available at Guidance on Choosing a Sampling Design for Environmental Data Collection: for use in Developing a Quality Assurance Project Plan (epa.gov)

U.S. Environmental Protection Agency (EPA). 2009. Region III Fact Sheet, Quality Control Tools: Blanks. Revision 1. Available at https://www.epa.gov/sites/production/files/2015-06/documents/blanks.pdf

U.S Environmental Protection Agency (EPA). 2013. Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater. EPA-822-R-13-001. Available at https://www.epa.gov/sites/default/files/2015-08/documents/fact_sheet_aquatic-life-ambient-water-quality-criteria-for-ammonia-freshwater-2013.pdf

APPENDIX A: TABLE OF SPAWNING TIMES OF MONTANA FISHES

SPAWNING TIMES OF MONTANA FISHES, Prepared by Don Skaar, Montana Fish, Wildlife and Parks, 3/6/01. This table is a combination of known spawning times for fish in Montana and estimates based on spawning times reported in other areas in North America of similar latitude. Sources used for this table include: G.C. Becker, Fishes of Wisconsin; C.J.D. Brown, Fishes of Montana; K.D. Carlander, Handbook of freshwater fishery biology, volumes 1 and 2; R.S. Wydoski, and R.R. Whitney. Inland fishes of Washington; Scott and Crossman. Freshwater fishes of Canada; Montana Fish, Wildlife and Parks fisheries biologists.

The code for the table is as follows: J1, J2, F1, F2 refer to the half month increments of January 1-15, January 16-31, February 1-14, February 15-29, and so on. In the table S = spawning period, I = incubation period for eggs of salmonids, E = time period in which salmonid sac-fry are in the gravels

Species	J1	J2	F1	F2	M1	M2	A1	A2	M1	M2	J1	J2	J1	J2	A1	A2	S1	S2	O1	O2	N1	N2	D1	D2
White sturgeon									S	S	S	S												
Pallid sturgeon										S	S	S	S	S										
Shovel. sturgeon										S	S	S	S	S										
Paddlefish									S	S	S	S	S	S										
Goldeye						S	S	S	S	S	S													
Cisco	I	I	I	I	I	I															S	S	S	S
Lake whitefish	I	I	I	I	I	I													S	S	S	S	S	S
Mount. whitefish	I	I	I	I	I	I												S	S	S	S	S	I	I
Pygmy whitefish																					S	S	S	S
Kokanee	I	I	I	I	I													S	S	S	S	S	I	I
Chinook salmon																			S	S				
Golden trout											S	S	S	S	I	I,E								
Cutthroat trout							S	S	S	S	S	S	S	I	I	E								
Rainbow trout					S	S	S	S	S	S	S	S	I	I	E									
Brook trout	I	I	I	I	E	E	E	E	E								S	S	S	S	I	I	I	I
Bull trout	E	E	E	E	E	E	E	E	E							S	S	S	S	S	I	I	I	I
Lake trout	I	I	I	I	I	I	I	I											S	S	S	S	S	I
Brown trout	S	I	I	I	I	I	I	I,E										S	S	S	S	S	S	S
A. grayling								S	S	S	S	S	S,I											
Redband trout												S	S	I										

Species	J1	J2	F1	F2	M1	M2	A1	A2	M1	M2	J1	J2	J1	J2	A1	A2	S1	S2	O1	O2	N1	N2	D1	D2
Northern pike					S	S	S	S	S															
Carp									S	S	S	S	S	S	S	S								
Golden shiner									S	S	S	S	S	S										
Pearl dace																								
Creek chub						S	S	S	S	S	S	S												
N. redbelly dace									S	S	S	S	S	S										
Finescale dace							S	S	S	S														
Utah chub									S	S	S	S	S	S										
Flathead chub									S	S	S	S	S	S	S									
Sturgeon chub										S	S	S	S	S	S									
Lake chub										S	S													
Sicklefin chub											S	S	S	S	S	S								
Peamouth									S	S	S	S												
Emerald shiner													S	S	S	S								
Spottail shiner											S	S	S	S	S	S								
Sand shiner									S	S	S	S	S	S	S	S								
Brassy minnow									S	S	S	S												
Plains minnow							S	S	S	S	S	S	S	S	S									
WSilveryminnow									S	S	S	S	S	S										
Fathead minnow									S	S	S	S	S	S	S	S								
N. Pike minnow									S	S	S	S	S											
Longnose dace									S	S	S	S	S	S	S									
Redside shiner										S	S	S	S	S	S									
River carpsucker									S	S	S	S												
Blue sucker							S	S	S	S	S													
Small. Buffalo									S	S	S													
Big. Buffalo									S	S	S	S	S											
Short. Redhorse							S	S	S	S	S	S												
Longnose sucker						S	S	S	S	S	S	S	S											

Species	J1	J2	F1	F2	M1	M2	A1	A2	M1	M2	J1	J2	J1	J2	A1	A2	S1	S2	O1	O2	N1	N2	D1	D2
White sucker							S	S	S	S	S	S												
Largesc. Sucker							S	S	S	S														
Mountain sucker											S	S	S	S										
Black bullhead									S	S	S	S	S											
Yellow bullhead									S	S	S	S	S											
Channel catfish									S	S	S	S	S											
Stonecat											S	S	S	S	S	S								
Burbot			S	S	S	S																		
Brook stickleback									S	S	S	S												
Rock bass									S	S	S	S												
Green sunfish									S	S	S	S	S											
Pumpkinseed										S	S													
Bluegill									S	S	S	S	S											
Smallmouth bass									S	S	S	S												
Largemouth bass									S	S	S	S	S											
White crappie										S	S	S	S											
Black crappie									S	S	S	S												
Yellow perch						S	S	S	S	S	S	S												
Sauger						S	S	S	S	S														
Walleye							S	S	S	S														
Iowa darter									S	S	S	S	S											
Mottled sculpin									S	S	S	S												
Slimy sculpin																								
Torrent sculpin																								
Shorthead sculpin																								
Spoonhead sculpin																								