

Alaska Department of Environmental Conservation Alaska Consolidated Assessment and Listing Methodology



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1 Executive Summary

The purpose of this document is to provide guidance to Alaska Department of Environmental Conservation (DEC) staff in their analysis of water quality data for the Alaska Integrated Water Quality Monitoring and Assessment Report (Integrated Report) under Clean Water Act sections 303(d) and 305(b). This guidance defines minimum data requirements and data evaluation methods used to complete waterbody impairment or attainment determinations to satisfy Integrated Report reporting requirements.¹

The CALM employs a two-step process where:

1. DEC considers minimum data qualification requirements to determine if data is Screening or Assessment Level (Table 2). Screening Level data will not be used for further decision making.
2. If data meets minimum data qualifications to be considered Assessment Level, DEC evaluates data to make an attainment or impairment (303(d) listing) determination. Attainment means that a waterbody is supporting all designated uses for the pollutant parameters evaluated. Impairment means that a waterbody is persistently exceeding criteria for one or more pollutants and not supporting all designated uses.

All data is evaluated with respect to Alaska's Water Quality Standards (WQS) found at 18 Alaska Administrative Code (AAC) 70.020 and criteria adopted by reference in the 2008 Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances.² Data evaluation should yield transparent and reproducible recommendations based on clear numeric thresholds, allowing decisions to be largely data driven. This guidance aligns with the Environmental Protection Agency's (EPA's) Consolidated Assessment and Listing Methodology³ recommendations.

2 Background

2.1 Call for data

DEC staff collaborate on water quality monitoring with a diverse group of partners including governmental agencies, Alaskan tribes, municipalities, and watershed-based nongovernmental

¹ More information on the Integrated Report is available at <http://dec.alaska.gov/water/water-quality/integrated-report>

² Alaska Water Quality Standards, 18 AAC 70. More information is available at <http://dec.alaska.gov/water/water-quality/standards/>

³ EPA. 2002. Consolidated Assessment and Listing Methodology Toward a Compendium of Best Practices, First Edition

organizations. DEC issues a public notice every two years requesting submission of water quality data for Alaska’s waters for inclusion in the Integrated Report; however, DEC accepts water quality data and information on a continuous basis.

DEC maintains the Ambient Water Quality Management System (AWQMS) database to store water quality data locally. AWQMS serves as the mechanism to submit data to EPA’s National database, the Water Quality Portal, through the Water Quality Exchange data network.

2.2 Categories

Waterbodies are assigned to one of five possible categories based on the data evaluation methodology described in this guidance. The methodology will guide staff in determining whether a waterbody is impaired (Categories 5 and 4), if there is not enough information to make a determination (Category 3) or considered to be attaining (Categories 1 or 2) (Table 1).

Table 1. Category definitions

Category	Description
5	Waterbody is determined to be impaired; data indicate that a designated use or water quality standard is not attained. Also known as 303(d) impaired or “listed” waters.
4	Waterbody is determined to be impaired, but has an approved recovery plan in place. <ul style="list-style-type: none"> • 4a: Waterbody has an approved Total Maximum Daily Load (TMDL) • 4b: An alternative TMDL or other pollution control requirements are in place
3	There is not enough data to make an attainment or impairment determination or to determine whether a designated use is supported.
2	Data indicate that water quality standards are attained for some of the designated uses.
1	All designated uses are supported (DEC does not currently use this category)

The CALM will not be used for pollutants for which specific methodologies have been developed by DEC including:⁴

- Pathogens (2021)
- Petroleum Hydrocarbons, Oils, and Grease (2015)
- Turbidity (2016)

⁴ Links to final DEC listing methodologies can be found on the Integrated Report webpage at: <https://dec.alaska.gov/water/water-quality/integrated-report/>

2.3 Waterbody Delineation

DEC evaluates data for waters of the state, which are defined in Alaska's Water Quality Standards.⁵ DEC identifies waterbody assessment units as the basic unit for data evaluation based on the National Hydrography Dataset, Hydrologic Unit Codes (HUC) at the watershed or HUC 10 level. Assessment unit identifiers are assigned sequentially within the HUC 10.

3 Data Qualification

DEC will review data and assign it to one of three possible data levels based on spatial and temporal coverage and data quality as described below (Table 2). Data must qualify as Assessment Level or as Overwhelming Evidence for use in attainment or impairment decisions. Waterbodies with data at the Screening Level will automatically be placed in Category 3.

3.1 Supporting Information

Assessment Level data is considered as the primary evidence for a waterbody determination for impairment or attainment decisions. To qualify as Assessment Level data, DEC requires additional supporting information such as a quality assurance plan and metadata to be submitted including:

- Waterbody name and location
- Sampling location identifiers including latitude and longitude
- Date and time each sample was collected
- Type of sample
- Parameters analyzed and analytical methods
- Quality Assurance/Quality Control data and any data qualifiers
- Standard operating procedures used (for example data rejection procedures)

Laboratory data transmittals, chain of custody forms, calibration records and laboratory qualifications should be available to DEC upon request. Non direct measurements such as photos, weather conditions and waterbody conditions (such as flow) may be requested as supporting documentation for establishing the data quality for impairment or attainment determinations.

If it is suspected that an impairment is the result of naturally occurring pollutant, the department will follow the procedures set out in the Department's Natural Conditions

⁵ Alaska Water Quality Standards, Definitions are found at 18 AAC 70.990(66)

Guidance and Tools⁶ at <http://dec.alaska.gov/water/water-quality/standards/natural-conditions> to determine an appropriate reference site and/or choose to pursue site-specific criteria per 18 AAC 70.235 for the water of concern.

3.2 Data Considerations

DEC normally requires data be collected within the past five years for use in the Integrated Report. EPA guidance does allow DEC to consider data older than five years, provided that natural or anthropogenic conditions in the waterbody have not changed significantly since the original sampling event(s).

All pollutants may be subject to discrete data assessment (e.g., data from grab samples); however, discrete measurement may have a tendency to underestimate daily extreme values. Discrete samples may be considered to be representative of averaging periods if limited data (e.g., multiple samples over a 4-day period) is available.

Data collected on a continuous basis (using automated instruments such as sondes) is most often available for conventional pollutants such as dissolved oxygen, pH, and turbidity. Continuous monitoring is generally considered to be a more reliable means of assessing water quality data because it captures diurnal cycles and other naturally occurring fluctuations. Continuous datasets must be reviewed in their entirety.

In cases where multiple discrete samples are available for assessment in a representative time period (e.g., multiple samples in a single day), or for continuous data, the applicable duration value will be dependent on the type of pollutant.

DEC may define a specified critical period or season in which the criteria need to be met, based on the specific needs of the designated use (e.g., agriculture period), water temperatures and seasonal water use patterns. The time period in which data will be collected is typically defined in the QAPP and may bracket specific months or seasons in which pollutants are more prone to exceed criteria. Where a critical period applies, DEC will conduct assessments for the critical period as well as for the entire water year.

⁶ Note that the 2006 DEC Guidance was not approved of by EPA for use in Clean Water Act approved programs and additional consultation with EPA may be required before a reference site will be considered applicable.

Table 2. Water quality data qualification

Data Level and IR Category	Technical Component	Spatial and Temporal Coverage	Data Quality
Screening Level (Category 3)	Monitoring via grab sampling	Low spatial and temporal coverage: <ul style="list-style-type: none"> • Sampling locations are not representative of the assessment unit • Sampling frequency does not meet minimum requirements for data evaluation • Data older than 5 years 	<ul style="list-style-type: none"> • No QAPP (or alternative plan) or plan not followed • QA/QC results do not meet data quality objectives • Methods not documented • Incomplete metadata⁷
Assessment Level (Categories 2, 4, 5)	Monitoring via grab sampling, composite sampling, or continuous monitoring instruments	Broad spatial and temporal coverage with sampling frequency and coverage to capture acute events and chronic conditions: <ul style="list-style-type: none"> • Representative site(s) within an assessment unit • Sampling during key periods (e.g., critical hydrological regimes) • Minimum of 10 representative data points total⁸ (5 data points for toxic pollutants for the acute aquatic life use) from multiple sampling events over two years, not necessarily consecutive, within the most recent 5-year period 	<ul style="list-style-type: none"> • QAPP (or alternative plan) • QA/QC results meet data quality objectives • Approved methods used for field and lab • Complete metadata
Overwhelming Evidence (Category 4 or 5)	Monitoring via grab sampling or single visit surveys	Moderate spatial and temporal coverage, but does not meet requirements for assessment level. <ul style="list-style-type: none"> • Best professional judgement and case by case evaluation, including weight of evidence and timing of exceedance(s) • Conventional pollutants: 100% of at least 5 samples exceeding or more than one exceedance of 5x criterion • Toxic pollutants: >1 instantaneous exceedance of 2x acute criterion for aquatic life • Data may be more than five years old • No association with a discharge or other short-term event 	<ul style="list-style-type: none"> • QAPP (or alternative plan) • QA/QC results meet data quality objectives • Approved methods used in field and lab • Complete metadata

⁷ Metadata includes information such as data source, analytical methods, and project objectives.

⁸ 10 points over evaluated years after summarizing for appropriate pollutant duration (such as daily average).

4 Category Determination

DEC evaluates water quality data to determine if there are persistent exceedances of WQS. The evaluation should yield transparent and reproducible recommendations based on clear numeric or narrative thresholds. In most cases, data must meet the qualifications for Assessment Level (Table 2) to be evaluated for an attainment or impairment determination. See the section on Overwhelming Evidence (below) for a description of evaluating when minimum data qualification is not met.

4.1 Impairment thresholds

Data is evaluated to determine whether a waterbody is attaining or impaired with respect to WQS by applying an impairment threshold that considers the magnitude, frequency and duration of exceedances. Waterbodies are characterized as impaired (Category 5) when the data evaluation demonstrates a pollutant is present, at a magnitude and duration beyond the allowable frequency value. If the data threshold is not exceeded, then the waterbody is considered to be attaining (Category 2).

Magnitude describes the allowable maximum or minimum numeric concentration of a pollutant determined to meet WQS and be protective of the designated use. Conventional pollutant criteria are specified in 18 AAC 70(b) and the numeric criteria for toxic pollutants are identified in the 2008 *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances*. DEC conducts water quality assessments using the most stringent of fresh and marine water criteria as such criteria would be protective of all designated and existing uses.⁹

Duration describes the length of time a pollutant may be present and potentially impacting a designated use before the criterion is considered exceeded and WQS are not met. DEC will accept data from discrete (e.g., instantaneous or grab samples) measurements or continuous datasets collected using probes or sondes.

Frequency describes the allowable number of times a water quality criterion can be exceeded before WQS are not met and an impairment of the designated use occurs. Frequency is intended to allow inconsequential excursions above the magnitude and to account for uncertainty in the accuracy and representativeness of random samples collected from the waterbody.

For conventional pollutants, this typically means that a pollutant must exceed the numeric

⁹ If a waterbody is determined to be impaired for the most stringent criteria, additional analysis will consider evaluation with respect to other criteria to determine how many of the designated uses are impacted.

criterion more than 10 percent of the time in each dataset to be considered impaired. For toxic pollutant, this means that a pollutant must exceed the numeric criterion more than once in three years or more than five percent of the time to be considered impaired.¹⁰ The binomial test described next describes how DEC determines the frequency component for data sets of variable sample size to reduce making errors in determinations.

4.2 Critical Values and Binomial Test

DEC applies a binomial hypothesis test that accounts for sample size, errors in sample accuracy and precision, and explicitly defines acceptable levels of certainty to address the frequency component when making an attainment or impairment determination. Using this method, the risk of making errors in determining both impairment and attainment is defined and can be weighed.

Absent complete information characterizing the water quality of a particular waterbody, application of binomial statistics informs the decision-making process by considering uncertainty, potential for error, and confidence in the attainment or impairment determination. This creates a balance between the availability of data and the strength of that data.

Overestimation of the number of “true” exceedances of a criterion has the potential to result in an incorrect impairment determination (Type I error or false positive) which could significantly increase regulatory burdens on dischargers or disincentivize the collection and submission of long-term datasets to DEC. Incorrectly determining that a water is attaining when it is actually impaired (Type II error or false negative) could result in environmental degradation. DEC will seek to maintain balance between Type I errors and Type II errors by applying a 90 percent confidence level (10 percent chance of a Type I error) (Table 3). With small sample sizes, uncertainty and the probability of making Type II errors is higher and decreases with larger sample sizes.

4.2.1 Conventional Pollutants

The magnitude, duration and frequency impairment thresholds for conventional pollutants are shown in Table 3. DEC will use the impairment thresholds in Table 3 and apply the critical values in Table 4 to evaluate data for conventional pollutants for attainment or impairment. If the waterbody condition is currently unknown or attaining, DEC applies the null hypothesis *actual exceedance proportion is ≤ 10 percent* which assumes that the water is attaining WQS. If the

¹⁰ EPA, 2003. Guidance for 2004 assessment, listing, and reporting requirements pursuant to sections 303(d) and 305(b) of the Clean Water Act.

waterbody is considered impaired, DEC applies the alternate null hypothesis *actual exceedance proportion is >10 percent* which assumes that the water is impaired, or not attaining WQS.

When evaluating whether a waterbody that is considered impaired is attaining WQS, the minimum number of samples is increased to 15 to balance between Type I and II errors and avoid potentially moving a water out of Category 5 when it is still impaired. Increasing the minimum sample size increases the statistical power and confidence in the determination, avoids committing a Type II error, and prevents waters from moving back and forth between different categories with each assessment cycle.

Table 3. Impairment thresholds for conventional pollutants

Magnitude	Criterion as specified in 18 AAC 70(b)
Duration	Daily average except for pH, where a daily minimum and daily maximum are applied
Frequency	10% of the time

Table 4. Critical values for making an impairment or attainment determination for conventional pollutants

	Attaining or unknown waters (is the water impaired?)	Impaired waters (is the water attaining?)
Null Hypothesis	Actual exceedance proportion is ≤ 10 percent (e.g., the water is attaining WQS)	Actual exceedance proportion is > 10 percent (e.g., the water is not attaining WQS)
Alternate hypothesis	Actual exceedance proportion is > 10 percent	Actual exceedance proportion is ≤ 10 percent
Minimum confidence level	90 percent	90 percent
Minimum sample size	10	15

DEC will use the binomial test to apply the impairment thresholds (Table 3) with the appropriate hypothesis test and critical values (Table 4) to evaluate the data for attainment or impairment. Example exceedance frequencies based on these values for a range of samples sizes are shown in Table 5.

Table 5. Example exceedance frequencies for different samples sizes for conventional pollutants¹¹

Attaining or unknown waters		Impaired waters	
Sample Size	Minimum frequency to impair	Sample Size	Minimum frequency to attain
10-11	2	15	1
12-18	4	16-18	2
19-25	5	19-25	3
26-32	6	26-32	4
33-40	7	33-40	5
41-47	8	41-47	6
48-55	9	48-55	7
56-63	10	56-63	8
64-71	11	64-71	9
72-79	12	72-79	10
80-88	13	80-88	11
89-96	14	89-96	12
97-104	15	97-104	13

4.2.2 Toxic Pollutants

The magnitude, duration and frequency impairment thresholds for toxic pollutants are shown in Table 6. Duration periods and frequency thresholds for toxic pollutants for the protection of aquatic life and human health vary depending on short term (acute) or longer-term (chronic) exposure. Discrete data may be considered representative of duration averages for acute and chronic criteria for aquatic life provided it meets assessment level data requirements (Table 1). Duration values for other designated uses (e.g., drinking water) vary depending on the pollutant in question.

- For the acute aquatic life use, the instantaneous (or one-hour exposure) duration value may not exceed the magnitude of the pollutant criterion more than once in the most recent three-year period.

¹¹ Adapted from Oregon Department of Environmental Quality. 2018. Draft Methodology for Oregon's 2018 Water Quality Report and List of Water Quality Limited Waters. Water Quality Division. Portland, Oregon

- For the chronic aquatic life use, the four-day average¹² duration value may not exceed the magnitude of the pollutant criterion more than 5% of the time (as evaluated using the binomial, see Tables 7 and 8).^{13,14,15}
- For the human health and drinking water uses, the arithmetic mean of the most recent three years duration value may not exceed the magnitude of the pollutant criterion.¹⁶

Table 7 shows the critical values used to evaluate data for toxic pollutants for WQS attainment or impairment for the chronic aquatic life use. If the waterbody condition is currently unknown or attaining, DEC applies the null hypothesis *actual exceedance proportion is ≤5 percent* which assumes that the water is attaining WQS. If the waterbody is considered impaired, DEC applies the alternate null hypothesis *actual exceedance proportion is >5 percent* which assumes that the water is not attaining WQS.

When evaluating a whether waterbody that is considered impaired for the chronic aquatic life use is attaining WQS, the minimum number of samples is increased from 10 to 18 to balance between Type I and II errors and avoid potentially moving a water out of Category 5 when it is still impaired. Increasing the minimum sample size increases the statistical power and confidence in the determination, avoids committing a Type II error, and prevents waters from moving back and forth between different categories with each assessment cycle.

Table 6. Impairment thresholds for toxic pollutants

Magnitude	Criterion as specified in <i>Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances</i> (2008)
Duration	<ul style="list-style-type: none"> • Acute aquatic life criteria – instantaneous; or one-hour exposure • Chronic aquatic life criteria – four-day arithmetic average • Human Health and Drinking Water criteria – arithmetic mean
Frequency	<ul style="list-style-type: none"> • Acute aquatic life – not more than once in the most recent three-year period • Chronic aquatic life – 5% in the most recent three-year period • Human Health – The harmonic mean concentration of the most recent

¹² Averaging only required if sampling frequency is > 1 sample within any 4-day period

¹³ Oregon 2018 Integrated Reporting Improvements: Statistical Methods for Listing and Assessment of Large and Long Term Data Sets. Pg 20. Water Quality Standards and Assessments. Oregon Department of Environmental Quality.

¹⁴ Oregon. 2018 Summary of Binomial Listing Methodology Peer Review: Pg 5. Water Quality Standards and Assessments. Oregon Department of Environmental Quality.

¹⁵ If a waterbody exceeds the not more than once in three years for the chronic aquatic life criterion, but does not meet the minimum data requirements for the binomial 5% test, it will be prioritized for additional data collection.

¹⁶ DEC will apply the arithmetic mean of the most recent three years of data unless a skewed dataset exists and application of a geometric mean is more appropriate for assessment purposes per EPA 2002 CALM

	three years of data <i>on average</i> ¹⁷ may not exceed criterion
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Table 7. Critical values for making an impairment or attainment determination for toxic pollutants for the chronic aquatic life use

	Attaining or unknown waters (is the water impaired?)	Impaired waters (is the water attaining?)
Null Hypothesis	Actual exceedance proportion is ≤5 percent (the water is attaining)	Actual exceedance proportion is >5 percent (the water is impaired)
Alternate hypothesis	Actual exceedance proportion is >5 percent (the water is impaired)	Actual exceedance proportion is ≤5 percent (the water is attaining)
Minimum confidence level	90 percent	90 percent
Minimum sample size	10	18

*Table 8: Binominal sample exceedance frequency requirements for impairment and attainment determinations for toxic pollutants for the chronic aquatic life use*¹⁸

Attaining or unknown waters		Impaired waters	
Sample Size	Minimum frequency to impair	Sample Size	Minimum frequency to attain
10-18	2	18-22	1
19-22	3	23-35	2
23-35	4	36-49	3
36-49	5	50-63	4
50-63	6	64-78	5
64-78	7	79-94	6
79-92	8	95-109	7
93-109	9	110-125	8

5 Overwhelming Evidence Policy

In cases where data is limited due to small or incomplete datasets, DEC may apply the concept of *Overwhelming Evidence* in which information besides the total number of samples is used in the decision-making process. EPA's 2002 CALM states:

¹⁷ DEC generally limits assessment periods to the most recent credible period. Data beyond three years may be considered on a case-by-case basis if it can be demonstrated that such data is credible and applicable to the assessment process.

¹⁸ Adapted from Oregon Department of Environmental Quality. 2018. Draft Methodology for Oregon's 2018 Water Quality Report and List of Water Quality Limited Waters. Water Quality Division. Portland, Oregon

An assessment methodology should take into account the balance between desired data requirements and the practical realities affecting the availability of information and the strength of the available evidence... Generally, decisions should be based on very small sample sizes only when there is overwhelming evidence for impairment.¹⁹

Overwhelming evidence uses multiple lines of evidence to determine whether a particular narrative threshold is exceeded. DEC will consider overwhelming evidence in cases where sample sizes do not meet minimum criteria or sampling data is inconclusive and yet there is other overwhelming evidence of an impairment. DEC will also consider the anthropogenic factors (e.g., current and historic regulatory practices, monitoring efforts) that may have a relationship between water quality and its management in a particular waterbody. DEC does not consider the factors noted as overwhelming evidence to alone be sufficient for placement of a waterbody in Category 5. Data used for a determination using the overwhelming evidence must meet the minimum data qualification requirements in Table 2 and should not be associated with wastewater treatment system upset or other short-term event.

- Conventional pollutants: 100% of at least 5 samples exceeding or more than one sample exceeds the most stringent criterion by five times (5x)
- Toxic pollutants: more than one sample exceeds the acute criterion for aquatic life by two times (2x); case by case for drinking water and human health criteria
- Best professional judgement – the dataset must provide clearly valid, reliable, and relevant exceedances of a numeric criterion of sufficient magnitude, frequency and/or duration to ensure that an actual impairment exists based on limited data.
- Weight of evidence – quality and quantity of all readily available data and ancillary information (e.g. biological evaluations, older data, pollutant source information)
- Timing of exceedances – consideration of factors that may be contributing to the presence of pollutant concentrations including weather and flow (e.g. storm events)

Additional factors applicable to the assessment process for both conventional and toxic pollutants may also include the use of biologic indicators (as available), habitat data, or public health advisories. DEC reserves the right to use additional lines of evidence during the data evaluation process.

¹⁹ EPA 2002 CALM