Waterbody Assessment Guidance
for 2023 - 2024

Wisconsin Consolidated Assessment and Listing Methodology (WisCALM) 2024

Wisconsin Department of
Natural Resources

101 S. Webster Street
PO Box 7921
Madison, Wisconsin 53707-7921
608-266-2621

BUREAU OF WATER QUALITY
PROGRAM GUIDANCE

Wisconsin 2024 Consolidated Assessment and Listing Methodology (WisCALM) for CWA Section 303(d) and 305(b) Integrated Reporting

Assessment Guidance for 2023 - 2024

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APPROVED:

Adrian Stocks

Adrian Stocks, Director
Water Quality Bureau

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Date

This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

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Editor

Ashley Beranek

Contributors

Tim Asplund, Jim Baumann, Ashley Beranek, Nicki Clayton, Jacob Dickmann, Matt Diebel, Donalea Dinsmore, Jennifer Filbert, Aaron Fisch, Kari Fleming, Toni Glymph, Mark Hazuga, Dave Heath, Lisa Kosmond Helmuth, Katie Hein, Dan Helsel, Jim Kreitlow, Gina LaLiberte, Aaron Larson, Mary Anne Lowndes, John Lyons, Robert Masnado, Molli MacDonald, Michael Miller, Kristi Minahan, Amanda Perdzock, Ruth Person, Kurt Rasmussen, Russ Rasmussen, Candy Schrank, Ken Schreiber, Greg Searle, Mike Shupryt, Tim Simonson, Alex Smith, Brian Weigel, Mike Wenholz, Meghan Williams, Scott Van Egeren, Valerie Villeneuve, Sarah Yang

Statutory Authority

State

- Chapter 102.04(1)d Wis. Adm. Code provides narrative standards for the protection of fish and other aquatic life in surface waters, stating: “Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life.”
- Sections 281.11 and 281.12, Wis. Stats., grant necessary powers and establish a comprehensive program under the WDNR to enhance quality management and protection of all waters of the state. It grants the WDNR general supervision and control to carry out the planning, management and regulatory programs necessary for prevention/reduction of water pollution and for improvement of water quality.
- Section 281.13, Wis. Stats., grants the department authority to research and evaluate the quality and condition of the state’s natural water sources.
- Section 281.15, Wis. Stats. mandates that the department promulgate water quality standards, including water quality criteria and designated uses. It recognizes that different use categories and criteria are appropriate for different types of waterbodies, and that the department shall establish criteria which are not more stringent than reasonably necessary to assure attainment of the designated use for the water bodies in question.
- Section 281.65(4)(c) and (cd), Wis. Stats., directs the department to prepare a list of waters impaired by nonpoint source pollution.
- Section 283.83, Wis. Stats., mandates the departments establish a continuing water quality management planning process, part of which is identifying water quality status.

Federal

- Sec. 303 (d)(1)(A) of the Federal Water Pollution Control Act (Clean Water Act) requires states to develop an impaired waters list that identifies waters that are not meeting any water quality standard.
- Sec. 305(b)(1) of the Federal Water Pollution Control Act (Clean Water Act) requires states to prepare a biennial report documenting which waterbodies are attaining their designated uses.
- 40 CFR s. 130. 4 Water Quality Monitoring. This section requires water quality monitoring and assessments of state waters.
- 40 CFR s. 130.7 Total maximum daily loads (TMDLs) and individual water quality-based effluent limitations. This section provides additional information related to requirements for developing the impaired waters list.
- 40 CFR s. 130.8 Water Quality Reports. States must submit water quality reports to EPA that include a water quality assessment of state waters.
- 40 CFR s. 130.3. Water quality standards. This section defines water quality standards as setting water quality goals for a waterbody that will protect its designated uses (such as protection of fish, wildlife, recreation, and public health and welfare). Criteria will be set to protect those uses.
- 40 CFR s. 131.11 Criteria. States must adopt those water quality criteria that protect the designated use. Such criteria must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use. For waters with multiple use designations, the criteria shall support the most sensitive use.

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Background

Over 16,000 lakes and 85,000 miles of streams and rivers in Wisconsin are managed to ensure that their water quality condition meets state and federal standards. Water quality standards (WQS) are the foundation of Wisconsin's water quality management program and serve to define goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants.

Waters are monitored to collect water quality data to determine, or *assess*, its current status or condition. Water quality monitoring results and assessment data are stored in state and federal databases and the majority of data are available online to agencies and the public. *General assessments* are known as "305(b) assessments" in the Federal Clean Water Act (CWA). Waters with available data are reviewed by Wisconsin Department of Natural Resources (WDNR) biologists and placed in one of three categories: attaining, not attaining, or insufficient information. If biological data is available the water will further be placed in one of four categories: excellent, good, fair, and poor, as defined in section 2.4 of this document.

Impairment assessments are conducted to determine if a waterbody is "impaired," or not meeting WQS. Waters that do not meet WQS are placed on Wisconsin's Impaired Waters List—also known as the 303(d) list—under Section 303(d) of the CWA. Wisconsin is required to submit list updates every 2 years to the United States Environmental Protection Agency (EPA) for approval. WDNR has submitted Impaired Waters Lists, as required[1], every other year since 1996.

Water quality assessments aid Department staff in determining management actions that are needed to meet WQS, including restoration of impaired waters and anti-degradation, also known as maintenance of existing water quality condition.

Each state must document the methodology used to assess waters, including how the state makes decisions to add or delete waters from the existing Impaired Waters List. Waters may be removed from the list (delisted) when water quality data identifies that the designated use has been restored (i.e., the water is meeting WQS). The methodology for conducting general and impairment assessments is outlined, and updated for 2022, in this WisCALM guidance document.

GovDelivery, a web-based service used by WDNR, offers the public real-time updates on topics of interest via email or text messages. It is used to provide information regarding the Integrated Reporting Process, Wisconsin's Impaired Waters Program, and WisCALM updates, among other topics.

Anyone is able to sign up for GovDelivery emails for a number of topics on WDNR's website https://public.govdelivery.com/accounts/WIDNR/subscriber/new

[1] EPA did not require and WDNR did not submit an Impaired Waters List in FFY 2000.

2024 Version Updates

The majority of updates for this version of WisCALM were in response to new criteria. Surface water thresholds for PFOS and PFOA were published in August 2022 and the Biological Assessment Thresholds rule was published in October 2022. Other updates were for clarity. A full list of changes is available in the 2024 Change Log.

- Changed “Healthy Waters” list to “Waters Attaining Standards” to avoid confusion with the Healthy Watersheds, High Quality Waters (HWHQW) project.
- Changed “Restoration Waters” list title to “Waters In Restoration” for clarity.
- Added section 2.5.4 Biological Threshold Assessments, including new Table 5 to distinguish biological thresholds from water quality criteria.
- Updated Table 7 to include cycles 2026 and 2028.
- Updated Reservoir code reference in section 4.4 Lake Classification.
- Updated section 6.1.5 Applying a Combined Approach: Phosphorus Response Indicators and added Table 15 to show phosphorus ranges for applying response indicators.
- Added subsections under 6.1:
  - 6.1.6 Chlorophyll-a (Lakes & Reservoirs)
  - 6.1.7 Macrophytes (aquatic plant metrics) (Lakes & Reservoirs) with new Table 16.
  - 6.1.8 Oxythermal Habitat (Two-Story Fishery Lakes)
  - 6.1.9 Benthic Algal Biomass & Diatom Taxa (Rivers & Streams)
  - 6.1.10 Combined Phosphorus and Response Metric Listings with new Table 17, containing information moved from former section 6.3.
  - 6.1.11 Listing vs. Delisting Total Phosphorus updated Table 18 to reflect new TP-Biology listing determinations.
- Under 6.2 Biological Assessments, updated subsection 6.2.2 Macrophytes (aquatic plant metrics) (Lakes and Reservoirs) and moved prior subsection to 6.2.3 Macroinvertebrate and Fish Indices of Biological Integrity (Stream & River)
- Updated section 6.4 Dissolved Oxygen (DO) and Table 22 to reflect criteria updates for Class III Trout waters.
- Added section 6.5 Oxythermal Habitat, including Figure 13 that demonstrates oxythermal habitat in a two-story fishery lake during spring and peak summer, and Table 23 with oxygen and temperature requirements by coldwater fish species.
  - Updated Table 22 and Table 26 to reflect new oxythermal criteria.
  - Removed footnotes 14 and 15 that described upcoming oxythermal habitat criteria.
  - Renumbered the next sub-section to 6.6.
- Updated Table 26 to reflect the new chlorophyll-*a* threshold for Two-Story Fishery Lakes (8 ug/L).
- Updated section 7.2.1 Chlorophyll-a (Algal blooms) and added Table 28 to house AL Chl-*a* thresholds.
- Added sections 8.2 PFOS and PFOA and 8.5.6 PFOA to incorporate newly approved PFOS and PFOA criteria. Created Table 33. Wisconsin DNR surface water criteria for PFOS and PFOA.
  - Renumbered the next sub-sections to 8.3, 8.4, and 8.5.
- Added Appendix E to show parameter IDs for parameters used in assessment packages; Section 12.6 Assessment Package Documentation was removed.

1. Water Quality Standards: Three Elements

Wisconsin's assessment process begins with water quality standards (WQS). WDNR is authorized to establish WQS that are consistent with the CWA (Public Law 92-500) through Chapter 281 of the Wisconsin Statutes. These WQS are explained in detail in chs. NR 102, 103, 104, 105, and 207 of the Wisconsin Administrative Code (Wis. Adm. Code).

The WQS described in the Wis. Adm. Code rely on three elements to collectively meet the goal of protecting and enhancing the state's surface waters:

- *Use designations*, which define the goals for a waterbody by designating its uses,
- *Water quality criteria,* which are set to protect the water body's designated uses, and
- *Anti-degradation provisions* to protect water quality from declining.

Waters not meeting one or more of these water quality elements are to be included on the Impaired Waters List.

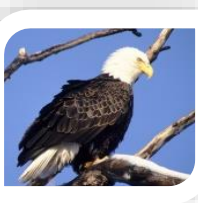
1.1 Designated Uses

Designated uses are goals or intended uses for surface waterbodies in Wisconsin, which are classified into the following categories: Aquatic Life, Recreation, Public Health and Welfare, and Wildlife. The following designated uses are described in ch. NR 102, Wis. Adm. Code:

Aquatic Life[2]*:* All surface waters are considered appropriate for the protection of fish and other aquatic life. Surface waters vary naturally with respect to factors like temperature, flow, habitat, and water chemistry. This variation allows different types of fish and aquatic life communities to be supported.

Use Designations for Aquatic Life (AL) are separated into the following sub-categories: Coldwater (Cold), Warmwater Sport Fish (WWSF), Warmwater Forage Fish (WWFF), Limited Forage Fish (LFF) and Limited Aquatic Life (LAL). More detail on these subcategories is in the Streams and River Classification chapter of this guidance document.

Recreation*:* All surface waters are considered appropriate for Recreation use. Recreation use is only removed through a Use Attainability Analysis (UAA); removal could be evidenced by a sanitary survey showing that humans are unlikely to participate in activities requiring full body immersion.



Public Health and Welfare*:* All surface waters are considered appropriate to protect for incidental contact, ingestion by humans and human consumption of fish. All waters of the Great Lakes as well as a small number of inland water bodies are also identified as public water supplies and have associated water quality criteria to account for human consumption[3].

Wildlife*:* All surface waters are considered appropriate for the protection of wildlife that relies directly on the water to exist or rely on it to provide food for existence.

[2] Formerly called 'Fish and Aquatic Life'. The word 'Fish' was removed in 2020 because it was redundant.
[3] Distinct water quality criteria are specified for public water supply and non-public water supply waters.

1.2 Water Quality Criteria – Numeric and Narrative

Each designated use has its own set of water quality criteria, either numeric or narrative requirements that must be met to protect the intended use. Some of these requirements relate to the amount of the physical (e.g., water temperature) or chemical (e.g., ammonia concentrations) conditions that must be met to avoid causing harm. Wisconsin's water quality criteria are authorized by state statutes and enumerated in chs. NR 102, 104, and 105, Wis. Adm. Code.

Numeric criteria: Numeric criteria are quantitative and are often expressed as a concentration or range of concentrations for a substance. Numeric surface water quality criteria have been established for conventional parameters (e.g., dissolved oxygen, pH, and temperature), toxics (e.g., metals, organics, and ammonia), and pathogens (e.g., *E. coli* bacteria). These numeric criteria are established for each designated use.

Narrative criteria: All waterbodies must meet a set of narrative criteria which qualitatively describe the conditions that should be achieved. A narrative water quality criterion is a statement that prohibits unacceptable conditions in or upon the water, such as floating solids, scum, or nuisance algae blooms that interfere with public rights. These standards protect surface waters and aquatic biota from eutrophication, algae blooms, and turbidity, among other things. The association between a narrative criterion and a waterbody's designated use is less well defined than it is for numeric criteria; however, most narrative standards protect aesthetic or AL designated uses. Wisconsin's narrative criteria are found in s. NR 102.04(1), Wis. Adm. Code.

1.3 Anti-degradation

Wisconsin's anti-degradation policy is intended to maintain and protect existing uses and high-quality waters. This part of a water quality standard is intended to prevent the degradation of water quality, especially when reasonable control measures are available. The anti-degradation policy in Wisconsin is stated in s. NR 102.05(1) of the Wis. Adm. Code:

> "No waters of the state shall be lowered in quality unless it has been affirmatively demonstrated to WDNR that such a change is justified as a result of necessary economic and social development, provided that no new or increased effluent interferes with or becomes injurious to any assigned uses made of or presently possible in such waters."

One component of Wisconsin's anti-degradation policy is the designation of Outstanding Resource Waters (ORW) and Exceptional Resource Waters (ERW). These are surface waters which provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. ORWs typically do not have any dischargers, while ERW designation offers limited exceptions for dischargers if human health would otherwise be compromised (e.g., expansion of wastewater treatment facilities to protect public health).

Inherent in the assessment and impaired waters listing process is the application of anti-degradation provisions. Anti-degradation is an important aspect of pollution control because preventing deterioration of surface waters is less costly to society than attempting to restore waters once they have become degraded.

How is a water designated as Outstanding or Exceptional(ORW or ERW)?

ORWs are listed in NR 102.10 and include national and state wild and scenic rivers. ERWs are listed in NR102.11. Surface waters, or portions thereof, may be added to, or deleted from, the ORW and ERW designations through the rule making process.

Current ORW and ERW waters can be found here: https://dnr.wisconsin.gov/topic/SurfaceWater/orwerw.html

2. The Assessment Process

2.1 Assessment Cycle Timeline

Each assessment cycle is two years long and begins on April 1 of even numbered years (Figure 1).

Broad steps in the assessment cycle include:

1. Update current assessment guidelines (WisCALM).
2. Solicit public comment on updated WisCALM.
3. Finalize WisCALM.
4. Request public water quality data submittal.
5. Prepare databases and datasets.
6. Assess water quality.
7. Review assessments internally.
8. Compile 303(d) Impaired Waters List.
9. Take public comments on 303(d) List and other assessments.
10. Compile Integrated Report (combination of CWA 305(b), 303(d), and 314 reporting requirements).
11. Submit final lists and report to EPA's ATTAINS data system.

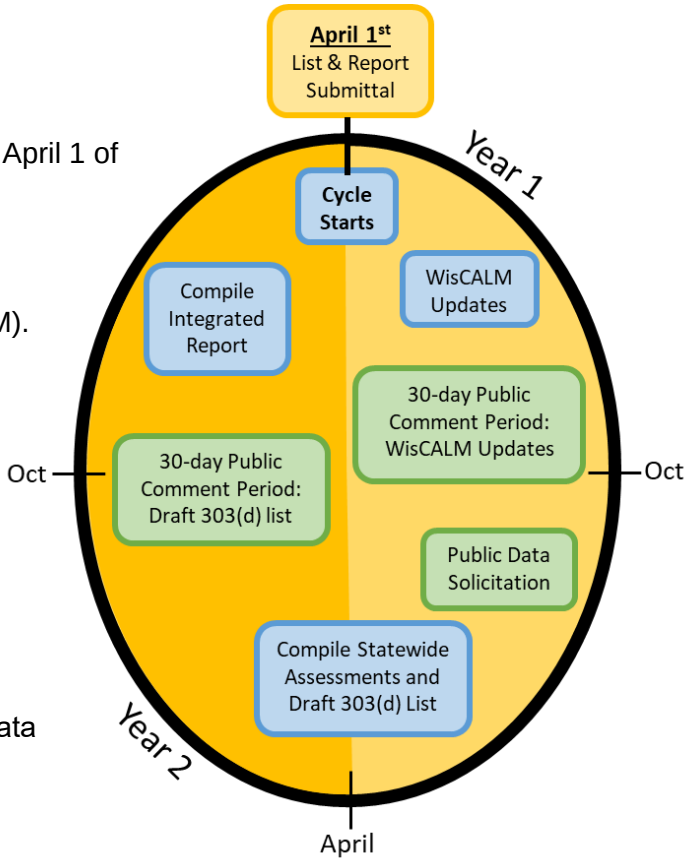


Figure 1. General assessment timeline for Wisconsin's assessment cycles.

During the first year of the assessment cycle assessment guidance is updated, public data are requested, and databases are prepared for running automated assessment packages (description of packages in section 4.2 Automated Assessment Packages). The second year is dedicated to finalizing assessments, obtaining and utilizing public comments on the impaired waters list, and creating the Water Quality Report to Congress (aka the Integrated Report).

The timeline in Figure 1 is a general outline that does not take into consideration extenuating factors that may delay steps.

2.2 Public Participation

WDNR recognizes the importance of public involvement in the assessment, restoration and protection of the state's water resources. Public involvement in the development of the state's Impaired Waters List is required by the CWA and the state's listing program. Several opportunities are provided for public comment on the water quality assessments related to the development of the Impaired Waters List and Integrated Report, including the following:

- Public call for surface water quality data prior to assessments;
- Public comment period on draft assessment methodology;

Water Quality Bureau Staff Directory

Contact information for WDNR staff can be found at https://dnr.wi.gov/staffdir/_newsearch/contactsearchext.aspx You can search by name, county, and topic to narrow down staff contacts.

Waterbody Assessment Inbox

Questions specifically on assessments can be sent to: DNRWYWaterbodyAssessments@wisconsin.gov

- Public comment period on draft water quality assessment determinations;
- Statewide public informational meetings (webinars);
- Informal meetings, as resources allow, with interested parties.

Public comments must be sent to WDNR during the formal comment periods to be considered in the assessment methodology or water quality decisions. However, general questions or comments may be sent to WDNR via the Waterbody Assessment Inbox at any time during the process.

2.2.1 Public Data Solicitation

The WDNR provides an opportunity for the public, partners and stakeholders to submit water quality datasets for inclusion in assessment of waters against water quality standards for the Integrated Report of Water Quality. Submittals of quality-assured datasets meeting minimum requirements for assessment will be used in the development of the Integrated Report. See 3.2 Use of Monitoring Data from Other Sources of this report on use of external data.

2.3 Water Quality Condition Categories and Lists

An assessed waterbody is placed into one of 5 condition categories, also known as integrated report (CWA 305(b)) categories (Figure 2). These categories cover the range of assessment outcomes, from meeting all uses (Category 1) to impaired and in need of a restoration (TMDL) plan (Category 5). The result of a general assessment can only be placement in categories 2 or 3. The result of a full impairment assessment is placement in any of the 5 categories. Category 3 is for waterbodies with insufficient data for a clear general or full assessment, or ambiguous assessment results where an attainment determination cannot be made. Waterbodies where all designated uses have been assessed and found to be supporting are placed in Category 1. Waterbodies where at least one designated use is attained, and no use is impaired, are placed in Category 2 (Table 1).

Water Condition Lists

Find current waterbody categorizations here:

https://dnr.wisconsin.gov/topic/SurfaceWater/ConditionLists.html

Waters with impairments are placed in either category 4 or 5 depending on whether a restoration plan (TMDL or alternative) has been approved by the EPA. Each of these categories has subcategories to further define the type of listing. Category 4 waters, also referred to as Wisconsin's Waters In Restoration List, are subcategorized by restoration plan type (Table 2). Waters on the Impaired Waters List are those in category 5 and are subcategorized by pollutant, source, or restoration plans (Table 3). Further description of these categories and listings can be found in Integrated Report Listing Categorization.

Table 1. Description of category 2 subcategories. These subcategories are based on DNR's need to distinguish determinations based on weight of evidence, i.e., the amount of data that is available. These waters have no known impairment.

Sub-category	Description	Key Defining Factor
2A	An impairment-level assessment was done for at least two designated uses with at least two total parameters.	Strong weight of evidence.
2B	An impairment-level assessment was done for at least one parameter.	Moderate weight of evidence.
2C	A general-level assessment was done for at least one parameter.	Based on a few samples.

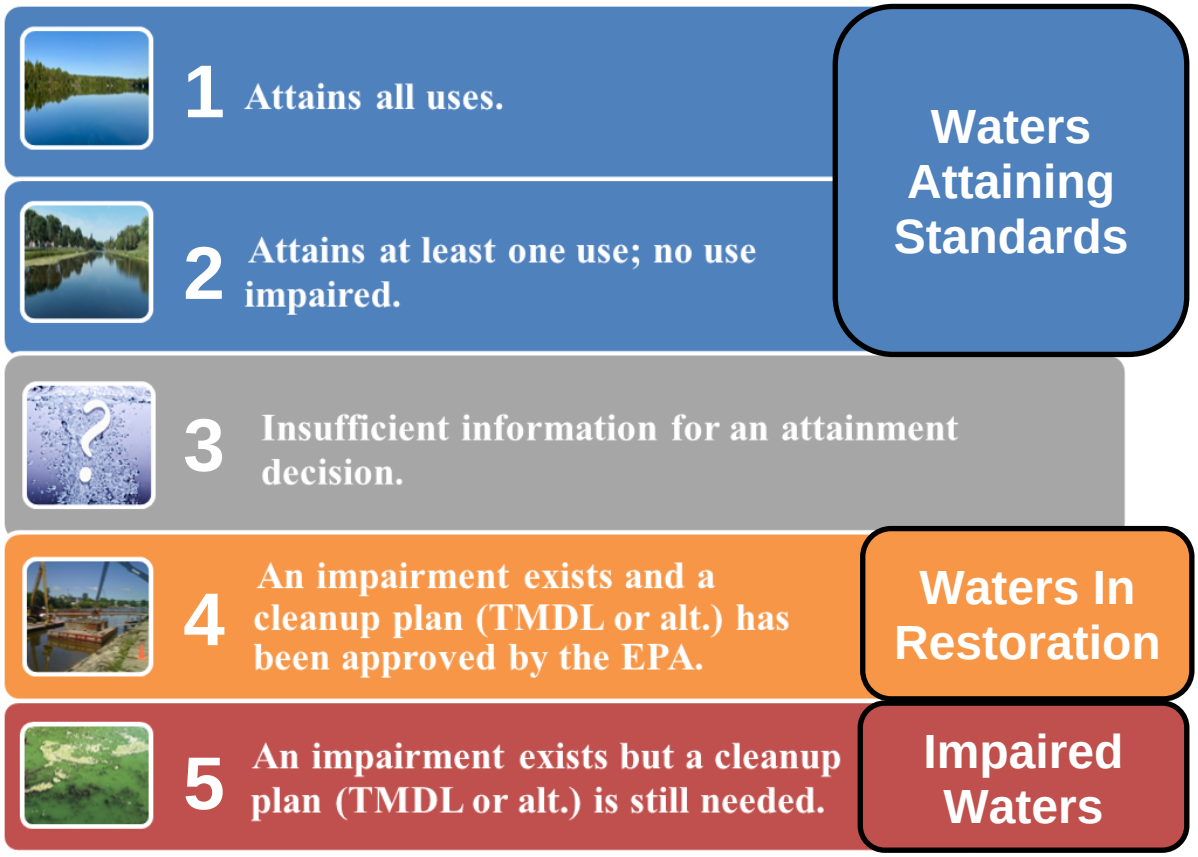


Figure 2. Categorization of waterbodies based on water quality assessments. Categories 1 – 5 align with EPA's CWA 305(b) reporting categories. Impaired waters are defined as those in category 5, which is consistent with all states. Wisconsin defines category 4 waters as its Waters In Restoration List and waters in categories 1 and 2 as its Waters Attaining Standards List.

Table 2. Description of category 4 subcategories. These subcategories are based on those outlined by the EPA. Waters in category 4 are on Wisconsin's Waters In Restoration List because a TMDL or alternative restoration plan has already been created and approved by the EPA.

Sub-category	Description	Key Defining Factor
4A	A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.	TMDL approved or established by EPA.
4B	Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time.	Alternative to TMDL approved by EPA.
4C	The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.	No pollutant.

Table 3. Descriptions of category 5 subcategories. These subcategories are specific to Wisconsin but loosely based on ones outlined by EPA. All waters in category 5 are part of the state's Impaired Waters List, also known as the CWA 303(d) List.

Sub-category	Description	Key Defining Factor
5A	Available information indicates that at least one designated use is not met or is threatened, and/or the anti-degradation policy is not supported. One or more TMDLs are still needed. This is the default category for impaired waters.	TMDL needed. Default subcategory.
5B	Available information indicates that atmospheric deposition of mercury has caused the impairment and no other sources have been identified.	Mercury only.
5C	Available information indicates that non-attainment of water quality standards may be caused by naturally occurring or irreversible human-induced conditions.	Natural or irreversible conditions.
5P	Available information indicates that the applicable total phosphorus criteria are exceeded; however, biological impairment has not been demonstrated (either because bioassessment shows no impairment or because data are not available).	Phosphorus only.
5W	Pollutant/impairment is a low priority for a TMDL because the impaired water is included in a watershed area addressed by at least one of the following 9-Key Element plans: adaptive management plan, adaptive management pilot project, lake management plan, or Clean Water Act Section 319-funded watershed plan.	EPA approved alternative restoration plan.

2.4 General Condition Assessment

General assessments are used to begin assessing whether a waterbody is attaining its assigned designated uses. A general condition assessment can be done with biological and water quality metrics, but is only considered a general assessment because there is insufficient data for a full impairment assessment. Minimum data requirements for each assessment type are available throughout this document. General assessments fulfill part of the CWA 305(b) requirement to evaluate water quality across the state.

WDNR uses four levels of biological conditions to represent water's placement in the overall water quality continuum:

- *Excellent* – Waters are considered to be fully supporting their assessed designated uses.
- *Good or Fair* – Waters are considered to be supporting their assessed designated uses.
- *Poor* – Waters may not support assessed designated use(s) but have insufficient information for a decision at the impairment assessment level.

Waters meeting criteria for any of the chemical, physical, and biological parameters, which include temperature, total phosphorus, and chloride, are considered attaining their assessed designated uses. Waters determined to be in poor condition or exceeding criteria based on a limited amount of monitoring data are considered to have insufficient information for an attainment decision. These waters are further evaluated and may be selected for additional monitoring or, if the limited dataset includes overwhelming evidence of impairment (e.g., large

magnitude of exceedance), it might be considered for Wisconsin's Impaired Waters List based on best professional judgment (section 10.2 Professional Judgment).

2.4.1 General Assessment Categorization

Waters assessed at the general level are placed onto the Waters Attaining Standards List or into Category 3 (insufficient information) (Figure 2). General assessments do not result in impairment listings unless a biologist demonstrates a reason for listing using their best professional judgment (section 10.2 Professional Judgment). General condition assessments that produce 'May Not Support Use' result in the water being placed in Category 3 and are potential follow-up monitoring priorities (Table 4).

Waters that start in Category 2 but have a new general assessment metric that may not support the designated use, will remain in Category 2 until an impairment condition assessment can be done or a decision is made based on best professional judgment.

Table 4. General water condition assessment decisions based on biological and water quality metrics.

Metric		Assessment		
Biological Metrics (TSI[1], mIBI[2], fIBI[2])	**Water Quality Metrics (TP, Temp., Chloride, etc.)**	**Designated Use Support**	**Attainment Decision**	**Category Determination**
Excellent	Meets Criteria	Fully Supports Use	Attaining	Category 2C
Good				
Fair				
Poor[3]	Exceeds Criteria[3]	May Not Support Use	Insufficient Information	Category 3

1. Trophic State Index (Carlson, 1977) based on Secchi, chlorophyll, and satellite-based values.
2. Macroinvertebrate and Fish Indexes of Biotic Integrity (5.2 Stream and River General Assessment).
3. Not enough data to do a full impairment assessment.

2.5 Impairment Condition Assessment

The assessment of whether a waterbody is meeting designated uses requires comparison to applicable water quality criteria or thresholds. This section briefly outlines the concepts of indicators and associated thresholds to measure attainment status of Wisconsin lakes, rivers, and streams. For purposes of this guidance, the term "indicator" is used to describe the various measures of water quality, including those that represent physical, chemical, biological, habitat, and toxicity data. The term "threshold" is used when referring to the numeric value (criterion) or narrative description that distinguishes attainment of the WQS versus values that indicate impairment. In the simplest sense, a waterbody is defined as "impaired" when it is not meeting WQS, including its assigned designated uses.

2.5.1 Key Indicators for Assessments

Detailed assessments are tailored to the specific characteristics of a waterbody. Some assessments will focus upon one key indicator only, whereas others use multiple indicators. Furthermore, a stepwise process of indicator selection may be employed. For example, for assessment of total phosphorus impacts in cases of moderate enrichment, available biological information will be used to determine AL use impairment and place the water in the proper reporting category. However, if phosphorus levels are exceedingly high, biological indicator data are not needed to determine impairment (i.e., the biological impairment is assumed). Assessment indicators are sub-divided into the following categories:

- Conventional physical-chemical
- Toxicity
- Biological

2.5.2 Impairment Thresholds

Impairment thresholds are applied to determine whether waterbodies should be placed on the Impaired Waters List. These thresholds are usually expressed as ambient water concentrations of various substances based on numeric water quality criteria included in chs. NR 102-105, Wis. Adm. Code, WDNR technical documents, and federal guidance (document links found in 12. Quick Link Guide). In some cases, qualitative thresholds based upon narrative standards may be used to make impairment decisions. In those cases, a thoroughly documented analysis of the contextual information should be used in conjunction with professional judgment to collectively support a decision. Impairment thresholds outlined in WisCALM guidance must be in line with the intent of the water quality criteria in code. In some cases, WisCALM lists impairment thresholds for parameters for which water quality criteria have not been promulgated, for example, macroinvertebrate and fish indices of biotic integrity.

For some assessment methods, a single criterion or threshold may not be applicable across all the different waterbody types. For assessments of waters against the statewide total phosphorus criteria, for example, an initial waterbody classification analysis is required to ensure the assessment process applies the correct criteria. For other assessment methods, the WDNR applies the same water quality criterion or threshold across all resource types. An example is the use of the same fish tissue mercury concentration for all our lakes and rivers in the assessment of Fish Consumption Advisories as part of the Public Health and Welfare Use.

2.5.3 Exceedance Frequency

In the context of numeric water quality criteria, *exceedance frequency* refers to the number of times a criterion may be exceeded over a period of time before the water is no longer attaining the criterion and is considered impaired. Allowable exceedance frequencies for criteria contained in Wis. Adm. Code, are outlined in this WisCALM document in the assessment requirements for each parameter.

2.5.4 Water Quality Criteria vs Biological Assessment Thresholds

Water quality criteria (WQC) describe the physical and chemical characteristics that a waterbody needs to meet to support its designated uses. Most often when a parameter does not attain WQC a new “Pollutant” listing is created. In terms of 303(d) listing, Pollutants are substances in a waterbody that cause disruption to normal function (designated uses); these include toxic substances, nutrients, and sediment. Some parameters describe the characteristics of a waterbody but are not considered Pollutants; these include dissolved oxygen (DO), pH, and temperature. When these parameters do not attain WQC then a new “Observed Effect” listing is created. Observed Effect listings are associated with a specific Pollutant, if known. Only water quality criteria for Pollutants are used to set discharge permit limits or to set targets for Total Maximum Daily Load (TMDL) analyses (Table 5).

Biological assessment thresholds describe the condition of the living things within the waterbody, such as plants, fish, aquatic insects, and algae. They are used to determine the health of an aquatic life community and whether designated uses are supported. Aquatic life communities may be impacted by pollutants or by other factors such as physical impacts (stream bank erosion, dams), invasive species, or climate change. Therefore, there are a wide range of actions that may be taken to address biological degradation, commonly including habitat restoration, watershed work, and invasive species management. Whether biological assessment thresholds are codified or in guidance, or are narrative or numeric, they are not

used for setting permit limits. Listings that result from biological assessments are "Observed Effects", also known as "Impairments", and do not determine permit limits or TMDL allocations (Table 5).

In cases where an observed effect has been documented but it is unclear whether a specific pollutant is one of the underlying causes (e.g. available data indicate pollutants are attaining their respective water quality criteria), the department would evaluate what stressors are affecting the waterbody before determining whether to list a specific pollutant as a cause. Stressors may include not only pollutants, but habitat degradation or erosion, invasive species, dams or water levels, or other issues. Although a stressor evaluation may be designed on a case-by-case basis for individual waterbodies, guidance is available from U.S. EPA at: Stressor Identification Guidance Document | Risk Assessment Portal | US EPA.

Table 5. Differences between application of water quality criteria and biological assessment thresholds.

	Used to derive permit limits?	Parameter Examples	Shown on 303(d) list as	Actions toward improvement
Water Quality Criteria (describe the water itself)	Yes	Toxics, Nutrients, Sediment	"Pollutant"	- Permit limits - TMDLs
		DO, pH	"Observed effect" of degradation (aka "Impairment")	- Habitat restoration - Watershed work - Invasive species mgmt. - Site-specific criteria
Biological Assessment Thresholds (describe living things)	No	Plants, fish, insects, algae		

3. Wisconsin's Monitoring Program and Data Management

3.1 Water Quality Monitoring

WDNR's Surface Water Monitoring Strategy directs monitoring efforts in a manner that efficiently addresses the wide variety of information needs, while providing adequate depth of surface water knowledge to support decision making. A *stratified monitoring approach* (see below) to gathering information ensures that the status of Wisconsin's water resources can be determined in a comprehensive manner, without depleting the capacity to conduct in-depth analyses and problem-solving where needed. Monitoring activities are grouped into three types: baseline, prescribed, and local needs, which form the basis of the *integrated reporting process* (Figure 3).

Wisconsin DNR's Water Division Monitoring Strategy is available on WDNR's website at: https://dnr.wisconsin.gov/topic/SurfaceWater/Monitoring.html

3.1.1 Stratified Monitoring Approach

Baseline Monitoring – Statewide

- Trends sites (Lakes, Rivers)

- Probabilistic surveys (Streams, Aquatic Invasive Species (AIS), National Aquatic Resource Surveys (NARS) (coastal condition and wetlands))
- Reference sites (wadeable streams, macrophytes, large river macroinvertebrates)

Prescribed Monitoring – Statewide and District
- Targeted Watershed Approach
- Directed Lake Assessment (including Aquatic Plant Management (APM) and Critical Habitat)
- 319 (non-point) Project Evaluation
- Follow-up for Impaired Waters

Local Needs Monitoring – District Initiated
- Cross program support
- Unique stressors, projects

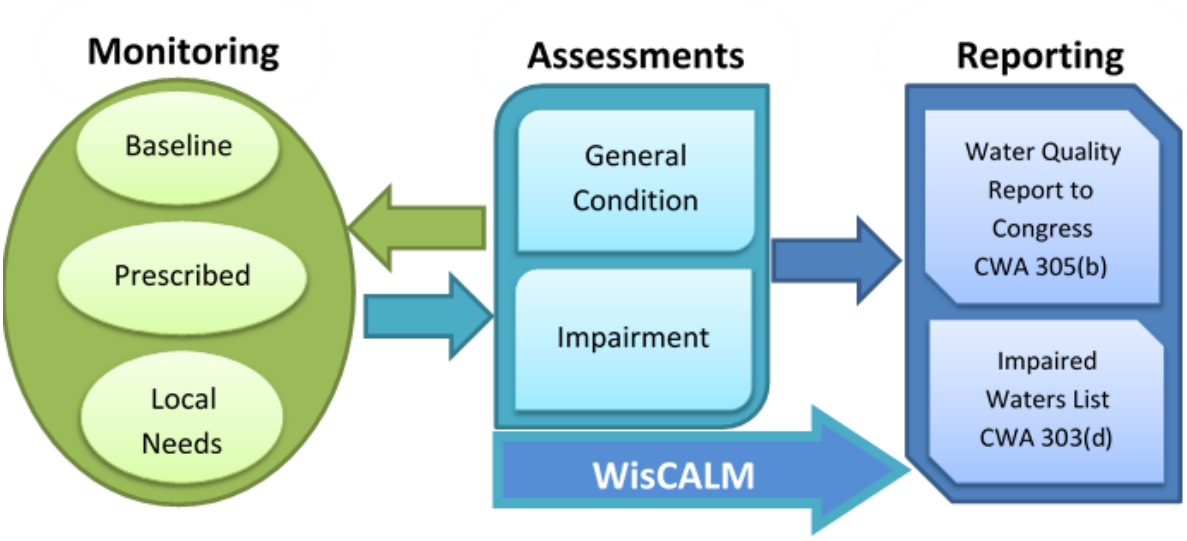


Figure 3. Wisconsin's integrated reporting process.

3.2 Use of Monitoring Data from Other Sources

In addition to Department-generated data, WDNR biennially seeks information from partners and the public to use in its assessment of waterbodies (see Section 4.1, assessment cycle timeline, Figure 1). Partners include: the U.S. Geological Survey, EPA, U.S. Fish and Wildlife Service, other state agencies, universities, regional planning commissions, major municipal sewerage districts, and lake/river/stream local groups. Guidance is provided on how to submit third party data on the WDNR assessment website (https://dnr.wisconsin.gov/topic/SurfaceWater/PublicParticipation.html).

Agencies and individuals submitting data for assessment purposes must meet minimum data requirements, demonstrate that sample collection occurred at appropriate sites, during appropriate periods, and use certified laboratories for sample analysis. If the quality assurance procedures are not adequate, staff may use this data to initiate further investigations by Department staff. If quality assurance procedures are adequate, WDNR may use this data to assess the water for possible impairment listing. Data submitters outside of WDNR are referred to EPA's site for questions on quality assurance project plans at https://www.epa.gov/quality.

WDNR may assist outside groups in the design and implementation of data quality procedures necessary for data to be used for assessments. Department staff will consult with EPA water quality criteria guidance, state WQS, and use professional judgment (10.2 Professional Judgment) to interpret the results of field sampling to determine whether or not WQS are achieved. Groups outside of WDNR who regularly collect and submit data to WDNR may work with staff at Central Office to upload data into the SWIMS database to be considered as part of our evaluation and assessment process.

WDNR also supports Citizen Based Monitoring Programs for rivers, streams, and lakes, including the Citizen Lake Monitoring Network (CLMN) and Water Action Volunteers (WAV). As stated in the WDNR's Water Resources Monitoring Strategy for Wisconsin, "If citizens follow defined methodology and quality assurance procedures, their data will be stored in a Department database and used in the same manner as any Department-collected data for status and trends monitoring defined in the Strategy." Citizen data are currently used for general and impairment water quality assessments, including broad-scale statewide assessments. If these data indicate a potential water quality problem at a specific site, additional data may be collected by Department staff to verify the extent of the problem and determine if a waterbody should be placed on the Impaired Waters List.

3.3 Quality Assurance and Laboratory Analysis

Information used for assessments must be consistent with the WDNR Quality Management Plan or have been obtained using comparable quality assurance procedures. For all baseline monitoring supporting general and statewide assessments, quality assurance measures are described within each applicable chapter of the *2021 – 2025 Wisconsin Water Monitoring Strategy*. WDNR uses only certified laboratories sample analysis, primarily the State Lab of Hygiene and the University of Wisconsin Stevens Point Aquatic Entomology Laboratory. For targeted or special monitoring studies, which are frequently used to discern impairment prior to listing a waterbody, quality assurance protocols, such as field blanks, field duplicates, or lab spikes, are incorporated as warranted and as funds allow.

3.4 Data Management

Well organized and readily accessible data is fundamental to a smooth functioning, scientifically grounded water quality monitoring and assessment program. The WDNR has invested many resources into building and maintaining monitoring and assessment databases.

3.4.1 SWIMS – Monitoring Data

The Surface Water Integrated Monitoring System (SWIMS) is a WDNR information system that holds chemical (e.g., pH, dissolved oxygen), physical (e.g., flow, turbidity), and biological (e.g., macroinvertebrate, aquatic invasive) data.

SWIMS is the state's repository for water and sediment monitoring data collected for CWA work and is the source of data sharing through the federal Water Quality Exchange Network, which is an online federal repository for all states' water monitoring data. Volunteers and partners can directly enter field data into SWIMS. Lab analyzed data enters SWIMS through the Lab Data Entry System (LDES), used by facilities and labs across the state. A link to how the LDES system is accessed can be found here: https://dnr.wi.gov/topic/labServices/labDataTransmittal.html.

3.4.2 WATERS – Waterbody and Assessment Data

The Water Assessment, Tracking and Electronic Reporting System (WATERS) is an internal WDNR data system that includes the following water program items:

- CWA Use Designations and Classifications (chs. NR 102 and 104, Wis. Adm. Code);
- Outstanding and Exceptional Resource Waters Designations (ch. NR 102, Wis. Adm. Code);
- Fisheries Trout Classifications [s. NR1.02(7), Wis. Adm. Code];
- CWA assessment data, including decisions about whether a waterbody is meeting its designated use or is considered "impaired";
- Impaired waters tracking information, including the methodology used for listing, the status of the Total Maximum Daily Load (TMDL) creation, and restoration implementation work;
- Watershed planning recommendations, decisions, and related documents.

3.4.3 ATTAINS – EPA's Assessment Database

The Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) is the federal government's new tracking system for state assessment information. Prior to 2018 all assessment information was sent to the EPA in several formats including paper, CDs, PDFs, and Excel spreadsheets. Older methods of sharing assessment information with EPA including mailing a hard copy have been retired in favor of the ATTAINS system. The DNR's WATERS and SWIMS databases communicate with ATTAINS. More information on the ATTAINS system can be found at EPA's website: https://www.epa.gov/waterdata/attains.

3.5 Total Waters Baseline

Each cycle, DNR reports the percentage of water assessed in the state. In past reports this calculation was done using historical summary numbers of 1.2 million lake acres and 88,000 river and stream miles. Mapping has become more accurate, so a new baseline was created with new geospatial data (Table 6). Individual waterbodies are identified with a Waterbody Identification Code or a WBIC. These summary values will change slightly over time as maps are updated.

Table 6. Total size and count of water types in the state of Wisconsin. The totals are the basis of "percent assessed" calculations. Lake summaries do not include the Great Lakes. River and stream types are based on the Strahler Stream Index (1 – 3 Headwater Streams; 4 – 6 Medium Streams; 7 – 8 Rivers).

LAKES & RESERVOIRS	Acres	Count (WBIC)
ALL	**1,032,373**	16,743
5 acres or greater	1,017,753	7,898
Less than 5 acres	14,621	8,845

STREAMS & RIVERS	Miles	Count (WBIC)
ALL	**85,896**	53,235
Headwater Streams	68,624	52,573
Medium Streams	15,772	762
Rivers	1,499	6

Over half of the state's lakes are less than 5 acres in size. The larger lakes understandably dwarf the acreage of the small lakes. Headwater streams, by size and count, make up the majority of streams in the state. Most new stream miles will be headwater streams.

For assessment purposes each waterbody or segments of the waterbody are given Assessment Unit (AU) IDs. Rivers and streams are often segmented into several AUs because natural conditions can be different throughout the length of a waterbody. When reporting on the number of waterbodies listed the count of AUs is used because there may be portions of a WBIC not yet assessed. For information on AUs please see section 4.3 Assessment Unit Delineation.

4. General Aspects of Data Assessment

4.1 Data Requirements

By establishing data requirements, WDNR staff collect representative data as efficiently as possible with limited staff and fiscal resources and use those data in a manner that minimizes the chance of incorrectly characterizing the attainment status of a particular water. Minimum data requirements have been established for the following aspects.

4.1.1 Period of Record

Generally, data from the most recent 5-year period are considered when assessing waters but an extension to the most recent 10-year period may be considered to ensure that the data are representative of a wide range of factors that affect water quality (i.e., weather, flow). When there is insufficient data available in the 5-year period then data will be taken from the 10-year period, the most recent data first. Staff may determine that older data within the 10-year period are no longer representative of recent conditions, based on considerations of significant changes at the watershed or local scale, such as changes in land use, nonpoint source controls, or the amount of pollutants discharged from point sources.

Table 7. Date range for data used each assessment cycle. This 5 and 10-year pattern is consistent back to the 1998 list.

Assessment Cycle	Period of Record (5-Year)	Period of Record (10-Year)
2028	2022 - 2026	2017 - 2026
2026	2020 - 2024	2015 - 2024
2024	2018 – 2022	2013 – 2022
2022	2016 – 2020	2011 – 2020
2020	2014 – 2018	2009 – 2018
2018	2012 – 2016	2007 – 2016
2016	2010 – 2014	2005 – 2014
2014	2008 – 2012	2003 – 2012

Assessment Cycle	Period of Record (5-Year)	Period of Record (10-Year)
2012	2006 – 2010	2001 – 2010
2010	2004 – 2008	1999 – 2008
2008	2002 – 2006	1997 – 2006
2006	2000 – 2004	1995 – 2004
2004	1998 – 2002	1993 – 2002
2002	1996 – 2000	1991 – 2000
2000	1994 – 1998	1989 – 1998
1998	1992 – 1996	1987 – 1996

4.1.2 Sampling Period

The WisCALM guidance document identifies the appropriate sampling period for each parameter and waterbody type. The determination of appropriate sampling period is based on seasonal variability in pollutant levels and corresponding ecological responses. Further parameter and waterbody specific details on sampling periods are included in each of the sections.

4.1.3 Representative Data

Sampling Protocol: Individual data points must have been collected according to parameter-specific protocols. Prescheduled sampling designs are often used for 305(b)/303(d)-related monitoring in order to randomly capture the range of conditions. In these cases, targeted samples that are collected for other purposes (e.g., monitoring targeted during runoff events) should not be incorporated into the 305(b)/303(d) assessment datasets. In other cases, weather and hydrologic conditions must match intended conditions specified in the sampling protocols.

For example, biological samples should be collected during base flow, not following a runoff or scouring flow event, to ensure the sample is representative of normal conditions.

Lab Quality Assurance: water quality samples analyzed by a lab are accompanied by quality assurance comments. Comments indicating issues with analysis or missing field information (e.g., no date) are considered when determining if a sample is representative. Samples labeled 'duplicate' or 'field blank' are not used; these samples are filtered out of the process by the automated assessment packages.

Extreme Weather Years: Chemical and biological parameters are likely to be affected by extreme weather conditions. If a prescribed sampling schedule falls during an extreme weather year, exhibiting unusual average air temperature, precipitation, stream flow or water levels, a determination should be made as to whether that year was an extreme weather year that resulted in unrepresentative conditions. As a very general guideline, an extreme weather year may be defined as a year where precipitation, flow, stage/elevation, and/or temperature are above the 90th or below the 10th percentile of the annual averages within the period of record. Staff may use a combination of the following sources to document their determination of whether data were collected from a particular waterbody during an extreme weather year:

- Climate data from nearest regional weather station(s);
- Regional stream stage/flow gage(s);
- Indices of drought severity (e.g., Palmer Drought Severity Index, U.S. Drought Monitor).

If it is determined that a year was an extreme weather year resulting in unrepresentative conditions, that year's data points should not be excluded, but rather should be supplemented with data from an additional year of monitoring. In this case, combined data from a minimum of two years should be used for assessments to account for variability between years. Gaps in assessment datasets left when samples are determined to be unrepresentative should be filled by either collecting additional data or considering data from outside the standard period of record.

Best professional judgment may be used to determine whether data were collected from an extreme weather year and are considered unrepresentative of normal conditions. For instance, a region may be experiencing drought, but stream flow may not be impacted significantly for those streams that are dominated by groundwater flows.

"Evaluated" Information: Information that is not considered representative of current conditions or was not collected according to WDNR's Quality Management Plan cannot be used in preparation of the Impaired Waters List. WDNR classifies these types of data as "evaluated" information, which may include:

- Information provided by groups, other agencies or individuals where collection methods are not documented and thus the data quality cannot be assured;
- Projected surface water conditions based on changes in land use with no corresponding in-water data (i.e., desktop analyses or models);
- Visual observations that are not part of a structured evaluation;
- Anecdotal reports.

Though not used directly to update the impaired waters list, "evaluated" data may potentially be used to identify areas where further monitoring may be needed for future assessment cycles.

Sample Type: The indicator being evaluated will dictate what type of samples should be used for an assessment decision. In some cases, samples may be collected as instantaneous measurements vs. continuous measurements. In other cases, the choice may be between a

grab sample and a composite sample. In either case, the selection of the values should result in using the most representative data available.

Sample Size: This document outlines sample sizes that appropriately and efficiently represent existing and relevant conditions. Sample size requirements differ by water body type and parameter. The number of samples required is commensurate with the inherent sampling error and annual variation of the parameter measured. Available representative data should be reviewed to ensure that the minimum data requirements are met. However, a waterbody may be listed as impaired despite minimum sample size not being achieved if overwhelming evidence of impairment exists (see Ch. 10.2, Professional Judgment).

4.2 Automated Assessment Packages

There is a large amount of water quality and biological data available for the waters across the state. Automated assessment packages were created to reduce error and assess more waters. These packages are automated in that computer code is written to follow all assessment guidelines outlined in this WisCALM document. Data are drawn from the state's SWIMS database. Assessment packages are specific to parameter and waterbody type. Each cycle these packages are checked to confirm compliance with the current WisCALM protocols. These are the current parameter assessment packages used:

- Total Phosphorus – Lake/Reservoir
- Total Phosphorus – River/Stream
- Temperature – River/Stream
- Chloride - all
- *E. coli* – all and beaches
- Fish IBI, Wadable – River/Stream*
- Chlorophyll-*a* – Lake/Reservoir (REC)
- Chlorophyll-*a* – Lake/Reservoir (AL)
- Macroinvertebrate IBI, Wadable – River/Stream
- Macroinvertebrate IBI, Non-Wadable – River/Stream
- Trophic State Index (TSI) – Lake/Reservoir
- Fish IBI, Non-wadable – River/Stream*

*Requires manual data transfer and manipulation (process update in progress).

The results from these automated assessment packages are uploaded to the SWIMS database and the WATERS internal assessment review tool.

4.3 Assessment Unit Delineation

Assessment units (AUs) represent the spatial area that data can be associated with for the purpose of categorizing a waterbody or developing management goals. Data collected within an assessment unit's boundaries may be compared when determining the health of a waterbody. When working on a project for a specific waterbody, such as assessing its monitoring data or developing a TMDL, it may be necessary to split an existing AU for efficiency and practicality.

The following are guidelines DNR staff consider when determining breakpoints between AUs.

Change in Natural Community classification and/or codified designated uses: Natural Communities (NCs) are assemblages of specific plant and animal species within a specific habitat. A waterbody's NC determines the type of assessment done. Other pertinent classifications may also be considered, such as trout fishery classifications.

- EXAMPLE: NC verification shows a current AU that has two different NCs, which means one portion is not representative of the other.

Change in flow or assimilative capacity of waterbody: Flow is important because it impacts assimilative capacity, a waterbody's ability to carry pollutants without adverse impacts. Compliance points are also often determined just upstream of major changes in flow or assimilative capacity.

- EXAMPLE: Where a significant tributary joins a stream; or where a permittee's discharge significantly changes the flow or the concentration of the pollutant of concern.

Change in criteria: A breakpoint may be warranted if the assessed pollutant's criteria changes.

- EXAMPLE: A stream's Total Phosphorus (TP) criterion changes from 75 µg/l to 100 µg/L; a stream flows into a lake with a lower criterion; a site specific criterion has been established; or there are variances to water quality criteria (such as listed in Ch. NR 104 Wis. Adm. Code).

Major Land Use changes: land use changes that may alter the pollutant load or habitat being assessed.

- EXAMPLE: Major change in farming practices; rural to urban changes.

Best Professional Judgment: use professional judgment to account for other natural habitat changes or anthropogenic modifications that might be unique to the water being assessed.

- EXAMPLE: Major stream bed changes (e.g., from gravel to silt, or natural to concrete).

4.4 Lake Classification

WDNR classifies or groups similar lake types based upon physical data. Specifically, lake size, stratification characteristics, hydrology and watershed size are identified as the primary influences on a lake and, to a large degree, these characteristics determine the natural biological communities each lake type supports. Using this information, lakes and reservoirs should fall into one of ten natural community types (Table 8).

The WDNR recognizes that lakes may vary geographically. Spatial data are available for each of the lakes. Regional differences in soils, climate and land use may explain additional variation in the bio-indicator metrics used in the classification of lakes[4]. However, WDNR has determined that lake size, hydrology and depth are more critical factors for initial classification of lakes, and that regional differences are secondary.

For most lakes, the WDNR's automated data packages, that are performed by SWIMS and presented in WATERS, determine which natural community and which impairment thresholds are appropriate based on the parameters described below. However, if the biologist has information to suggest that a lake's automatically assigned natural community is inaccurate or not representative of the lake, a change to the natural community may be made if reasons for the change are documented. If a Partial Lake Listing is being considered, which is further described below, a different Natural Community may be assigned to the portion of the lake being considered for a Partial Lake Listing based on site characteristics that are significantly different from those in the rest of the lake.

Reservoirs –Section NR 102.03(4s) of Wis. Admin. Code defines a reservoir as "a waterbody with a constructed outlet structure intended to impound water and raise the depth of the water by more than two times relative to the conditions prior to construction of the dam, and that has a mean water residence time of 14 days or more under summer mean flow conditions using information collected over or derived for a 30 year period." Biologists may employ multiple sampling stations on reservoirs to provide more representative data.

[4] Past Wisconsin studies have used eco-regions to explain landscape variability and EPA has proposed using this framework for assessment (Omernik 1987).

Reservoirs are further subdivided into their relevant lake natural community type: shallow headwater, shallow lowland, deep headwater or deep lowland. The seepage lake categories do not apply, as reservoirs always have an outlet stream (i.e. are drainage lakes).

"Reservoirs" are distinguished from a similar category, "Impounded flowing waters," which both have a dam. However, an impounded flowing water behaves more like a river than a lake, with water flowing through it quickly (days vs years). Impounded flowing waters are described in more detail in section 4.6.3 Impounded Flowing Waters.

Table 8. Lake and reservoir natural communities and defining characteristics.

Natural Community	Stratification Status	Hydrology
Lakes/Reservoirs <10 acres		
• Small	Variable	Any
Lakes/Reservoirs ≥10 acres		
• Shallow Seepage	Mixed	Seepage
• Shallow Headwater		Headwater Drainage
• Shallow Lowland		Lowland Drainage
• Deep Seepage	Stratified	Seepage
• Deep Headwater		Headwater Drainage
• Deep Lowland		Lowland Drainage
Other Classification (any size)		
• Spring Ponds	Variable	Spring Hydrology
• Two-Story Fishery Lakes	Stratified	Any
• Impounded Flowing Waters	Variable	Headwater or Lowland Drainage

4.4.1 Size: Small vs. Large

Lake classification begins by first separating lakes into those 10 acres and greater and those less than 10 acres.

Small Lakes – Lakes less than 10 acres are classified into the Small Lake community. These lakes are different from communities in larger lakes, and there is limited monitoring data available in Wisconsin. Because data for lakes less than 10 acres is so limited, it is difficult to set quality thresholds for assessment. Currently, there are very few thresholds set for water quality, fisheries, or aquatic plants for lakes less than 10 acres[5]. To address these small lakes in the future, Wisconsin may look to emerging wetland assessment tools for guidance.

Large Lakes – Lakes 10 acres or more are classified as Large Lakes. Large Lakes are further subdivided, by stratification status, hydrology, and watershed size, as shown below.

4.4.2 Stratification Status: Shallow (Unstratified or Mixed) vs. Deep (Stratified)

Lakes that are 10 acres or greater may be further characterized by their tendency to mix or stratify thermally. Stratification is an important factor in determining overall lake water quality and availability of suitable habitat for fish and aquatic life. An equation developed by WDNR Researchers (Lathrop and Lillie, 1980) is used by WDNR to identify whether a lake is

[5] Total Phosphorus criteria apply to lakes of five acres and larger.

categorized as Deep (Stratified) or Shallow (Unstratified or Mixed)[6]. Although this model is used to automatically generate lake classifications from the WDNR database, use of field data on depth, area, residence time, and temperature profiles to refine the model-based lake classifications is encouraged.

The Lathrop/Lillie equation is represented by a ratio calculated as follows:

$$\frac{\text{Maximum Depth (meters)} - 0.1}{\text{Log 10 Lake Area (hectares)}} \quad \text{or} \quad \frac{\text{Maximum Depth (feet)}*0.3048 - 0.1}{\text{Log 10 (Lake Area (acres)}*0.40469)}$$

Shallow (Unstratified or Mixed) – When using the Lathrop/Lillie Equation, any value less than or equal to 3.8 predicts a mixed lake, which is placed in the Shallow category (Figure 4 A). Mixed lakes (Figure 4 B) tend to be shallow, well-oxygenated, and may be impacted by sediment re-suspension. In addition, shallow lakes have the potential to support rooted aquatic plants across the entire bottom of the lake (Figure 4A).

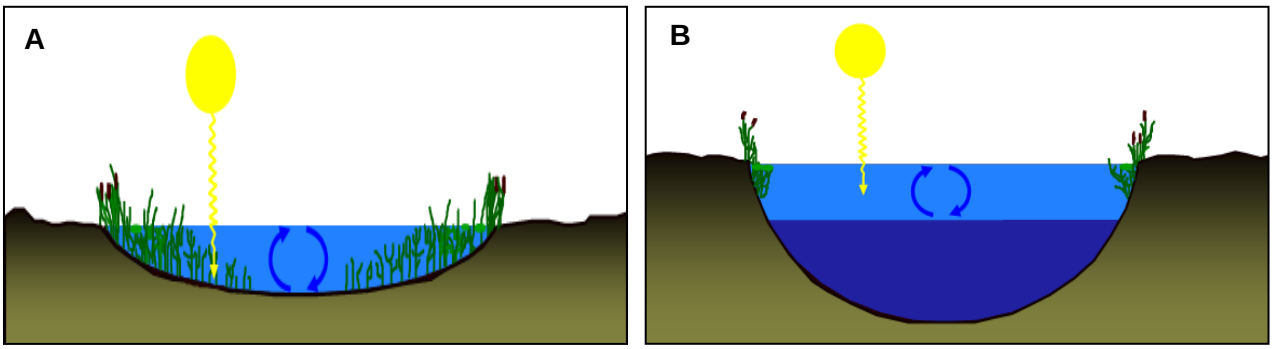


Figure 4. Illustrations of (A) a shallow, mixed lake and (B) a deep, stratified lake.

Deep (Stratified) –When using the Lathrop/Lillie Equation, any value greater than 3.8 predicts a stratified lake, which is placed in the Deep category. Stratified lakes tend to be deep, with a cold-water refuge for fish, and the potential for anoxic conditions (without oxygen) in the bottom layer which may release nutrients from sediments into the water column. Aquatic plants are typically confined to shallow (littoral) waters around the perimeter of the lake (Figure 4B). Stratified lakes exhibit thermal layering throughout the summer, or they undergo intermittent stratification.

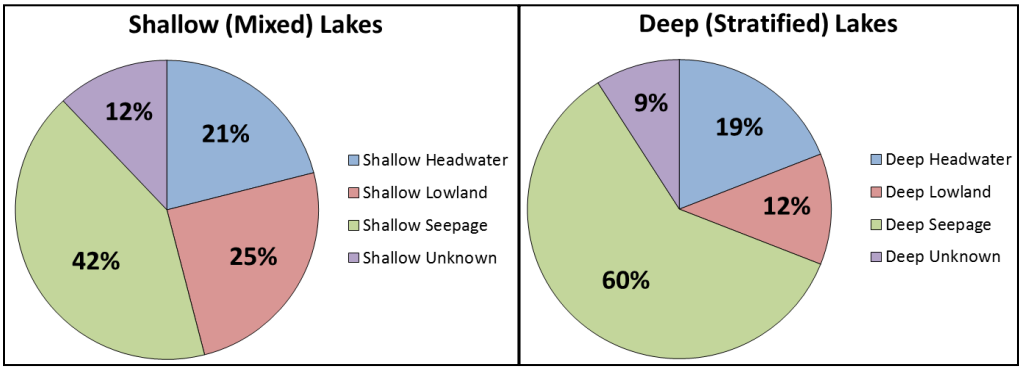


Figure 5. Distribution of Shallow and Deep lake types, greater than 10 acres. For unknown lake types a piece of information, like watershed size, is missing.

[6] WDNR's decision to use the Lillie/Lathrop equation to determine stratification status also examined several other models for predicting lake stratification based on depth and area. These included work by Emmons et al. (1999), the Osgood Index (Osgood 1988), a Minnesota "lake geometry ratio" (Heiskary and Wilson 2005) and a model by WDNR Researchers (Lathrop and Lillie, 1980). The Lathrop/Lillie Equation was selected because it better distinguishes between clearly stratified and mixed lakes.

4.4.3 *Hydrology and Watershed Size*

Lake hydrology is the measure of the relative inflow/outflow of surface water compared to direct precipitation and groundwater inputs. Lake hydrology and lake watershed size are two other critical factors in lake classification. Both Deep and Shallow Lakes are further divided based on hydrology. The terms “seepage” or “drainage” are best used to describe the appropriate hydrologic category for lakes.

Seepage Lakes – Seepage lakes receive their water from precipitation, groundwater, and runoff from the watershed (Figure 6). Seepage lakes do not have a perennial outlet but may have an intermittent outlet.

Drainage Lakes – Drainage lakes receive most of their water from a river or stream and have a perennial outlet (Figure 6). Impoundments and reservoirs, which are formed by damming a stream or river, are drainage lakes.

Specifically for application of phosphorus criteria, a perennial outlet is an outlet stream that continually flows under average summer conditions based on the past 30 years, as per Wisconsin Administrative Code NR 102.06 definitions of drainage and seepage lakes.

Drainage lakes tend to have more variable water quality and nutrient levels, depending upon the amount of land area drained by the lake’s watershed. For this reason, watershed size also plays a key role in the classification of Drainage Lakes (Emmons, et al, 1999). Drainage lakes are subdivided by watershed size as follows:

- Headwater Drainage Lakes: If the watershed draining to the lake is less than 4 square miles, the lake is classified as a Headwater Drainage Lake.
- Lowland Drainage Lakes: If the watershed draining to the lake is greater than or equal to 4 square miles, the lake is classified as a Lowland Drainage Lake.

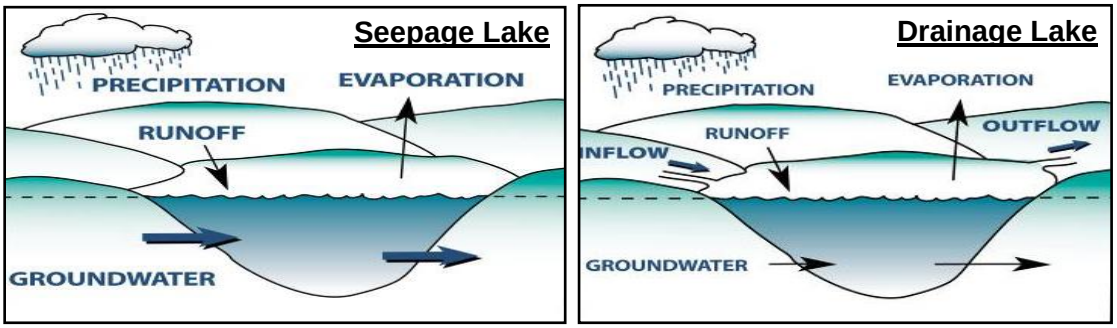


Figure 6. Hydrology of a seepage lake versus a drainage lake.

4.4.4 *Other Classifications (any size)*

Two other classes representing unique natural communities are recognized in this classification scheme: Spring Ponds and Two Story Fishery Lakes.

Spring Ponds –Spring ponds typically contain cold surface water and support coldwater fish species and are most often shallow headwater lakes. In order to be included in this category there should be documentation of a current or historical cold-water fishery (e.g., stream trout) and evidence of spring hydrology.

Two Story Fishery Lakes – Two-story fishery lakes are often more than 50 feet deep and are always stratified in the summer. They have the potential for an oxygenated hypolimnion during summer stratification and therefore the potential to support coldwater fish species in the hypolimnion. In order to be included in this category, a lake should meet the definition of "stratified" (Lathrop/Lillie equation value >3.8), be greater than five acres, and support a coldwater fishery. Supporting a coldwater fishery may either be demonstrated through documentation of a current or historical native cold-water fishery (e.g., cisco, lake trout), or verification with DNR fisheries biologists that the lake is on a long-term stocking plan for coldwater species, where the individuals have good year-to-year survival.

4.5 Selecting Representative Lake Stations

Station selection is determined by the regional DNR biologist.

4.5.1 Station Locations: Selecting representative stations for assessment

For the majority of lakes, a single "Deepest Spot" station has been selected for use in the automated assessment packages. If more than one station is designated in SWIMS as "Deepest Spot," the assessment packages will use both.

Lakes with multiple stations: Reservoirs, multi-lobed lakes, and very large lakes may not have a Deepest Spot station and/or may need more than one sampling station to accurately characterize the lake's morphology and to assess the lake. In these cases, staff use the following guidelines to determine which stations should be selected for assessments:

- Typically, between one and five stations are chosen to be representative of lake conditions, depending on the size and character of the lake.
- Only 'active' stations that have data from within the past ten years are selected.
- For **very large lakes** (Figure 8), well-spaced stations that are representative of the entire lake are selected.
- For **reservoirs/impoundments** (Figure 7), stations that are roughly equally spaced along the thalweg (the deepest channel along the river line) are selected. Data from stations in flowing portions near the upstream entry point of the river may be disregarded for this type of assessment.
- For **lobed lakes**,
    - if there are **multiple "deepest" spots** (Figure 10), a station for each deep spot is selected.
    - if there is **one deepest spot** but it is not representative of the entire lake (Figure 9), the deep spot, as well as other stations, are selected.

For lakes with multiple stations selected, the assessment results for each station will be shown individually. Note: The maps below are for illustrative purposes only; the stations shown may not be the most representative stations available.

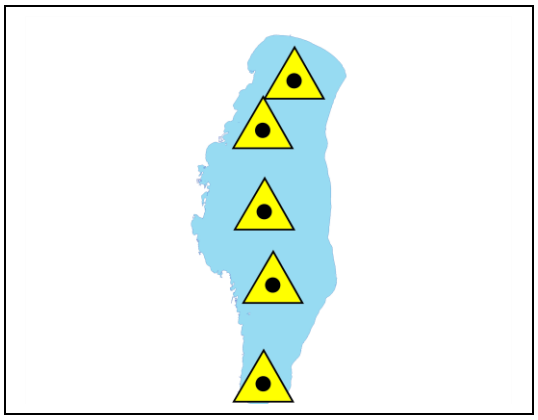


Figure 8. Large Lakes: Select well-spaced stations throughout lake.
Example: Lake Winnebago

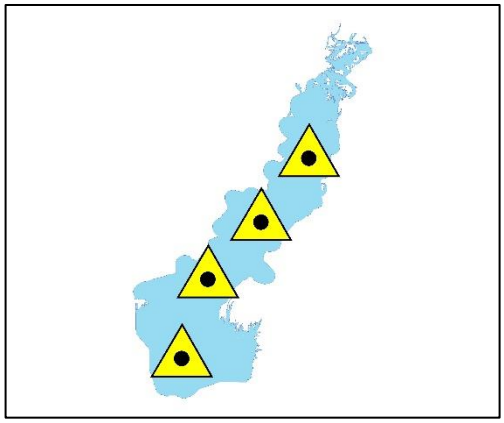


Figure 7. Reservoir/Impoundments: Select stations along the deepest channel.
Example: Lake Petenwell, Juneau County

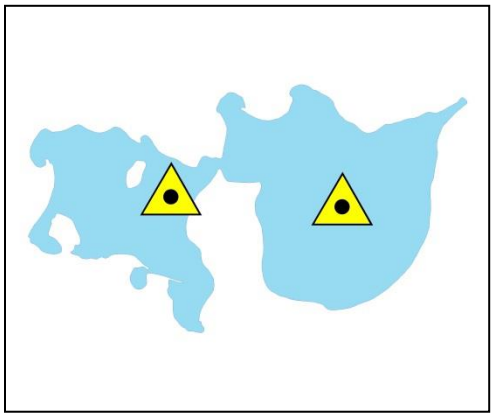


Figure 10. Lobed Lakes with multiple deep holes: One station per deep hole.
Example: Two Sisters Lake, Oneida County

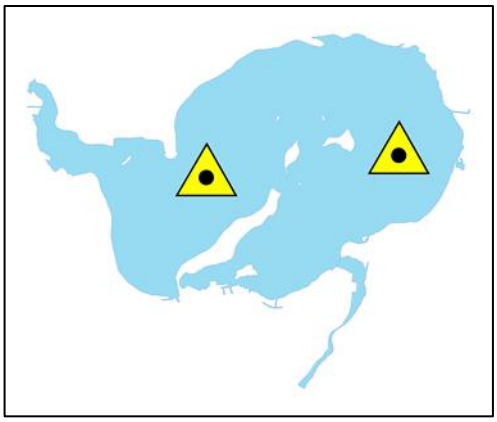


Figure 9. Lobed Lakes with one deep hole: Use Deep Hole station and another station representative of shallower area.
Example: Fox Lake, Dodge County

4.5.2 Whole Lake vs. Partial Lake Assessment

As a general rule, a lake is a mixed system that functions as a single, contiguous unit. Therefore, in the vast majority of situations where there are multiple stations used for assessments, if one station is impaired on the lake, the whole lake would be listed as impaired. However, in cases where a known or suspected localized pollution source is believed to cause impairment in only one portion of a lake (such as an isolated bay or well-defined lobe), biologists may consider assessing and listing that portion as impaired separate from the larger lake.

In cases where Partial Lake Assessments and/or Partial Lake Impairment Listing are warranted, the portion of the lake under consideration should be delineated as a separate Assessment Unit to differentiate it from the larger part of the lake. This is typically warranted when the geography of the lake is such that there is a physical barrier separating most of one portion of the lake from the main portion. In such cases, the partial lake area will typically be assigned its own Natural Community, which may differ from the greater lake.

For Partial-Lake assessments, a sampling station should be added that is representative of the partial-lake area. Such a station should be situated in open water, so that samples are not taken near-shore or in an effluent plume but in ambient lake water within the vicinity of the suspected source of the problem.

Partial Lake Impairment Listings

In cases where a localized pollution source is believed to cause impairment in only one portion of a lake biologists may consider listing only that portion of the lake as impaired using the appropriate Natural Community threshold. However, if, for instance, one area of a lake is experiencing high algae concentrations due to algae that are being produced throughout the lake but are blown by the wind to a particular area, this would be considered a whole lake problem and partial lake listing would not be appropriate.

4.6 Stream and River Classifications

The condition of streams and rivers in Wisconsin are currently assessed for the following use designations: Aquatic Life, Recreation, Public Health and Welfare (Fish Consumption), and Wildlife Uses. The following provides details on the classifications and water quality goals against which waters are assessed.

4.6.1 Aquatic Life: Stream and River Classifications

Assignment of designated uses for the protection of fish and aquatic life has been an iterative process dating back to the late 1960's. Many of the designated uses that are included in the Wis. Adm. Code date back to the 1980's. While efforts are underway to revise AL use subcategories, the current codified AL use designation subcategories in ch. NR 102, Wis. Adm. Code will be used for evaluating WQS attainment status. As defined in s. NR 102.04(3), Wis. Adm. Code, Wisconsin's Aquatic Life (AL) use designations for streams and rivers are categorized into the following subcategories:

Coldwater (Cold) Community: Streams capable of supporting a cold-water sport fishery or serving as a spawning area for salmonids and other cold-water fish species. Representative aquatic life communities associated with these waters generally require cold temperatures and concentrations of DO that remain above 6 mg/L. Since these waters are capable of supporting natural reproduction, a minimum DO concentration of 7 mg/L is required during times of active spawning and support of early life stages of newly hatched fish.

Warmwater Sport Fish (WWSF) Community: Streams capable of supporting a warm water-dependent sport fishery. Representative aquatic life communities associated with these waters generally require cool or warm temperatures and concentrations of DO that do not drop below 5 mg/L.

Warmwater Forage Fish (WWFF) Community: Streams capable of supporting a warm water-dependent forage fishery. Representative aquatic life communities associated with these waters generally require cool or warm temperatures and concentrations of DO that do not drop below 5 mg/L.

Limited Forage Fish (LFF) Community: Streams capable of supporting small populations of forage fish or macroinvertebrates that are tolerant of organic pollution. Typically limited due to naturally poor water quality or habitat deficiencies. Representative aquatic life communities associated with these waters generally require warm temperatures and concentrations of DO that remain above 3 mg/L.

Limited Aquatic Life (LAL) Community: Streams capable of supporting macroinvertebrates but do not have the potential to maintain a fish community. Typically, this category includes small streams with very low-flow and very limited habitat. Certain marshy ditches, concrete line-drainage channels, and other intermittent streams. Representative aquatic life communities associated with these waters are tolerant of many extreme conditions, and require concentrations of DO that remain above 1 mg/L.

Aquatic Life use designations for individual waters are defined in chs. NR 102 or 104, Wis. Adm. Code. In some cases, coldwater fish communities referenced in the 1980 Trout Book (Wisconsin Trout Streams – Publication 6-3600(80)) may be *codified by reference.* Waters that are not referenced in code are considered *default* AL waters and are assumed to support either a coldwater community or warmwater community depending on water temperature and habitat.

4.6.2 Natural Communities

Streams and rivers are evaluated for placement in a revised AL use classification system (currently non-codified), in which the AL use subclasses are referred to as *Natural Communities*. Natural Communities are defined for streams and rivers using model-predicted flow and temperature ranges associated with specific fish and/or macroinvertebrate communities (Table 9). This model developed by the USGS and WDNR Science Services research staff generated proposed stream natural communities based on a variety of base data layers at various scales. The Natural Communities data layer for Wisconsin rivers and streams identifies which fish index of biological integrity (F-IBI, 5.2 Stream and River General Assessment) to apply when assessing our waters. The following Natural Communities have been defined:

Macroinvertebrate: very small, almost always intermittent streams (i.e., cease flow for part of the year, although water may remain in the channel) with a wide range of summer temperatures. No or few fish (< 25 per 100 m of wetted length) are present, but a variety of aquatic invertebrates may be common, at least seasonally.

Coldwater: small to large perennial streams with cold summer water temperatures.

Cool-Cold Headwater: small, usually perennial streams with cool to cold summer water temperatures.

Cool-Cold Mainstem: moderate to large but still wadeable perennial streams with cool to cold summer water temperatures.

Cool-Warm Headwater: small, sometimes intermittent streams with cool to warm summer temperatures.

Cool-Warm Mainstem: moderate to large but still wadeable perennial streams with cool to warm summer temperatures.

Warm Headwater: small, usually intermittent streams with warm summer temperatures.

Warm Mainstem: moderate to large but still wadeable perennial streams with warm summer temperatures.

Large Rivers: non-wadeable large to very-large rivers. Summer water temperatures are almost always cool-warm or warm, although reaches are identified based strictly on flow.

Segments are initially classified into Natural Communities based on landscape-scale statistical models that predict long-term flows and temperatures from watershed characteristics such as

watershed size, surficial and bedrock geology, topography, climate, and land cover. These predictions represent the most likely Natural Community in the absence of significant site-specific human impacts, such as local riparian degradation. The Natural Community model is occasionally updated, and the most current model is used to classify streams that do not have monitored data. In independent validation tests, the models were found to be largely unbiased and to predict the correct Natural Community for about 70-75% of test segments.

Field verification of a site's modeled Natural Community is done at each site where a fish survey is conducted. If the modeled prediction was incorrect, the classification will be corrected at this stage. This is important for ensuring that the appropriate IBI is applied and bioassessment results are accurate. A separate document is in development to provide guidelines on validating or correcting a modeled Natural Community Classification, including the types of data that should be collected, how the data should be interpreted, and how new classifications should be determined.

Table 9. Stream Aquatic Life Use (AL) designations are further sub-divided into natural communities based on flow, temperature, and the types of fish species that typically live in streams with those flows and temperatures.

Natural Community	Maximum Daily Mean Water Temperature	Annual 90% Exceedance Flow*	Flow-Based Fish Community			Temperature-Based Fish Community		
			small-stream	medium-stream	large-river	cold-water	transitional	warm-water
	(˚F)	(ft^3/s)	Percent of individuals			Percent of individuals		
Macroinvertebrate	Any	0.0–0.03	< 25 total individuals per 100 meters of wetted length					
Coldwater	< 69.3	0.03–150	Any			> 25	< 75	< 5
Cool-Cold Headwater	69.3–72.5	0.03–3.0	> 50	< 50	< 10	< 75	> 25	< 25
Cool-Cold Mainstem	69.3–72.5	3.0–150	< 50	> 50	< 50			
Cool-Warm Headwater	72.6–76.3	0.03–3.0				< 25		
Cool-Warm Mainstem	72.6–76.3	3.0–150					25–75	< 75
Warm Headwater	> 76.3	0.03–3.0	> 50	< 50	< 10	< 5	< 25	Any
Warm Mainstem	> 76.3	3.0–150	< 50	> 50	< 50			> 75
Large River	Any	> 150	< 10	< 25	> 75			

*Exceedance flow represents baseflow as the daily average flow measurement where 90% of all flow measurements are larger.

4.6.3 Impounded Flowing Waters

An impounded flowing water is a waterbody impounded by a constructed outlet structure on a river or stream that is not a reservoir (NR 102.03(1q)). These waters have a water residence time of less than 14 days. Impounded flowing waters are lotic in nature and are evaluated using the river and stream criteria that apply to the primary stream or river entering the impounded water. Biological response metrics include metrics that are typically used for lakes, such as chlorophyll-*a*.

4.7 Selecting Representative Stream & River Stations

Station Locations: Selecting representative stations for assessment

Station selection is determined by the regional DNR biologist. In general, most river and stream stations are used for water quality assessments, so long as they are representative of the river or stream segment as a whole.

The following are reasons a river or stream site may not be representative. Station is:

- Near a discharger outfall before pollutants have mixed;
- Within a half mile of lake or reservoir outlet;
- Positioned outside area of water flow (e.g., an eddy, pool, or side channel);
- Not an appropriate station type (Beach, Boat Launch, Facility).

Station selection is based on best professional judgment of the biologists; more information on professional judgment is available in section 10.2 Professional Judgment.

5. General Condition Assessment – Aquatic Life Use

5.1 Lake General Assessment

Wisconsin bases its General Condition Assessment for lakes on multiple metrics including the Carlson Trophic State Index (TSI) (Carlson, 1977), water chemistry, and physical measures.

5.1.1 Carlson Trophic State Index (TSI)

Algal production is known to be highly correlated with nutrient levels (especially phosphorus). High levels of nutrients can lead to eutrophication and blue-green algae blooms. This limits the amount of available light to macrophytes and adversely affects other aquatic organisms. Information from each of these parameters is valuable because the interrelationships between them can be used to identify other environmental factors that may influence algal biomass. The Carlson TSI is the most commonly used index of lake productivity. It provides separate but relatively equivalent TSI calculations based on either chlorophyll-*a* concentration (chlorophyll-*a*, or CHL in the equation below) or Secchi depth (SD, for which Wisconsin also uses satellite clarity data as a surrogate)[7]. Because TSI is a prediction of algal biomass, typically the chlorophyll-*a* value is a better predictor than Secchi or satellite data. Water clarity as measured by Secchi depth or satellite is a practical measure of algal production and water color. TSI values range from low (less than 30), representing very clear, nutrient-poor lakes, to high (greater than 70) for extremely productive, nutrient-rich lakes (Figure 11).

5.1.1.1 Data requirements

TSI is automatically calculated using a programming package (TSI Package) in WATERS that draws from Department data in SWIMS. The rules used by the TSI Package are described below. These requirements are set to provide enough data to account for the average lake condition during the summer index period, when the lake responds to nutrient inputs and achieves maximum aquatic plant growth, and over several years to

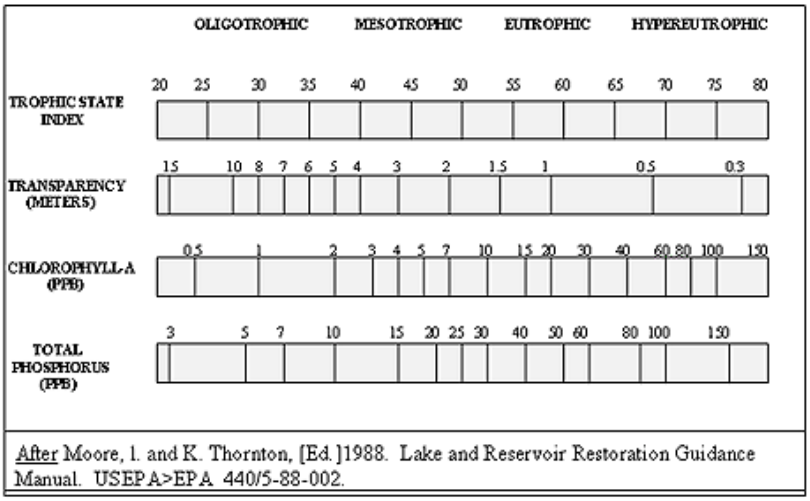


Figure 11. Continuum of lake trophic status in relation to Carlson Trophic State Index.

[7] Carlson also provides an equation to convert total phosphorus concentration to TSI, but WDNR is not using that equation for purposes of water quality assessments or 303(d) Impaired Waters Listing.

account for unusual weather (dry, wet, hot, cold).

a) *Year Range.* Sampling data are used from within the most recent 5 years

b) *Sampling Frequency and Seasonal Range.*

- For chlorophyll-*a* and Secchi data, the TSI Package requires 2 samples per year in 3 different years. Samples should be collected between July 15 – September 15.
- For satellite clarity data, the TSI Package requires at least one satellite inferred clarity reading in 3 different years (3 values minimum). Samples should be collected between July 1 – September 30.

c) *Sampling Depth.* Chlorophyll-*a* samples should be taken from the top 2 meters of the lake. Samples can be grab samples, excluding those collected immediately at 0 m, or integrated samples.

d) *Sampling and Analytical Methods.* Field collection, preservation and storage should follow procedures outlined in the WDNR Field Procedures Manual and the Citizen Lake Monitoring Manual (http://dnr.wi.gov/lakes/CLMN/manuals/). Laboratory analysis should follow standard methods (WSLH, 1993). Data collected using different protocols may be considered, with limitations, based upon professional evaluation.

5.1.1.2 Calculations

Performed by Automated TSI Assessment Package

a) For each year with sufficient data, all sample values are first converted to TSI values using the calculations below. TSI values are calculated separately by sampling collection type[8]. Note that satellite readings are automatically converted to clarity values (equivalent to Secchi depth) in SWIMS.

$TSI_{CHL} = 9.81 \ln (CHL) + 30.6$
$TSI_{SD} = 60 - 14.41 \ln (SD)$

Where:
TSI = Trophic Status Index
SD = Secchi depth (meters) or clarity data
Ln = natural log
CHL = Chlorophyll-*a* concentration (µg/L)

b) For each year of data, an Annual Average for each sample collection type is calculated.

c) All available Annual Averages from the last 5 years are averaged together, to produce a Multi-Year Average (Multi-year Averages are calculated separately for each parameter).

5.1.1.3 Application

a) The TSI Package automatically prioritizes which TSI Multi-Year Average to use in comparison against the General Condition Assessment Thresholds. Historically, there has been a tendency to average the three TSI values, but research suggests that this generally is not a good practice (Carlson and Simpson 1996). Therefore, Wisconsin has instituted a prioritization system for selecting which TSI score to use. When more

[8] Although Carlson's Trophic State Index also provides a calculation for TSI based on total phosphorus (TP), Wisconsin does not calculate TSI based on phosphorus for General Condition Assessments. TP concentrations are used to determine whether a waterbody exceeds thresholds for 303(d) listing as a pollutant.

than one Multi-Year Average TSI score is available, the calculation is performed hierarchically:

1. TSI based on chlorophyll-*a* will be preferred since this is the most direct measure of trophic state;
2. TSI based on measured Secchi data is the second preference; Secchi depth readings measures clarity as a surrogate for trophic state;
3. TSI based on satellite data is the third preference, as it infers water clarity rather than measuring water clarity directly.

b) The final step in the General Assessment is to compare the Multi-year Average TSI value to the lake general condition assessment thresholds shown in Table 10. As described previously, the lake condition assessment thresholds establish four categories for each Lake Natural Community: Excellent, Good, Fair, and Poor.

Table 10. Trophic Status Index (TSI) thresholds – general assessment of lake Natural Communities.

Condition Level	Shallow			Deep			
	Headwater	Lowland	Seepage	Headwater	Lowland	Seepage	Two-Story
Excellent	< 53		< 45	< 48	< 47	< 43	< 43
Good	53 – 61		45 – 57	48 – 55	47 – 54	43 – 52	43 – 47
Fair	62 – 70		58 – 70	56 – 62	55 – 62	53 – 62	48 – 52
Poor	≥ 71		≥ 71	≥ 63	≥ 63	≥ 63	≥ 53

Note: Although TSI thresholds are not yet available for three natural communities: 1) Small Lakes; 2) Spring Ponds; and 3) Impounded Flowing Waters, by default, assessments are completed for the most similar natural community for which thresholds are currently available. Derivation of these thresholds is described in Appendix D.

5.2 Stream and River General Assessment

WDNR uses biological indices, including fish indices of biological integrity (F-IBI) and the macroinvertebrate index of biological integrity (M-IBI), to determine whether current water quality conditions support the AL designated use.

5.2.1 Fish Indices of Biological Integrity

Multiple, peer-reviewed F-IBIs have been developed by WDNR research staff and are used to assess the biological health and quality of fish assemblages of streams and rivers (Lyons, Wang, and Simonson 1996; Lyons 1992, 2001, 2006, and 2012). F-IBIs have been customized to account for differences in stream morphology, water temperature and fish species associated with rivers and streams. The IBIs "…explicitly formulate an expected condition for the biota in the absence of substantial environmental degradation and take into account inherent natural sources of variation in community characteristics. Based on empirical data, the relationship between the biological community and the amount of environmental degradation is estimated" (Lyons et al., 2001). An objective procedure was used to select and score the metrics that compose the various F-IBIs, choosing metrics that represent a variety of the structural, compositional, and functional attributes of fish assemblages (Table 11).

Table 11. Fish Indices of Biological Integrity for Wisconsin streams and rivers.

	Cold F-IBI (Lyons et al., 1996)	**Warm F-IBI** (Lyons, 1992)	**Small F-IBI** (Lyons, 2006)	**Large River F-IBI** (Lyons et al., 2001)	**Cool-Warm F-IBI** (Lyons, 2012)	**Cool-Cold F-IBI** (Lyons, 2012)
Temperature	Maximum daily mean <22° C	Maximum daily mean >22° C	Maximum daily mean >22° C	N/A	Maximum daily mean 22.6–24.6 °C	Maximum daily mean 20.7–22.5 °C
Applicable Stream Size & Location	Streams of any size or watershed area	Wadeable streams of a width between 2.5m and 50m, and depth of at least ~1.25m	Streams with watershed areas that are 4km^2 to 41km^2	Rivers with at least 3km of contiguous, non-wadeable channel	Scoring criteria depend on the watershed area ("large" is > 200 km^2 and "small" is ≤ 200 km^2) and latitude ("north" > 44.6◦N and "south" is ≤ 44.6◦N)	Scoring criteria depend on the watershed area ("large" is > 200 km2 and "small" is ≤ 200 km2) and latitude ("north" > 44.6◦N and "south" is ≤ 44.6◦N)
Individual Metrics	a) # intolerant species b) % tolerant species c) % top carnivore species d) % native or exotic stenothermal coldwater or coolwater species, e) % salmonid individuals that are brook trout	a) # native species b) # darter species c) # sucker species d) # sunfish species e) # intolerant species f) % tolerant species g) Percent omnivores h) % insectivores i) % top carnivores j) % simple lithophils k) # of individuals per 300m^2 l) % diseased fish	a) # native species b) # intolerant species c) # minnow species d) # headwater species e) Total catch per 100m, excluding tolerant species f) Catch per 100 m of brook stickleback g) % diseased fish	a) Weight Biomass PUE b) # native species c) # sucker species d) # intolerant species e) # riverine species f) % diseased fish g) % riverine h) % lithophils i) % insectivore j) % round suckers	a) # native minnow species b) # intolerant species c) % tolerants d) # benthic invertivore species e) % omnivores	a) # darter, madtom and sculpin species b) # coolwater species c) # intolerant species d) % tolerant species e) % generalist feeders

5.2.2 Macroinvertebrate Indices of Biological Integrity

Data derived from aquatic macroinvertebrate samples, combined with stream habitat and fish assemblages, provide valuable information on the physical, chemical and biological condition of streams. Most aquatic macroinvertebrates live for one or more years in streams, reflecting various environmental stressors over time. Since the majority of aquatic invertebrates are limited in mobility, they are good indicators of localized conditions, upstream land use impacts and water quality degradation.

WDNR uses the M-IBI developed by Weigel (2003) to assess wadeable streams. The M-IBI is composed of various metrics used to interpret macroinvertebrate sample data. The M-IBI was developed and validated for cold and warm water wadeable streams and cannot be used as an assessment tool for non-wadeable rivers or ephemeral streams. The following metrics are included in the M-IBI:

- Species richness
- Ephemeroptera–Plecoptera– Trichoptera (EPT)
- Mean Pollution Tolerance Value
- Proportion of Depositional Taxa
- Proportion of Diptera (Dipt)
- Proportion of Chironomidae (Chir)
- Proportion of Shredders (Shr)
- Proportion of Scrapers (Scr)
- Proportion of Gatherers (Gath)
- Proportion of Isopoda (Isop)
- Proportion of Amphipoda

A macroinvertebrate IBI has been developed, validated, and applied to assess nonwadeable rivers (Weigel and Dimick 2011). Hester–Dendy artificial substrates were used to conduct a

standardized macroinvertebrate survey at 100 sites on 38 nonwadeable rivers in Wisconsin. Ten metrics that represent macroinvertebrate assemblage structure, composition, and function constitute the IBI:

- Number of Insecta taxa
- Number of EPT taxa
- Proportion of Insecta individuals
- Proportion of intolerant EPT individuals
- Proportion of tolerant Chironomidae individuals
- Proportion of gatherer individuals
- Proportion of scraper individuals
- Proportion of individuals from the dominant 3 taxa
- Mean Pollution Tolerance Value
- Number of unique functional trait niches

Fish and macroinvertebrate data are used to calculate the appropriate F-IBI and M-IBI scores. Biological data collected within the last ten years are assessed. General biological condition assessments require at least one F-IBI value or one M-IBI value, whereas at least two values of a particular index are required for impairment assessments. Due to strong temporal variations in biological assemblage characteristics at degraded sites, more samples and a longer time frame are needed to determine biotic integrity at sites with human impacts than is needed at least-impacted sites (Lyons et al., 2001). Natural Community classifications are used to determine which biological index to apply (Table 9).

The biological indices respond to watershed scale impacts of agricultural and urban land uses, local riparian stressors, nutrient enrichment, and instream habitat degradation including sedimentation and scouring. In general, as the rate of stream degradation increases, a corresponding decrease in the number of environmentally sensitive species and an increase in environmentally tolerant species are observed. These changes in aquatic community composition are scored relative to a reference or “least-impacted” condition and are placed in a condition category based on the resulting score. The condition categories (excellent, good, fair, poor) and corresponding F-IBI scores are shown in Table 12, and the wadeable M-IBI and nonwadeable river M-IBI thresholds are given in Table 13 and Table 14, respectively. To determine the biological condition of streams and rivers for assessments, the F-IBI or M-IBI values should be compared against thresholds established for each natural community class.

For general condition assessments, all waters scoring in the excellent, good, or fair categories are considered supporting the AL use, unless corroborating physical or chemical data exceed impairment thresholds. Waters scoring in the poor condition category based on general assessments using one bioassessment result are flagged for follow-up monitoring.

Table 12. Condition category thresholds for applicable fish indices of biotic integrity (IBI).

Natural Community	Fish IBI Type	Fish IBI	Condition Category
Coldwater	Coldwater Fish	81-100	Excellent
		51-80	Good
		21-50	Fair
		0-20	Poor
Cool-Cold or Cool-Warm Headwater	Small-Stream (Intermittent) Fish	91-100	Excellent
		61-90	Good
		31-60	Fair
		0-30	Poor
Cool-Cold Mainstem	Cool-Cold Transition Fish	61-100	Excellent
		41-60	Good
		21-40	Fair
		0-20	Poor
Cool-Warm Mainstem	Cool-Warm Transition Fish	61-100	Excellent
		41-60	Good
		21-40	Fair
		0-20	Poor
Warm Headwater	Small-Stream (Intermittent) Fish	91-100	Excellent
		61-90	Good
		31-60	Fair
		0-30	Poor
Warm Mainstem	Warmwater Fish	66-100	Excellent
		51-65	Good
		31-50	Fair
		0-30	Poor
Large River	River Fish	81-100	Excellent
		61-80	Good
		41-60	Fair
		0-40	Poor

Table 13. Condition category thresholds for wadeable stream macroinvertebrate index of biotic integrity.

Wadeable Stream M-IBI Thresholds	*Condition Category*
> 7.5	Excellent
5.0-7.4	Good
2.5-4.9	Fair
< 2.5	Poor

Table 14. Condition category thresholds for nonwadeable river macroinvertebrate index of biotic integrity.

River M-IBI Thresholds	*Condition Category*
>75	Excellent
50-75	Good
25-49	Fair
<25	Poor

6. Aquatic Life[9] Use Assessment

All assessments follow the data requirements outlined in Chapter 4. General Aspects of Data Assessment.

6.1 Total Phosphorus (TP)

Phosphorus is one of Wisconsin's most common pollutants. In 2010, Wisconsin developed numeric criteria for TP and corresponding protocols for listing waterbodies for TP as a pollutant. There are separate criteria based on waterbody type and natural community (Table 26 and Table 27); the methods for criteria comparison are outlined below.

6.1.1 Lake Data Selection and Calculations

Data Requirements

a) *Year Range.* Data from the most recent 10-year period may be used, but data from the most recent 5 years is given preference, as it is more representative of current conditions.

b) *Sampling Frequency and Seasonal Range*. For official assessment purposes, the goal of the DNR's lake monitoring program will be to have 3 samples per year that meet the data requirements outlined below.

- One sample per month should be taken during the designated sampling season. They should be taken as close as possible to the middle of the month.
- Samples must be spaced at least 15 days apart, to evenly represent the season.
- The allowable date range is June 1 – Sept. 15, allowing for four monthly samples (June, July, August, Sept.). Only three samples are needed for the calculations, but more samples will be used if available. For Deep (stratified) Lakes, samples from May and/or late September may be manually added if it can be demonstrated that the lake is thermally stratified during that time period.
- At least 2 years of data are required to do a lake phosphorus assessment.

c) *Sampling depth.* Only surface samples taken from the top 2 meters of the lake will be used (excluding grab samples collected at 0 m because these may contain a scum layer). Samples can be grab samples or depth-integrated samples. If samples were taken from more than one depth within this zone at a single station on a single day, average the samples for that station for that day to produce the station's daily average.

d) *Sampling and Analytical Methods.* Field collection, preservation and storage should follow procedures outlined in the field procedure manuals (12.3 Monitoring Strategies, Protocols, and Standard Operating Procedures). Laboratory analysis should follow standard methods (WSLH 1993). Data collected using different protocols may be considered, with limitations, based upon professional evaluation of data.

- *Data quality*: Sample points may be excluded if there are quality control concerns or if the data were collected for specific studies that are not representative of overall lake conditions. See 4. General Aspects of Data Assessment.
- *Units*: Values should be expressed in µg/L. This is consistent with phosphorus water quality criteria in ch. NR 102, Wis. Adm. Code.

[9] Aquatic Life Use was previously referred to as "Fish and Aquatic Life (FAL)". This was only a terminology change; no changes to the use definition were made.

Calculations

a) *Calculate Daily Mean.* Most lakes will have only one sample per day within the correct depth zone (0-2 m or 0-6 ft); in these cases that single sample serves as the daily mean. If there is more than one sample from a single station on a single day from within the correct depth zone, then these samples should be averaged into one, and flagged. Samples with no depth or wrong depth should be excluded.

b) *Determine "Qualifying Years"*[10]*:* A "qualifying year" is one that has at least 2 daily means that are in different months of the appropriate date range and that are at least 15 days apart. Whether or not a year is a qualifying year is indicated by the assessment package output.

c) *Calculate Monthly Mean*: For all years, regardless of whether they are qualifying years, calculate the monthly mean from the daily means. Most lakes will have only one daily mean per month; in these cases that single value serves as the monthly mean. If more than one daily mean is available for a given month, average them into a monthly mean. A minimum of 6 monthly means over at least two qualifying years are required to meet assessment requirements.

6.1.2 Stream and River Data Selection and Calculations

For streams and rivers, TP can be linked as a pollutant causing biological impairment using WDNR's sampling protocol, which has been developed consistent with considerations of seasonality, timing and frequency of sample collection used by USGS for development of the TP criteria [s. NR 102.06(3) Wis. Adm. Code]. Field collection, preservation and storage should follow procedures outlined in the field procedure manuals (12.3 Monitoring Strategies, Protocols, and Standard Operating Procedures).

Data Requirements

a) *Year Range.* Data from the most recent 10-year period may be used, but data from the most recent 5 years is given preference, as it is more representative of current conditions.

b) *Sampling Frequency and Seasonal Range.* Waters should be sampled monthly over a 6-month period from May through October, ideally within the same year. Each sample should be collected approximately 30 days apart, with no samples collected within 15 days of one another. If more than one sample is available per month, the sample closest to mid-month should be used in the analysis.
   - If one or more monthly samples are missed within a year, additional samples may be collected in subsequent years corresponding with the missed months (e.g., if July and August samples were not collected in the first year, they could be collected in the second year to make a complete data set).
   - If multiple years of data are available, the three most recent years of data should be used.

[10] At this stage, biologists may also determine whether any years should be considered "Extreme Weather Years", as described in 4. General Aspects of Data Assessment. If so, and if the biologist feels the extreme weather year resulted in data that would make the assessment result unrepresentative, the biologist may manually check to determine that at least one "normal year" was included in the assessment before making impairment decisions. Gaps in assessment datasets left when samples are determined to be unrepresentative should be filled by either collecting additional data or considering data from outside the standard period of record.

- TP data collected for study-specific purposes as part of a targeted monitoring design (e.g., storm event sampling or targeted flow regimes) are not appropriate for assessment of attainment of the applicable TP water quality criterion.
- One year of sampling is usually sufficient for assessment purposes.

Calculations

- *Determine "Qualifying Years":* A "qualifying year" is one that has at least 2 samples that are in different months of the appropriate date range and that are at least 15 days apart. Whether or not a year is a qualifying year is indicated by the assessment package output.

6.1.3 Calculation of Comparison Statistics

Calculate the grand mean or median and related statistics. For lakes and reservoirs take the average of monthly means across years to calculate each station's grand mean. For rivers and streams calculate the grand median from the selected data points as described above. The list of statistical values needed for this calculation and other values useful for assessment and reporting are:

- Applicable impairment thresholds for the lake, river/stream type
- Grand Mean
- Grand Median
- Min
- Max
- Lower Confidence Limit (LCL) (see formula below)
- Upper Confidence Limit (UCL) (see formula below)
- Standard Deviation
- # of data points used
- Period of Record (the most recent 10-year period, starting with the most recent **even numbered** year)
- Year range used from within the period of record
- Number of years used
- Number of monthly means/samples used

The confidence interval (CI) around the mean is:

$$CI = exp\left(\bar{Y} \pm t_{1-\frac{\alpha}{2},N-1}\frac{S}{\sqrt{N}}\right)$$

where $\bar{Y}$ and S are the mean and standard deviation, respectively, of the natural logarithms of the measured values, N is the sample size, α is the desired significance level, and $t_{1-\alpha/2,\,N-1}$ is the 100(1-α/2) percentile of the t distribution with N – 1 degrees of freedom.

Calculations are run on all stations that have any data, regardless of whether they have enough data to meet the minimum data requirements for assessment purposes. However, stations that do not meet the minimum data requirements for an assessment are flagged. Years that did not have at least 2 monthly means are also flagged.

6.1.4 *Comparison to Thresholds*

Compare the resulting mean (lakes) or median (stream & rivers) to the applicable TP criteria If the criterion falls within the confidence interval the Upper and Lower Confidence Limits (UCL and LCL, respectively) are used to compare to the criterion.

Relation of mean/median to criteria (visualized in Figure 12):

- If the LCL ***is greater than*** the criteria, then the water "Clearly Exceeds" the criteria.
- If the UCL ***is less than*** the criteria, then the water "Clearly Meets" the criteria.
- If mean/median > criteria, AND LCL < criteria, AND UCL > criteria = the water "May Exceed" the criteria.
- If mean/median < criteria, AND LCL < criteria, AND UCL > criteria = the water "May Meet" the criteria.

Regardless of whether the decision was a "Clear" decision, the package will report the decision based upon the data points used to meet the minimum data requirements, rather than including older data that may be less representative[11].

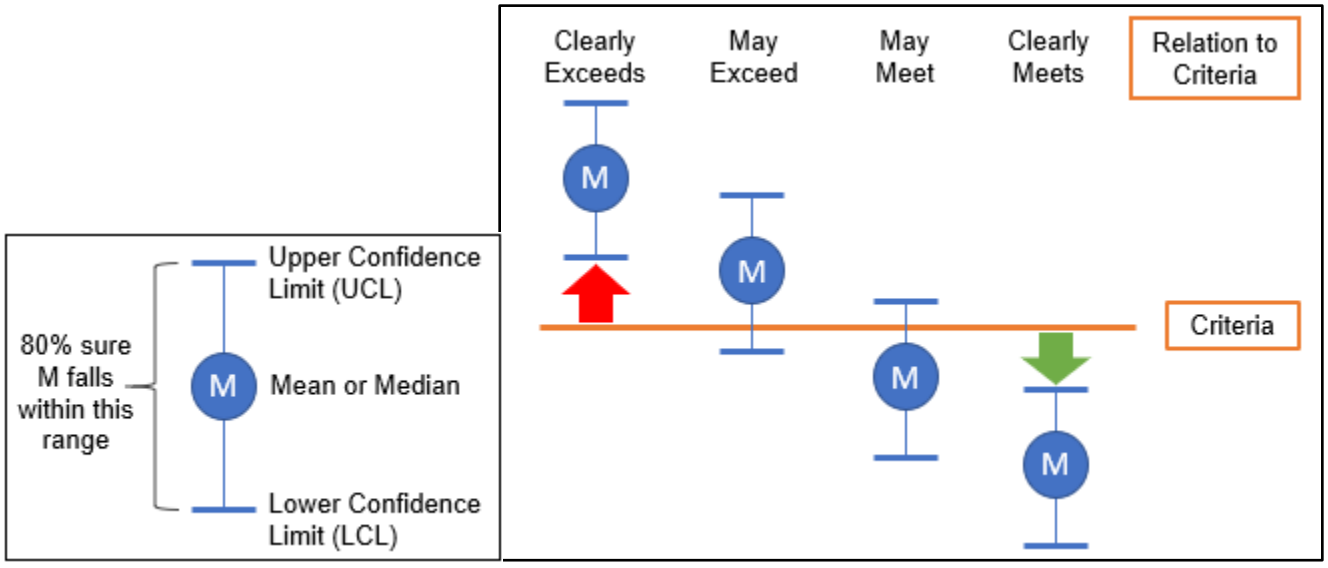


Figure 12. Comparison of the Upper and Lower Confidence Limit values and Mean/Median (M) to the criteria.

Note: Along with the automated assessment packages, an Excel spreadsheet template is also available for performing the calculations manually. Manual calculations of the statistical values may be required to assess data that is not in the SWIMS database.

6.1.5 *Applying a Combined Approach: Phosphorus Response Indicators*

Phosphorus response indicators based on biological metrics can influence whether or not a waterbody is listed for phosphorus. New phosphorus response indicators were codified in October 2022 and apply when a waterbody's phosphorus assessment shows exceedance but not an overwhelming exceedance (defined below). In these cases, a combined assessment approach is used. If a waterbody has phosphorus levels that overwhelmingly exceed the criteria, then it will be listed for phosphorus regardless of biological metrics.

[11] If the lake is trending better or worse over time, it is most appropriate to use the most recent data and recommend future monitoring to reach a more "Clear" decision rather than using older data. However, biologists may incorporate less recent data, as appropriate.

Overwhelming exceedance of the phosphorus criteria is when the lower bound of a water's two-sided 80% confidence interval exceeds its phosphorus criterion by 1.5 times for lakes or 2 times for streams and rivers. The ambient total phosphorus ranges that qualify for the combined assessment approach are displayed in Table 15 by waterbody type.

Table 15. Range of ambient total phosphorus levels for applying combined assessment for total phosphorus, by waterbody type. Unstratified refers to Shallow lakes and stratified refers to Deep lakes.

Waterbody Type	Total Phosphorus Criterion (ug/L)	Combined Approach Range (ug/L ambient total phosphorus)
Stream or its Impounded Flowing Water	75	75 to <150
River or its Impounded Flowing Water	100	100 to <200
Unstratified Reservoirs, Unstratified Drainage or Seepage Lakes	40	40 to <60
Stratified Reservoirs, Stratified Drainage Lakes	30	30 to <45
Stratified Seepage Lakes	20	20 to <30
Two-Story Fishery Lakes	15	15 to <22.5

Phosphorus response indicators are used in conjunction with the state's phosphorus criteria, as a "Combined Assessment Approach". In this approach if a waterbody exceeds its applicable phosphorus criterion, but within a prescribed range, then its phosphorus response indicators are reviewed before making the decision to list as impaired for phosphorus. If all phosphorus response indicators are attaining the established thresholds, the waterbody will not be listed as impaired for phosphorus. If any one phosphorus response indicator is not attained, the waterbody is listed as impaired for phosphorus.

6.1.6 Chlorophyll-a (Lakes & Reservoirs)

The chlorophyll-*a* assessment methods for aquatic life described in detail in section 6.2.1 Chlorophyll-a are also applied as phosphorus response indicators for lakes and reservoirs.

a) The arithmetic mean suspended chlorophyll *a* concentrations in lakes and reservoirs other than stratified two-story fishery lakes shall not exceed 27 ug/L.
b) The arithmetic mean suspended chlorophyll *a* concentrations in stratified two-story fishery lakes shall not exceed 8 ug/L.

6.1.7 Macrophytes (aquatic plant metrics) (Lakes & Reservoirs)

Aquatic plants are sensitive to nutrient enrichment, and species-specific differences in tolerance to enrichment may be used to detect impairment in natural lakes. Thus, the composition of aquatic plant communities in many cases can show impairment prior to algal indicators. Aquatic plants play stabilizing roles in lake ecosystems, supporting clear-water conditions via a positive influence on settling rates, nutrient burial and uptake. Some lakes that are enriched with nutrients will not show evidence of impairment in their ambient water phosphorus or chlorophyll-*a* concentrations. However, as a lake begins to become enriched, plant community composition shifts toward more tolerant species adapted to enriched conditions. Following these principles, an assessment method relating aquatic plant abundance and tolerance to total phosphorus (Macrophyte Assessment of Condition for Phosphorus, MAC-P) was created.

Data Requirements

a) *Year Range*. Surveys from the past 5 years will be reviewed but the most recent survey is used for decision making.

b) *Sampling Frequency and Seasonal Range*. One survey in a given year is required for assessments. Surveys are taken during the growing season. The growing season for the northern and southern regions of Wisconsin (defined by an east-west line lying at 44.84707°N latitude) are as follows: for the north, July 1 – August 31, and for the south, June 15 – September 30.
c) *Data quality*. Surveys that are influenced by herbicide treatments or remediation work within the past year should not be used for impairment decisions. Use of a survey is based on best professional judgment.

Comparison to Thresholds

Compare the Macrophyte Assessment of Condition-General (MAC-Gen) calculations for percent Tolerant, Moderately Tolerant, and Sensitive species to the thresholds in Table 16. A lake will have an Impairment/Observed Effect for Degraded Submerged Aquatic Vegetation (SAV) if the most recent survey does not attain MAC-Gen thresholds.

Table 16. Lake aquatic plant community phosphorus response indicator attainment thresholds by lake type.

Subcategory: Lake Type[1]	Macrophyte Assessment of Condition for Phosphorus (MAC-P) attains if:
Northern Seepage	Phosphorus Tolerant ≤ 44.3%
Northern Drainage	Phosphorus Sensitive > 51%
Southern Seepage	Phosphorus Sensitive > 26%
Southern Drainage	Phosphorus Sensitive > 42%

[1] Northern lakes are those north of 44.84707°N latitude, and southern lakes are those south of that latitude. Seepage and drainage lakes follow the definitions in s. NR 102.03 (6h) and (1o). Seepage lakes include both stratified and unstratified seepage lakes, and drainage lakes include both stratified and unstratified drainage lakes. Plant phosphorus response indicators have not been established for Great Lakes and lakes less than 5 acres in surface area.

6.1.8 Oxythermal Habitat (Two-Story Fishery Lakes)

For two-story fishery lakes, the oxythermal layer thickness criteria specified in section 6.5 Oxythermal Habitat also applies as a phosphorus response indicator. Elevated phosphorus can lead to oxygen depletion in lakes and reduce the habitat necessary for coldwater fish. Although phosphorus may not be the only factor affecting oxythermal habitat, if the oxythermal habitat requirement is not met in a waterbody with elevated TP levels, it is appropriate to determine that the waterbody is experiencing stress due to phosphorus, and list it as impaired for TP, unless further studies indicate otherwise.

6.1.9 Benthic Algal Biomass & Diatom Taxa (Rivers & Streams)

For rivers and streams primary productivity measured by benthic algal biomass and diatom community are used as phosphorus response indicators. Elevated phosphorus can be expected to result in greater biomass and coverage of benthic algae in streams. The first tool used is quantification of benthic algal biomass using a viewing bucket. The method is employed during evaluation of habitat assessment transects and is used to assess both Aquatic Life Use and Recreation Use. Guidance on data collection is linked under 12.3 Monitoring Strategies, Protocols, and Standard Operating Procedures.

6.1.9.1 Benthic Algal Biomass

Benthic algal biomass is observed and characterized on a grid with a minimum of 25 points with a viewing bucket. This is done once on each of the twelve habitat transects for a reach, staggered across the stream from left to right. Scores from each transect are then averaged for the reach.

The assessments are conducted using data from the growing season (July, Aug, or Sept), during baseflow conditions, with the first viewing bucket assessment in July or August, and second (if needed) in August or September. Sampling should be avoided within 14 to 21 days of a storm event because scouring during stream spate events may reduce algal biomass. Algal abundance is strongly influenced by the amount of light that reaches the benthos; canopy needs to be considered in selecting sites representative of stream condition and monitoring purpose.

The viewing bucket scoring scale is from 0 (low biomass) to 3 (high biomass) (Table 17). If the average algal biomass score for the reach is less than 1, the stream is not impaired by TP and there is no need for further primary production assessment. If the algal biomass score is greater than 2, the stream is impaired by TP and no further assessment is necessary. If the algal biomass score is between 1 and 2, further primary production assessment via the Diatom Phosphorus Index (DPI) is needed.

Table 17. Stream benthic algal biomass phosphorus response indicator using viewing bucket method.

Benthic algal biomass, viewing bucket score (0-3)	Attainment decision	
	Aquatic Life Use	Recreation Use
< 1	Attained[1]	Attained
1 - 2	Inconclusive; assess benthic diatoms using DPI	
> 2	Not attained	Not attained

[1] If the mean score is <1 but 20% or more of individual transect points score a 3, a benthic diatom assessment under par. (b) is required to make an attainment determination.

6.1.9.2 Diatom Phosphorus Index (DPI)

This method can be used to determine whether the diatom community at an assessment site resembles the community that is typically found at sites meeting the stream TP criterion. The TP criterion is based on breakpoints in the relationships between TP and diatom (and other biological) metrics, and as such represents the level of TP where the biological community changes the most.

If only a single diatom survey is available from a sampling station, the department would not list a waterbody as impaired for phosphorus if it is 90% confident that the diatom community is not impaired. A bootstrapping procedure was used to estimate confidence intervals around DPI values. If the upper 80% confidence limit of DPI is < 75 µg/L, we would be 90% confident that the diatom community is not impaired.

If more than one diatom survey is available from a sampling station, the DPI scores are averaged, and the mean DPI score is compared directly to the threshold of 75 ug/L without using confidence intervals. This is because the bootstrapping procedures required to calculate the confidence intervals are not practicable with more than one sample. In this case, averaging the scores addresses sample variability.

6.1.10 Combined Phosphorus and Response Metric Listings

With the Combined Assessment Approach, a waterbody's listing determination depends on biological metrics. Assessment scenarios incorporating phosphorus and biological data are listed in Table 18. Lake specific listing decisions based on ambiguous phosphorus results are listed in Table 19.

Table 18. Listing determinations for phosphorus and phosphorus response indicators based on attainment.

	Phosphorus Response Indicators	Overall Assessment Result	Pollutant	Observed Effect	EPA Listing Category
Exceeds TP criteria (less than overwhelming exceedance)	One or more indicate impairment	Impaired	TP	Degraded Biology*	Category 5A
	None indicate impairment	Not Impaired	NA	NA	Category 2
	Insufficient Information	Impaired	TP	NA	Category 5P
Exceeds TP criteria by an overwhelming amount	None needed	Impaired	TP	NA or Degraded Biology*	Category 5A

*The observed effect listing will indicate which phosphorus response indicator is not attained (Table 35).

Table 19. Lake assessment decisions based on ambiguous phosphorus results and associated chlorophyll-*a* results. Chlorophyll-*a* results can be assessed without TP if there are 6 samples, meeting minimum data requirements. A listing decision will be made after more monitoring and at least 3 years of data are available.

TP	Chl-*a* (3 or 6 samples)	Assessment Decision	Category Decision
May Meet	Clearly Exceeds (3)	Not Impaired – Monitoring Priority	Category 3
	May Exceed (3 or 6)		
	Clearly Meets (3)	Not Impaired – Monitoring Recommended	
	May Meet (3 or 6)		
	Clearly Meets (6)	Not Impaired	Category 2
May Exceed	Clearly Exceeds (3)	Not Impaired – Monitoring Priority	Category 3
	May Exceed (3 or 6)		
	May Meet (3 or 6)		
	Clearly Meets (3)		
	Clearly Meets (6)		Category 2

6.1.11 Listing vs. Delisting Total Phosphorus

Because the TP assessment method involves the comparison of confidence interval ranges to the applicable thresholds, the calculated value that is compared against the water quality standard is different for *listing* versus *delisting*. The *lower* confidence limit value is compared against the applicable criterion for listing decisions and the *upper* confidence limit value is compared against the applicable criterion for delisting decisions (Figure 12). This method increases confidence in listing and delisting decisions and, for waters with ambient concentrations that hover around the applicable criterion, reduces the potential variability in

attainment status and avoids multiple changes to listing status for the same water due to natural variability in TP concentrations.

Phosphorus response indicators can be used to remove a phosphorus-listed water if phosphorus levels are within the range for a combined approach (Table 15), and all response indicators are attaining.

6.2 Biological Metrics

As in general condition assessments, biological indicators are also used to assess attainment of WQS and determine whether AL uses are supported. Section NR 102.01(2) of Wis. Adm. Code explains the goal of WQS is to "protect the use of water resource for all lawful purposes… which includes the protection of public health and welfare and the present and prospective uses of all waters of the state for public and private water supplies, propagation of fish and other aquatic life and wild and domestic animals, domestic and recreational purposes, and agricultural, commercial, industrial, and other legitimate uses." Chapter 102.04(1)d Wis. Adm. Code provides narrative standards for the protection of fish and other aquatic life in surface waters, stating: "Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life."

If a water has at least one biological metric exhibiting impairment over two years, the water can be listed as having an impaired AL use based on biology, under Category 5A. If there is a pollutant exceeding its criterion that is associated with the biological degradation, the pollutant would be listed as well. However, if there is no pollutant exceeding its criterion then the "Pollutant" field associated with this impairment will be listed as "Unknown". If it is believed that a pollutant is the causal factor in the biological impairment but the pollutant's criterion is not exceeded, the water may be more sensitive than typical to that pollutant, and it may be a good candidate for a more stringent site-specific criterion.

6.2.1 Chlorophyll-a (Lakes and Reservoirs)

Algal biomass, as measured by chlorophyll-*a* concentrations, is one of the most common response metrics to increased nutrients. It is used to assess both the AL use, described here, and the Recreation Use, described in 7.2.1 Chlorophyll-a (Algal blooms). Comparison of chlorophyll-*a* values to AL impairment thresholds is calculated in the same way as lake phosphorus (***6.1 Total Phosphorus (TP)***).

The following are the ways the methods differ:

Data Requirements

- *Sampling Frequency and Seasonal Range*. The target date range is July 15 – Sept. 15, which should result in one sample for each of July, August, and September. However, if sampling within that window is not possible, data will be accepted if it is collected within one week of the sample season (i.e., July 8-Sept. 22).
- The sampling periods for TP and chlorophyll-*a* are not identical. June samples are not used for chlorophyll-*a* assessments because many lakes have a clear water phase in June due to food web dynamics. Therefore, June samples do not appropriately represent lakes' summer chlorophyll-*a* conditions. However, for TP, June samples are included to reflect the range of summer conditions.

Calculations

- *Calculate Monthly Mean*. Number of samples required to meet assessment requirements: For chlorophyll-*a*, the minimum number of monthly means and years

required depends on whether the assessment is being used as a 'biology only' (i.e., standalone) impairment listing for chlorophyll-*a*, or whether it is being used in conjunction with TP for an impairment listing. For a 'biology only' assessment there need to be 3 monthly means over two qualifying years, for a total of 6 samples. For use in conjunction with TP there need to be at least 3 monthly means in one qualifying year.

Thresholds for attainment

a) The arithmetic mean suspended chlorophyll *a* concentrations in lakes and reservoirs other than stratified two-story fishery lakes shall not exceed 27 ug/L.
b) The arithmetic mean suspended chlorophyll *a* concentrations in stratified two-story fishery lakes shall not exceed 8 ug/L.

6.2.2 Macrophytes (aquatic plant metrics) (Lakes and Reservoirs)

Lake-dwelling aquatic plants, or macrophytes, are sensitive to multiple forms of anthropogenic disturbance and can be used as a metric to signify ecological impairment (Alahuhta and Aroviita 2016, Lacoul & Freedman 2006, Wilcox 1995). Two assessment methods were developed that evaluate the condition of a lake's aquatic plant community by relating aquatic plant abundance to anthropogenic disturbance. The first assessment method is called the Macrophyte Assessment of Condition-General (MAC-Gen) and describes overall aquatic plant community condition in response to multiple sources of anthropogenic disturbance. The second version of the method, called the Macrophyte Assessment of Condition-Phosphorus (MAC-P) is more narrowly focused, reflecting a plant community's tolerance of and response to phosphorus (see section 6.1.7 Macrophytes (aquatic plant metrics)).

Data Requirements

d) *Year Range*. Surveys from the past 5 years will be reviewed but the most recent survey is used for the assessment determination.
e) *Sampling Frequency and Seasonal Range*. One survey in a given year is required for assessments. Surveys are taken during the growing season. The growing season for the northern and southern regions of Wisconsin (defined by an east-west line lying at 44.84707°N latitude) are as follows: for the north, July 1 – August 31, and for the south, June 15 – September 30.
f) *Data quality*. Surveys that are influenced by herbicide treatments or remediation work within the past year should not be used for impairment decisions. Use of a survey is based on best professional judgment.

Comparison to Thresholds

Compare the Macrophyte Assessment of Condition-General (MAC-Gen) calculations for percent Tolerant, Moderately Tolerant, and Sensitive species to the thresholds in Table 20. A lake will have an Impairment/Observed Effect for Degraded Submerged Aquatic Vegetation (SAV) if the most recent survey does not attain MAC-Gen thresholds.

Table 20. Aquatic plant community thresholds for lakes and reservoirs for the Macrophyte Assessment of Condition-General (MAC-Gen).

Lake Subcategory[1]	Macrophyte Assessment of Condition (MAC-Gen) is attained if:
Northern Seepage	Moderately tolerant ≤ 64%
Northern Drainage	Tolerant ≤ 73%
Southern Seepage	Sensitive > 15%
Southern Drainage	Tolerant ≤ 50%

[1] Northern lakes are those north of 44.84707°N latitude, and southern lakes are those south of that latitude. Thresholds have not been established for the Great Lakes.

6.2.3 Macroinvertebrate and Fish Indices of Biological Integrity (Stream & River)

For streams and rivers, attainment of the narrative biological standards is assessed using the fish and macro-invertebrate indices described in section 5.2 Stream and River General Assessment. Biological indicator data collected from two or more sampling visits over at least two calendar years at the same station for a particular assessment unit (i.e., stream segment) are considered sufficient data to assess attainment of the narrative biological standards. The general condition category threshold for "poor" condition is used as the benchmark for evaluating attainment of WQS.

6.3 Temperature

Temperature criteria for Wisconsin's waters are based on waterbody type, AL use subcategory, or geographic location (Table 21). Specific criteria apply for several large rivers: Mississippi River, Rock River, Wisconsin River, and the Lower Fox River. Criteria for these waters can be found in APPENDIX A. Quick Reference Section.

6.3.1 Data Requirements

a) *Period of record.* Data from the most recent 10-year period may be used, but data from the most recent 5 years is given preference, as it is more representative of current conditions.

b) *Sampling Frequency and Seasonal Range.* A minimum of 20 daily maximum temperature values from continuous monitoring (e.g., hourly temperature readings). Criteria are available for each month so samples for assessment are collected at any time of year.

c) *Measurement Depth – Lakes only.* Temperature should be measured in the epilimnion of a lake, either at a discrete depth or over a vertical profile. With vertical profiles, the maximum temperature in the epilimnion is used in calculations.

d) *Sampling and Analytical Methods.*
- *Units.* Temperature values should be expressed in Fahrenheit.
- *Data Quality.* Data should only be used from temperature meters where calibration records are available.

6.3.2 Calculations

a) *Margin of Error*. For each daily maximum temperature value, a margin of error (MOE) of 0.7 C (1.3 F) is subtracted to account for error in the tool used to take the temperature reading and in the calibration tool.

b) *Calculations.* Calculate the percentage of days in each month where the daily maximum temperature values exceed (are greater than) criteria. Calculate the percentage of days in each month where the MOE-corrected daily maximum value exceeds criteria.

6.3.3 Application

Exceedance Frequency. If more than 10% of MOE-corrected samples within a month are above temperature criteria (Table 21) it is considered an exceedance; the water is considered impaired for temperature. If more than 10% of samples but fewer than 10% of MOE-corrected samples exceed criteria, then the regional biologist will determine if a listing is appropriate.

Table 21. Acute Temperature Criteria in Fahrenheit for each month by Water Type. This table is a combination of Acute Temperature Criteria found in Wisc. Admin. Code Chapter NR 102.25 Tables 2 and 4.

	Rivers & Streams				Lakes	
Month	Cold	Warm Large	Warm Small	LFF	Northern Lake*	Southern Lake*
Jan	68	76	76	78	76	77
Feb	68	76	76	79	76	78
Mar	69	76	77	80	76	78
Apr	70	79	79	81	78	80
May	72	82	82	84	81	82
Jun	72	85	84	85	85	86
Jul	73	86	85	86	86	87
Aug	73	86	84	86	86	87
Sep	72	84	82	85	84	85
Oct	70	80	80	83	80	81
Nov	69	77	77	80	78	78
Dec	69	76	76	79	76	77

**Northern means North of State Highway 10 and Southern means South of State Highway 10.*

6.4 Dissolved Oxygen (DO)

Low DO in a water occurs when oxygen consuming processes, such as microbial respiration of organic matter, exceed oxygen producing processes like aeration and photosynthesis. Criteria are outlined in Table 22 by waterbody type and classification; assessment steps are below.

6.4.1 Data Requirements

a) *Period of record.* Data from the most recent 10-year period may be used, but data from the most recent 5 years is given preference, as it is more representative of current conditions.

b) *Sampling Frequency and Seasonal Range – Streams and Rivers.* A minimum of 3 days of continuous measurements (no less than 1 sample per hour) in July or August collected from each of 2 separate calendar years.

c) *Sampling Frequency and Seasonal Range - Lakes.* A minimum of 10 discrete values, measured during the ice-free period. Discrete values refer to samples collected on separate calendar days.

d) *Measurement Depth – Lakes.* DO should be measured in the epilimnion of a lake, either at a discrete depth or over a vertical profile. With vertical profiles, the minimum DO in the epilimnion is used in calculations.

e) *Sampling and Analytical Methods.*
- *Units.* DO values should be expressed in mg/L.
- *Data Quality.* Data should only be used from DO meters where calibration records are available, or from titration methods.

6.4.2 Calculations

Calculate the percentage of all DO values meeting the data requirements, that exceed criteria (DO values are *below* applicable criteria).

Table 22. Dissolved oxygen criteria (minimum amount required) for healthy aquatic communities, ordered by waterbody type.

Waterbody Type	Waterbody Designation	Criteria (mg/L)
Streams, Rivers	Cold Waters	6.0, and 7.0 during spawning season
	Cold or Warm Water – Class III Trout	6.0
	Warm Waters	5.0
	Limited Forage Fish	3.0
	Limited Aquatic Life	1.0
Lakes	Other than Two-Story	5.0
	Two-Story Fishery	See Oxythermal Criteria

6.4.3 Application

Exceedance Frequency. If more than 10% of the qualifying DO values are less than the applicable criteria (Table 22) the water is impaired for DO.

6.5 Oxythermal Habitat

Two-story fishery lakes have coldwater fish species, but their dissolved oxygen requirements differ significantly from coldwater streams and from other lakes. In two-story lakes coldwater fishes have specific DO and temperature needs that are sometimes only met within a narrow vertical habitat range (Figure 13), The criteria combine oxygen and temperature measurements and are called oxythermal layer criteria.

Oxythermal layer criteria: a two-story fishery lake shall maintain, during its period of summer stratification, an oxythermal layer of at least 1 meter in thickness that maintains both a dissolved oxygen concentration of at least 6 mg/L and a maximum temperature determined by the coldwater fish species present (Table 23).

Table 23. Oxythermal Habitat requirements based on fish species. A layer of lake water must maintain both the temperature and dissolved oxygen (DO) requirements to support coldwater fish communities. If multiple coldwater fish species are present ('Mix') then use the species with the lowest temperature limit.

Fish Species	Upper Temperature Limit (≤,°F)	DO Lower Limit
Cisco	73	≥ 6 mg/L
Whitefish	66	
Lake Trout	57	
Brook, Brown, Rainbow Trout*	73	
Mix	Use species requiring lowest temperature	

*Department managed populations

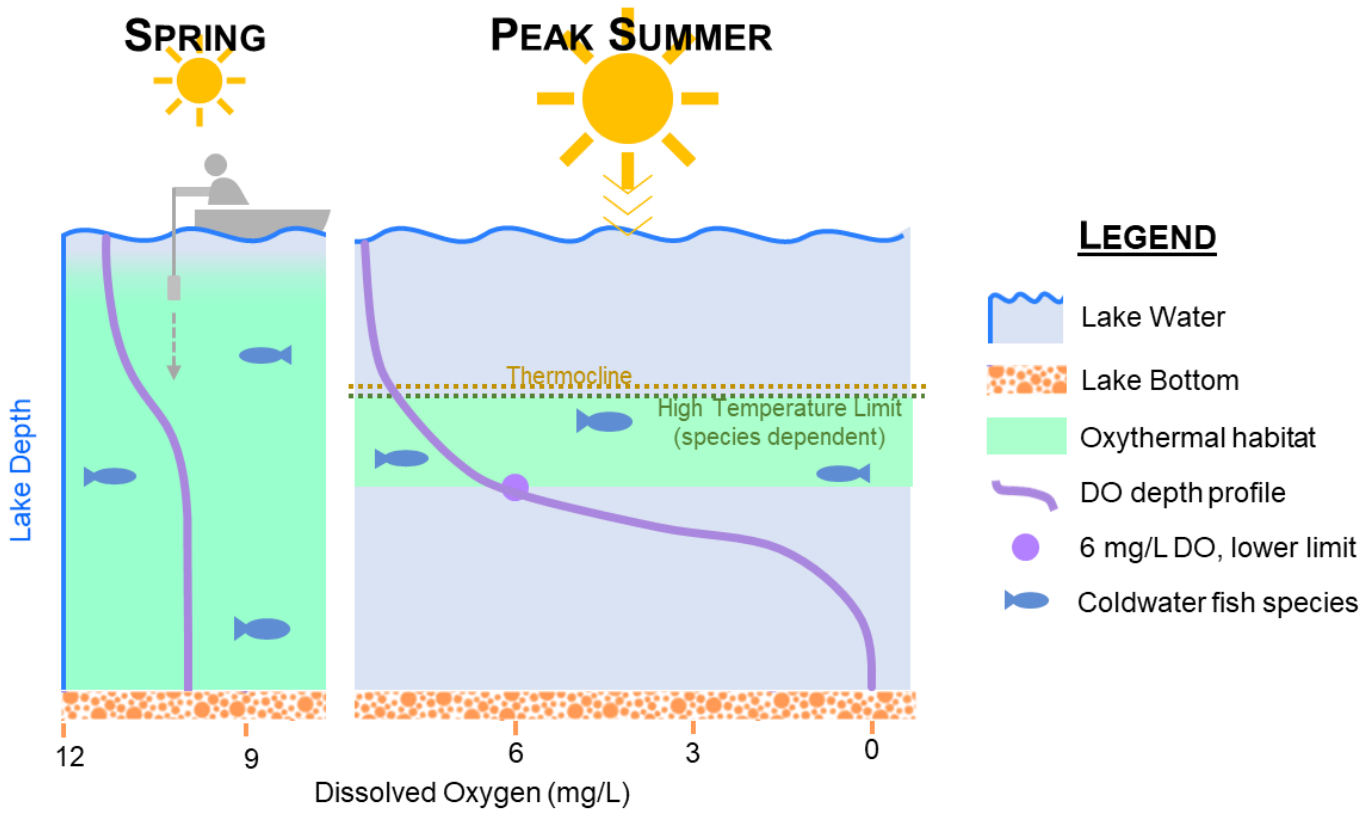


Figure 13. Availability of oxythermal habitat for coldwater fish species during the spring and summer in a two-story fishery lake. In the spring suitably cool and oxygenated water (oxythermal habitat, shown in green), is available from the top of the lake to the bottom because dissolved oxygen (DO) levels are high from the water's mixing in the spring (DO is shown as a purple line, with the DO scale along the bottom of the figure). In the summer, the lake has thermally stratified (producing a thermocline) and oxythermal habitat is limited in the top layer of the lake by warm temperatures. From below, oxythermal habitat is limited by low DO caused by oxygen depletion in the lake bottom. If a lake does not maintain a DO above 6 mg/L and with sufficiently cold temperatures, it is not fully protective of a healthy coldwater fish community, as reflected in new oxythermal criteria.

6.5.1 Data Requirements

a) *Period of record.* Data from the most recent 10-year period may be used, but data from the most recent 5 years is given preference, as it is more representative of current conditions. A minimum of 2 years of data is recommended.

b) *Sampling Frequency, Seasonal Range, and Measurement Depth.* Vertical temperature and DO profiles, at 1-meter increments, taken in the deep part of the lake while the lake is stratified, at least monthly from July to September (earlier samples may be useful).

c) *Sampling and Analytical Methods.*
- *Units.* DO values should be expressed in mg/L. Temperature values should be expressed in degrees Fahrenheit.
- *Data Quality.* Data should only be used from DO meters where calibration records are available, or from titration methods.

6.5.2 Calculations

The depth of available habitat for a given date is determined by comparing concurrent depth profiles of temperature and dissolved oxygen based on the requirements in Table 23.

6.5.3 Application

Exceedance Frequency. For a given date, if the available oxythermal habitat is less than 1 meter thick then the criterion is not met. During any given year, if at any point the applicable criterion is not met, that year is an exceedance year. If any two or more years within the most recent 5-year period are exceedance years, the lake is not attaining the water quality criterion. Data from up to 10 years may be used if representative of current conditions.

6.6 Chloride and Aquatic Toxins

Chloride is a concern for Wisconsin waters in part because of road salt used in the winter months. In surface waters chloride can be toxic to many forms of aquatic life. The chloride standards are set to protect aquatic life from chronic (long-term) and acute (short-term) toxicity. The criterion for chronic toxicity is 395 mg/L and for acute toxicity it is 757 mg/L. These criteria apply to AL use of streams, rivers, lakes, reservoirs, and impoundments. Chloride levels may be assessed at any time during the year because the aquatic community may be detrimentally impacted regardless of season; however, levels tend to be highest after snow melts.

For lakes, reservoirs, and impoundments samples can come from any depth and are not averaged across depths if a profile is taken. The highest chloride value at any depth is considered the daily maximum. A waterbody is considered impaired for chronic toxicity if a 4-day average of the daily maximum values taken from 4 consecutive days exceeds the chronic criterion more than once in a three-year period[12]. For acute toxicity, a waterbody is considered impaired if the daily maximum exceeds the acute criterion more than once in a three-year period (Table 24). Chloride has been assessed on a systematic statewide basis since the 2014 assessment cycle. The methods for assessing chloride apply to other parameters with chronic and acute aquatic toxicity criteria (Table 24).

Table 24. Aquatic Life Use aquatic toxicity impairment thresholds. The symbol * means total recoverable form.

Aquatic Toxicity-Based indicators			
Acute aquatic toxicity indicators	**Minimum Data Requirement**	**Exceedance Frequency**	**Criteria Table Reference**
Ammonia, Arsenic$^{(+3)}$*, Cadmium*, Chloride, Chlorine (total residual), Chlorpyrifos, Chromium$^{(3+)}$*, Chromium$^{(+6)}$*, Copper*, free Cyanide, Dieldrin, Endrin, Gamma – BHC, Lead*, Mercury$^{(+2)}$*, Nickel*, Parathion, Pentachlorophenol, Selenium, Toxaphene, and Zinc*	2 values within a 3-year period	Maximum daily concentration not exceeded more than once every 3 years	Criteria in NR 105.05 Wis. Adm. Code
Chronic aquatic toxicity indicators			
Ammonia, Arsenic$^{(+3)}$*, Cadmium*, Chloride, Chlorine (total residual), Chromium$^{(3+)}$*, Chromium$^{(+6)}$*, Copper*, free Cyanide, Dieldrin, Endrin, Lead*, Mercury$^{(+2)}$*, Nickel*, Parathion, Pentachlorophenol, Selenium, and Zinc*	2 values within a 3-year period	Maximum 4-day average concentration not exceeded more than once every 3 years	Criteria in NR 105.06 Wis. Adm. Code

[13] A chronic value determination for a water can be made if a single data point is available over a 4-day period.

6.7 Other Physical/Chemical Indicators

Other physical/chemical parameters in Table 25 can be used in best professional judgement assessment determinations. For other physical/chemical parameters listed in Table 26 and Table 27 monitoring data are evaluated against minimum data requirements, specific thresholds and allowable exceedance frequencies as indicated in the table. If readily available data for the parameters listed are evaluated and determined to be insufficient (i.e., does not meet minimum data quantity requirements), but the limited data indicates a potential use impairment, the waterbody may be a designated as a "Watch Water," and assigned a higher priority for monitoring in the near future.

Table 25. Additional parameters for impairment assessments. These parameters can be used in Best professional judgment evaluations or as part of other criteria (e.g., hardness is needed for some toxicity assessments).

Parameters		
• Alkalinity	• Land Use	• Sediment Chemistry
• Biochemical Oxygen Demand	• Nitrogen – Total Kjeldahl	• Solids – Total Suspended
• Flow	• Nitrogen – (Nitrate & Nitrite)	• Solids – Settleable
• Habitat – Qualitative	• Organic Compounds*	• Specific Conductivity
• Habitat – Quantitative	• Periphyton	• Toxicity – Sediment
• Hardness	• Phosphorus – Ortho	• Transparency

* = Numeric Water Quality Criteria are available in chs. NR 102 or 105, Wis. Adm. Code

Table 26. Aquatic Life Use impairment thresholds for lake and reservoir natural communities.

Indicators	Min. Data Requirement[1]	Exceedance Frequency (see text for details)	Impairment Thresholds – LAKES & RESERVOIRS – Aquatic Life Use				
			Shallow		Deep (Stratified)		
			Drainage[2] Lake	Seepage Lake	Drainage[2] Lake	Seepage Lake	Two-story fishery lake
Biological indicators							
Chlorophyll-*a*	3 monthly values from each of two years[3] from the period July 15 –Sept. 15	Lower bound 80% CI of the mean exceeds threshold	≥27 µg/L (≥63 TSI)		≥27 µg/L (≥63 TSI)		≥8 µg/L (≥51 TSI)
Aquatic plant metrics (MAC-Gen tool)	Baseline aquatic plant survey	1 survey	These threholds are in Table 20.				
Conventional physical-chemical indicators							
Total phosphorus (TP)[3]	3 monthly values from each of two years[4] from the period June 1 –Sept. 15	Lower bound 80%CI of the mean exceeds threshold	≥40 µg/L		≥30 µg/L	≥20 µg/L	≥15 µg/L
Dissolved oxygen (DO)	10 discrete[5] epilimnetic values (ice free period, epilimnetic samples)	Greater than 10% of values	< 5 mg/L				Refer to 6.5 Oxythermal Habitat
Temperature	20 discrete[5] values collected within a given calendar month	Greater than 10% of daily maximum or any weekly average temperature values[6] in a calendar month	Table 21 holds the acute temperature criteria by calendar month for non-specific waters				
pH	10 discrete[5] values collected within a given calendar month	Vary (see thresholds)	- Outside the range of 6.0-9.0 - Change >0.5 units outside natural seasonal maximum (mean) & minimum (mean). (Based on historical data or reference site.)				
Aquatic Toxicity-based indicators							
Acute aquatic toxicity	2 values within a 3-year period	Maximum daily concentration not exceeded more than once every 3 years	Criteria in NR 105.05 Wis. Adm. Code				
Chronic aquatic toxicity		Maximum 4-day concentration not exceeded more than once every 3 years	Criteria in NR 105.06 Wis. Adm. Code				

(1) Smaller datasets may be considered in certain cases, such as a high magnitude of exceedance.
(2) "Drainage" refers to both Headwater and Lowland Drainage natural communities.
(3) Phosphorus criteria do not apply to lakes with less than 5 acres in surface area (NR 102.06(6)(b)).
(4) When used in combination with TP criteria exceedance to assess impairment, chlorophyll data from only one year is required.
(5) Discrete values refer to samples collected on separate calendar days. DO, temperature, and pH criteria are taken from s. NR 102.04, Wis. Adm. Code, Water Quality Standards for Wisconsin Surface Waters.
(6) Weekly average temperature values are calculated using the daily max values when comparing data against applicable sub-lethal criterion.

Table 27. Aquatic Life Use impairment thresholds for streams and rivers.

Parameters	Minimum Data Requirement[1]	Exceedance Frequency	Impairment Thresholds – STREAMS & RIVERS – Aquatic Life Use			
			Cold Waters	Warm Waters	Limited Forage Fish	Limited Aquatic Life
Conventional physical and chemical indicators						
Dissolved Oxygen	3 days of continuous measurements (no less than 1 sample per hour) in July or August collected from each of 2 separate calendar years.	Greater than 10% of values	<6.0 mg/L and <7.0 mg/L during spawning season[2]	<5.0 mg/L	<3.0 mg/L	<1.0 mg/L
Temperature	20 discrete daily values[3] or days of continuous temperature data collected within a given calendar month to assess against acute and sub-lethal criteria, respectively.	Greater than 10% of daily maximum values or any weekly average temperature value in a calendar month exceeds acute criteria or sub-lethal criteria, respectively.	Table 21 holds the acute temperature criteria by calendar month for non-specific waters			
pH	10 discrete daily values[3]	Greater than 10% of values within a continuous sampling period or for instantaneous within season	Outside the range of 6.0 to 9.0 standard units (SU), or change is > 0.5 SU outside natural seasonal maximum (mean) and minimum (mean)			
Total Phosphorus[4]	6 samples monthly from May through October	Lower bound 80% CI of the median exceeds threshold	≥0.100 mg/l for rivers; ≥0.075 mg/l for streams			
Biological indicators						
Fish IBI	1 value when used in combination with TP data. For a standalone bio-assessment, 1 value from each of 2 years within 5 years	1 value when used in combination with TP data. For a standalone AL listing, average value from 2 samples across 2 years	See "poor" condition thresholds in Table 12.			
Macroinvertebrate IBI	1 value when used in combination with TP data. For standalone bio-assessment, 1 value from each of 2 years within 5 years	1 value when used in combination with TP data. For standalone AL listing, average value from 2 samples across 2 years	See "poor" condition thresholds in Table 13 and Table 14.			

(1) Smaller datasets may be considered in certain cases, such as a high magnitude of exceedance.
(2) Spawning season threshold does not apply to Class III Trout waters.
(3) Discrete values refer to samples collected on separate calendar days.
(4) One 'poor' F-IBI or one 'poor' M-IBI is also required to corroborate the impairment of the AL use for standard impaired waters Category 5A listings. Streams exceeding TP criteria alone will be placed in an impaired waters subcategory, Category 5P.

Note: Data are evaluated from within the most recent 10-year period for all parameters.

7. Recreation Use Assessment

Recreation Use is protective of full body immersion in the state's waterbodies. Two of the major issues for recreation are algal blooms and pathogens. All assessments follow the data requirements outlined in Chapter 4. General Aspects of Data Assessment.

7.1 Total Phosphorus (TP)

For Recreation uses, TP data are assessed in the same way as described in Chapter 6.1 Total Phosphorus (TP). As with Aquatic Life listings the phosphorus data should be reviewed in combination with phosphorus response indicators to determine listing category (described in 6.1.5 Applying a Combined Approach: Phosphorus Response Indicators).

7.1.1 Chlorophyll-a (Algal blooms) (Lakes, Reservoirs, Impounded Flowing Waters, Large Rivers)

The recreation thresholds for chlorophyll-*a* found in Table 28 also apply as phosphorus response indicators. In addition to lakes and impounded flowing waters, large rivers have been assigned an impairment threshold of exceeding 20 ug/L for more than 30% of days during the summer sampling period of July 15 to September 15, as calculated following the methods outlined in 7.2.1 Chlorophyll-a (Algal blooms). These thresholds are used only when phosphorus concentrations are within the combined approach range (Table 15).

7.1.2 Benthic Algal Biomass (Streams)

Benthic algal biomass also applies as a phosphorus response indicator for recreation use in streams. Methods are the same as in section 6.1.9 Benthic Algal Biomass & Diatom Taxa, except diatom taxa are not used. Waters with a viewing bucket score of greater than 2 are considered not attaining (Table 17).

7.2 Biological Metrics

7.2.1 Chlorophyll-a (Algal blooms) (Lakes, Reservoirs, Impounded Flowing Waters)

Algae, including blue-green algae, are naturally occurring organisms found throughout the state and are an important part of Wisconsin's freshwater ecosystem. However, excessive nutrient loading (particularly phosphorus) can cause algae populations to grow rapidly under certain environmental conditions and form "blooms" that can impact water quality and pose health risks to people, pets, and livestock. Blue-green algae pose the greatest nuisance and risk to people. Most blue-green algae are buoyant, and when populations reach bloom densities, they float to the surface where they form scum layers or floating mats. In Wisconsin, blue-green algae blooms generally occur between mid-June and late September, although in rare instances, blooms have been observed in winter, even under the ice.

Algae blooms can cause many water quality problems, including a) discoloration of water; b) taste and odor concerns; c) reduced light penetration affecting the ability of macrophytes to thrive; and d) reduced DO concentrations due to massive decomposition of the cells when they die. Another potentially harmful consequence of blue-green algae is their ability to produce naturally occurring toxins. Effects of algal toxicity and related thresholds are discussed further in the Public Health and Welfare Uses chapter.

Chlorophyll assessments for Recreation Use are based on the frequency of moderate algal levels; above moderate algal levels recreation is impeded. Moderate algal levels are defined as 20 µg/L chlorophyll-*a*.

Table 28. Chlorophyll-*a* assessment thresholds by waterbody type and phosphorus subcategory. Terms used for waterbody types and subcategories are defined in NR 102.03. These thresholds do not apply to streams or rivers.

Waterbody Type	Phosphorus Subcategory	Assessment Threshold
Lakes, Reservoirs,Impounded Flowing Waters (includes cold and warm)	Impounded flowing water, Unstratified drainage, Unstratified seepage	Does not exceed 20 ug/L for more than 30% of days during the summer sampling period
	Stratified drainage, Stratified seepage	Does not exceed 20 ug/L for more than 5% of days during the summer sampling period
	Stratified two-story fishery	

7.2.1.1 Data Requirements, Calculations, and Application

For Chlorophyll-*a* Recreation use assessments, the same protocols apply for data selection, calculating a grand mean, and comparison to thresholds as those described in 6.1 Total Phosphorus (TP) with the following exceptions:

Data Requirements

Sampling Frequency and Seasonal Range. The target date range is July 15 – Sept. 15, which should result in one sample for each of July, August, and September. However, if sampling within that window is not possible, data will be accepted if it is collected within one week of the sample season (i.e., July 8-Sept. 22).

Calculations

C*alculate Monthly Mean*: Number of samples required to meet assessment requirements: For chlorophyll-*a*, the minimum number of monthly means and years required depends on whether the assessment is being used as a 'biology only' (i.e., standalone) impairment listing for chlorophyll-*a*, or whether it is being used in conjunction with TP for an impairment listing. For a 'biology only' assessment there need to be 3 monthly means over two qualifying years, for a total of 6 samples. For use in conjunction with TP there need to be at least 3 monthly means in one qualifying year.

The following statistical formula replaces that found under the sub header 6.1.3 Calculation of Comparison Statistics.

The statistical formula for Chlorophyll-*a* Recreation assessments determines the frequency that a lake exceeds a specific chlorophyll threshold, and also calculates the two-sided 80% confidence interval. This formula is difficult to run manually but can be done through use of a programming package such as "R" (http://www.r-project.org/). Use the following procedure to calculate the percent of days a lake is exceeding 20 µg/L chlorophyll-*a* (P):

1. Using the chlorophyll sample values, calculate $= \frac{20-\bar{x}}{\sigma}$, where $\bar{x}$ is the sample mean and σ is the sample standard deviation.

2. Using the T table provided by the department[13], for each confidence level (lower bound of two-sided 80% CI, Tlow; median, Tmed; and upper bound of two-sided 80% CI, Thigh), and for the appropriate value of n (number of samples), find the value of T that is closest to the one calculated in step 1.
3. Report the value of P that is associated with the value of T that was selected in step 2.

Application
In the absence of meeting minimum data requirements (for instance, nearshore data are available but not from the deep station), the professional judgment of the District Biologist should be used to consider listing any waterbody that experiences frequent and severe algal blooms where there is strong reason to believe that designated uses are impaired and nutrient levels may be contributing to such blooms. Information such as taste and odor complaints, documentation of toxin-producing blue-green algae genera, and algal cell counts can be used as justification for impairment determinations based on best professional judgment.

7.2.3 Macrophytes (aquatic plants) (Lakes & Reservoirs)

Although healthy aquatic plant communities are necessary for a good quality lake system, impacted lakes that receive high nutrient inputs may respond not with excessive algal blooms (and the associated high chlorophyll-*a* values), but instead very high macrophyte growth that is matted and densely topped out across the lake surface. This can impact recreational boating and swimming if it becomes a severe problem.

The department has developed listing protocols based on macrophyte metrics for use in determining AL use impairments, as described in Chapter 6.2 on Biological Metrics for Aquatic Life. However, more research is needed to define how to appropriately conduct Recreation use assessments based on macrophytes. For use in future listing cycles, WDNR recognizes the importance of developing such a protocol and hopes to further investigate this issue through additional research and data review. Such research may investigate correlations between density of macrophytes or frequency of species occurrence with impacts such as inhibited Recreation uses or increased issuance of Aquatic Plant Management permits.

Invasive species such as Eurasian Water Milfoil and Curly Leaf Pondweed often contribute to high macrophyte levels. However, Wisconsin does not list waters as impaired due to invasive species, as no guidance is yet available from EPA on how to do so.

7.3 Pathogens – *E. coli*

To protect humans from illness caused by fecal contamination in surface waters during recreational contact, new *Escherichia coli* (*E. coli*) criteria were approved in 2020 (Table 29). These criteria replace the previous fecal coliform standards. There are two separate *E. coli* criteria, a Geometric Mean (GM) criterion and a Statistical Threshold Value (STV) criterion. The use of both GM and STV criteria protects against spikes in bacterial densities while allowing for natural variation in water quality. These criteria apply to lakes, reservoirs, impounded flowing waters, streams, rivers, inland beaches, and Great Lake beaches.

7.3.1 Data Requirements

a) *Period of record.* Data from the most recent 5 years is given preference as it is more representative of current conditions.

[13] The department can provide the appropriate T table file upon request as a CSV file (Ttable.csv).

b) *Sampling Frequency and Seasonal Range.* The assessment period in Wisconsin is May 1 to September 30. This time period is considered the default and can be extended beyond these dates based on recreation time frame for individual waterbodies.*

Within the assessment period a minimum number of values measured on separate calendar days within a 90-day period are required for comparison to the criteria. A minimum of 5 samples are required for comparison to the Geomean criterion; a minimum of 11 samples are required for comparison to the STV criterion (Table 29).

c) *Measurement Depth. E. coli* should be measured several inches below the surface, following *E. coli* collection protocols for each waterbody type. In lakes the maximum depth for collecting a subsurface sample is 6 ft (2 m). At beaches the typical maximum water depth for sample collection is 2 feet.

*This default period is consistent with the time frame during which dischargers typically disinfect their wastewater. Recreational patterns vary across the state. If recreational use on a specific waterbody or group of waterbodies is known to occur outside this date range the assessment period can be expanded based on best professional judgment on patterns of use.

7.3.2 Calculations

a) *Daily Maximum.* In cases where multiple samples exist for a given day, use the maximum value.

b) *Geometric Mean Criterion.* Calculate the geometric mean for each 90-day rolling period with distinct datasets (different set of data by even one value).

c) *Statistical Threshold Value (STV) Criterion.* Calculate the percent of values that exceed the STV criterion for each 90-day rolling period with distinct datasets (different set of data by even one value).

7.3.3 Application

a) *Exceedance Frequency.* Exceedance of the Geometric Mean criterion in any 90-day rolling period indicates impairment. Exceedance of the STV criterion by more than 10% in any given 90-day period indicates impairment. Listing for *E. coli* occurs when either or both criteria are exceeded.

All samples that meet data requirements will be used unless determined to be unrepresentative by the regional biologists (10.2 Professional Judgment). Enforcement samples (e.g., manure spill or sewerage overflow) will be taken into consideration when reviewing potential *E. coli* listings on a case-by-case basis. Use of enforcement samples does not preclude listing as it may be a chronic issue.

Table 29. The two criteria for *E. coli* in NR102 Wis. Adm. Code**.**

E. coli (counts[1] per 100 mL)	
Geometric Mean	**Statistical Threshold Value**
126	410

1. For determining attainment or compliance, counts are considered equivalent to either colony forming units (CFU) or most probable number (MPN).
2. The geometric mean shall not be exceeded in any rolling 90-day period during the recreation season.
3. The statistical threshold value shall not be exceeded more than 10 percent of the time during any rolling 90-day period during the recreation season.

7.3.4 Delisting E. coli

When a water demonstrates no exceedances of either *E. coli* criteria within the past 5 years then it is a candidate for delisting. Best professional judgment may be used to determine if all the recent 5 years are representative of current conditions. For example, if a best management practice (BMP) has taken place on the landscape to reduce the bacterial load of a water, then the bacteria data prior to BMP implementation could potentially be excluded from the assessment. Beach-specific delistings can take into consideration the number of days the beach was closed during the recreation season. If a beach has been closed for greater than 10% of the recreation season but the *E. coli* data do not exceed criteria, additional data can be requested before a delisting decision is made.

Table 30. Recreation impairment thresholds for lake and reservoir natural communities.

Indicators	Min. Data Requirement (see text for details)	Exceedance Frequency (see text for details)	Impairment Threshold – LAKES & RESERVOIRS – Recreation Use				
			Shallow		Deep (Stratified)		
			Drainage[1] Lake	Seepage Lake	Drainage[1] Lake	Seepage Lake	Two-story fishery lake
Conventional physical-chemical indicators							
Total phosphorus (TP)	3 monthly values from each of two years from the period June 1 – Sept. 15	Lower bound of 80% CI of the mean exceeds threshold	≥40 µg/L		≥30 µg/L	≥20 µg/L	≥15 µg/L
Biological indicators							
Chlorophyll-*a*	3 monthly values from each of two years[2] from the period July 15 –Sept. 15	Lower bound of 80% CI of the mean exceeds threshold	> 30% of days in sampling season have moderate algal levels (> 20 µg/L)		> 5% of days in sampling season have moderate algal levels (> 20 µg/L)		
Aquatic plant metrics	Baseline aquatic plant survey	*N/A (one survey)*	*(reserved until guidance available)*				
Pathogenic indicator							
E. coli	5 daily values within a rolling 90-day period	Any one 90-day geomean exceeds GM threshold	126 counts/ 100 mL				
	11 daily values within a rolling 90-day period	In any one 90-day period >10% of samples exceed STV threshold.	410 counts/ 100 mL				

(1) "Drainage" applies to both Headwater and Lowland Drainage natural community types.
(2) When used in combination with a TP dataset for impairment assessments, chlorophyll data from only one year is required.

Note: For all parameters, the assessment period is the most recent 10-year period, but data from within the most recent 5-year period are prioritized for impairment assessments.

Table 31. Recreation impairment thresholds for streams and rivers.

Indicators	Min. Data Requirement (see text for details)	Exceedance Frequency (see text for details)	Impairment Threshold – STREAMS & RIVERS – Recreation Use	
			Streams	Large River
Conventional physical-chemical indicators				
Total phosphorus (TP)	6 samples monthly from May through October	Lower bound 80% CI of the median exceeds threshold	75 ug/L	100 ug/L
Phosphorus Response Indicators				
Chlorophyll-*a*	3 monthly values from each of two years(2) from the period July 15 –Sept. 15	Lower bound of 80% CI of the mean exceeds threshold	NA	> 30% of days in sampling season have moderate algal levels (> 20 µg/L)
Benthic Algal Biomass	One survey (July – September)	One survey	Viewing bucket score greater than 2	NA
Pathogenic indicator				
E. coli	5 daily values within a rolling 90-day period	Any one 90-day geomean exceeds GM threshold	126 counts/ 100 mL	
	11 daily values within a rolling 90-day period	In any one 90-day period >10% of samples exceed STV threshold.	410 counts/ 100 mL	
Note: For all parameters, the assessment period is the most recent 10-year period, but data from within the most recent 5-year period are prioritized for impairment assessments.				

8. Public Health and Welfare Use Assessment

Wisconsin's water quality standards specify that all surface waters shall be suitable for supporting the Public Health and Welfare designated use. To protect the Public Health and Welfare use of waters of the state, water quality criteria were established, including temperature, taste and odor criteria, as well as human health criteria in ss. NR 105.08 and 105.09, Wis. Adm. Code, to protect humans from adverse effects resulting from contact with or ingestion of surface waters and from ingestion of aquatic organisms taken from surface waters. The human threshold criteria (HTC) were derived for those toxic substances for which a threshold dosage or concentration can be estimated below which no adverse effect or response is likely to occur. The human cancer criteria (HCC) are the maximum concentrations of substances established to protect humans from an unreasonable incremental risk of cancer resulting from contact with or ingestion of surface waters and from ingestion of aquatic organisms taken from surface waters.

Waters for which available datasets meet minimum data requirements are assessed against the applicable criteria, which may vary depending on the assigned AL use and whether the waterbody is a public water supply. Waters with two or more discrete values within a consecutive 3-year period (within the current 10-year assessment period) will be assessed against the applicable criteria. Discrete values refer to samples collected at least 30 days apart.

One exceedance within a 3-year period is allowed, while waters with two or more HTC or HCC criteria excursions within a 3-year period fail to meet the criteria and the Public Health and Welfare use is deemed not supported.

8.1 Blue-green Algal Toxin Health Risks (Harmful Algal Blooms)

Algal toxins can be harmful to humans and animals alike through skin contact (e.g., when swimming), inhalation (e.g., when boating or water skiing), or ingestion (swallowing water). Some of the species commonly found in Wisconsin that produce algal toxins include *Anabaena* spp., *Aphanizomenon* spp., *Cylindrospermopsis raciborskii*, *Dolichospermum* spp., *Microcystis* spp., and *Planktothrix* spp. During a harmful algal bloom (HAB), the algal toxin concentrations can be elevated before and after the bloom is visible. Measuring and evaluating toxin levels can protect human health through swimming advisories and identifying waters with long-term HAB issues.

In 2019 EPA published recommended thresholds for Microcystin and Cylindrospermopsin (Table 32, EPA 2019). EPA recommended the thresholds be used for state waterbody assessments and creation of swimming advisories. WDNR encourages local public health agencies to use these thresholds for creation of swimming advisories. Although WDNR chose not to implement these thresholds as numeric criteria, WDNR may also use the thresholds to determine if waters are attaining their Public Health and Welfare Use when necessary. For this purpose, best professional judgment is used to determine whether a waterbody exceeds EPA's recommended algal toxin thresholds, duration, and frequency, using Table 32 as a guideline.

Table 32. EPA 2019 recommended thresholds for algal toxins Microcystin and Cylindrospermopsin, including duration and frequency for recreation (public health) vs swimming advisory evaluation.

		Duration & Frequency	
Indicator	**Threshold (µg/L)**	**Public Health**	**Swimming Advisory**
Microcystin	8	≥3 excursions[1] per recreation season[2] in more than one year	Any exceedance during recreation season[2]
Cylindrospermopsin	15		

1. In a 10-day assessment period, if thresholds are exceeded then it is counted as an excursion.
2. Recreation season is, at minimum, May 1 to September 30, but can be expanded based on best professional judgement if recreational use on a specific waterbody or group of waterbodies is known to occur outside this date range.

When a waterbody is proposed to be included on the impaired waters list due to frequent and elevated blue-green algal toxins, the impairment indicator in the WATERS database is identified as "Recreational Restrictions – Blue-green Algae." If the cause of impairment can be identified (e.g., total phosphorus concentrations), then the pollutant is also listed. In the absence of meeting minimum data requirements to assess pollutant data (for instance, nearshore TP data is available but not deep station data), professional judgment should be used to consider listing any waterbody that experiences frequent and severe blue-green algal blooms or elevated levels of toxins where there is strong reason to believe that nutrient levels may be contributing to such blooms.

8.2 PFOS and PFOA

Poly- and perfluoroalkyl substances (PFAS) are human-made, organic compounds that have been manufactured for use in non-stick coatings, waterproof fabrics, firefighting foams, food packaging, and many other applications since the 1940s. PFAS are highly resistant to

degradation and have been detected globally in water, sediment, and wildlife. This global distribution is of concern as PFAS have documented toxicity to animals and because epidemiological studies have suggested probable links to several human health effects.

In 2022 surface water quality criteria were codified for two types of PFAS, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) (Table 33). These criteria represent levels of public health significance for the two types of PFAS based on preventing adverse effects from contact with or ingestion of surface waters of the state, or from ingestion of fish taken from waters of the state.

Table 33. Wisconsin DNR surface water criteria for PFOS and PFOA.

Indicator	Threshold (ng/L)	Minimum Data Requirement	Duration & Frequency
PFOS	8*	2 values within a 3-year period	>1 exceedance within a 3-year period
PFOA	95**		

* For all waters except those that cannot naturally support fish and do not have downstream waters that support fish.
**Surface waters not designated as public drinking water supply. See 8.5.6 PFOA for drinking water criteria.

Waters with two or more discrete values within a consecutive 3-year period (within the current 10-year assessment period) will be assessed against the applicable criteria. Discrete values refer to samples collected at least 30 days apart. One exceedance within a 3-year period is allowed, while waters with two or more criteria excursions within a 3-year period fail to meet the criteria and the Public Health and Welfare use is deemed not supported.

8.3 Fish Consumption Assessment

Waterbodies may be designated as impaired on the 303(d) list based on the level of fish consumption advice, which, in Wisconsin, is due primarily to mercury, PCBs, dioxin and furan congeners, and perfluorooctane sulfonate (PFOS). EPA generally considers that fish consumption advisories (FCAs) demonstrate impairment of CWA section 101(a) “fishable” uses. This applies to fish consumption advisories for all pollutants that constitute potential risks to human health, regardless of the source of the pollutant (2006 EPA IR Memo).

A waterbody is placed on the impaired waters list for the pollutant causing the specific advisory. Site specific advisories are created when game and panfish species require advice more stringent than the statewide general advice based on examination of data in conjunction with Wisconsin Department of Health Services.
APPENDIX C. Summary of Fish Tissue Criteria for Fish Consumption Advice, lists the fish tissue contaminant thresholds that are used when developing fish consumption advisories.

Specific waters are proposed for de-listing when chemical analysis of fish tissue demonstrates the general statewide advisory is adequate, and exceptions are not necessary. The general fish consumption advisory will still apply to these waters, but they will no longer be included on the 303(d) list.

Wisconsin Departments of Natural Resources and Health Services jointly manage the fish contaminant monitoring and advisory programs. The monitoring strategy for fish contaminants varies by the pollutant and the waterbody. WDNR fisheries staff conducts the fish sampling supported by a variety of fisheries funds. The Wisconsin State Laboratory of Hygiene supports most chemical analyses through general revenue and an agreement with the WDNR. Some EPA funds are used for supplies, lab and freezer rentals, advisory publications, and special analyses.

More information about the specific consumption advisory can be found in the publication: "Choose Wisely, A Healthy Guide for Eating Fish in Wisconsin" (PUB-FH-824 2020 or subsequent years). It is available online at https://dnr.wisconsin.gov/topic/fishing/consumption/.

8.4 Contaminated Sediment Assessment

Waterbodies that have sediment deposits that are known to have toxic substances that exceed state water quality criteria for ambient water (as specified in ch. NR 105, Wis. Adm. Code) will be included on the Impaired Waters List. These waters may be identified through various monitoring activities, including routine water quality monitoring, sediment analysis, and collection of fish tissue. In addition to a comparison to the water quality criteria found in ch. NR 105, Wis. Adm. Code, WDNR compares sediment concentrations of commonly found contaminants to the values outlined in a sediment quality guidance document *Consensus-Based Sediment Quality Guidelines, RR088, 2003*. The guidance was developed through an assimilation of results from multiple published effects-based toxicity testing to freshwater benthos and serves as part of a tiered approach to evaluating potential ecological and human health risks at sites under evaluation for various reasons.

8.5 Public Water Supply Use Assessment

The Public Health and Welfare designated use found at s. NR 102.04 (7), Wis. Adm. Code, contains a designation for public drinking water supply. The public water supply use is a subcategory under the Public Health and Welfare designated use. Chapter NR 104, Wis. Adm. Code, contains the listing of specific waterbodies that are to meet "the public water supply standard." Of the waters assigned the public water supply use, Lakes Winnebago, Superior and Michigan (including Green Bay) are the surface waters currently used as a source for a public water supply.

Surface water quality standards were established to protect public water supply (PWS) source waters to the extent that the PWS can meet the Safe Drinking Water Act (SDWA) standards using only conventional treatment technologies as defined by the SDWA. The PWS use will be assessed, where data that meet minimum data quantity and quality requirements are readily available, by comparing ambient source (i.e., raw) water data or PWS facility intake data against applicable human health surface water quality standards in ch. NR 105, Wis. Adm. Code, and additional water quality indicators for which surface water quality standards are not yet established. Assessment indicators and methods are described below.

8.5.1 Cyanobacteria (Blue-green Algae) Toxins

There are no federal or state regulatory standards for cyanobacteria toxins (cyanotoxins) in drinking water. However, the World Health Organization (WHO) adopted a provisional drinking water guideline value of 1.0 µg/L for microcystin-LR (WHO 1998). Since the cyanobacteria thresholds are based on acute exposures, assessment methods will be based on a maximum concentration not to be exceeded. Source waters with finished water samples showing two or more excursions in a 3-year period above the WHO guideline for microcystin-LR (1.0 µg/L) will be identified as impaired and not supporting the PWS use. The assessment will also consider whether the dataset is representative of the current conditions of the source water. Quality assured sample data from ambient (raw) water or PWS intakes will be evaluated from the most recent 10-year period of record; two or more discrete values within a consecutive 3-year period are required to assess against the applicable criteria. Discrete samples are those collected at least 30 days apart; multiple samples collected within a 30-day period will be averaged.

8.5.2 Nitrate

Elevated levels of nitrate can cause acute health effects. The SDWA finished water standard of 10 mg/L will be applied as a maximum concentration not to be exceeded. Using this indicator, the PWS use is not supported when two or more discrete samples exceed the SDWA Maximum Contaminant Level (MCL) standard within a 3-year period. Quality assured sample data from ambient (raw) water or PWS finished water will be evaluated from the most recent 10-year period of record; two or more discrete values within a consecutive 3-year period are required to assess against nitrate standard. Discrete samples are those collected at least 30-days apart; multiple samples collected within a 30-day period will be averaged. Source waters with nitrate sample datasets showing concentrations exceeding 5 mg/L will be identified as "watch waters" and prioritized for additional monitoring to evaluate nitrate concentration trends.

8.5.3 Cryptosporidium

Public water systems are required to collect *Cryptosporidium* raw water samples at a minimum frequency of monthly over a two-year period at their point of intake in order to fulfill SDWA regulations. The maximum rolling annual average *Cryptosporidium* concentration is used to place the public water system in SDWA Bin classifications of 1 through 4. Concentrations of *Cryptosporidium* greater than or equal to 1.0 oocysts/L place the system in Bin 3 or 4 and require additional treatment beyond conventional or source water controls in the watershed. Therefore, the PWS use will be deemed as not supported for source waters when one or more public water supply systems fall in Bins 3 or 4.

8.5.4 Pollutants with Human Health-based Water Quality Criteria

Human health criteria in ss. NR 105.08 and NR 105.09, Wis. Adm. Code, are established to protect humans from adverse effects resulting from ingestion of surface waters of the state and from ingestion of aquatic organisms taken from surface waters of the state. The human threshold criteria (HTC) are derived for toxic substances that have a threshold dosage or concentration below which no adverse effects or responses are likely to occur. The human cancer criteria (HCC) are the maximum concentrations of substances established to protect humans from an unreasonable incremental risk of cancer resulting from contact with or ingestion of surface waters of the state and from ingestion of aquatic organisms taken from surface waters of the state. The applicable HTC and HCC are determined both by a waterbody's AL use subcategory and whether the waterbody is a public water supply.

Source waters having readily available pollutant datasets containing two or more discrete sample values within a consecutive 3-year period (from the current 10-year assessment period) will be assessed against the applicable HTC or HCC criteria. Discrete samples are those collected at least 30-days apart; multiple samples collected within a 30-day period will be averaged. Source waters with two or more excursions in a 3-year period may be identified as impaired and not supporting the PWS use.

8.5.5 Taste and Odor-producing Substances

Available information regarding non-natural substances producing taste and odor will be assessed against the taste and odor criteria found in NR 102.04(8)(b), Wis. Adm. Code. In addition, the public water supply use will be deemed not supported when taste and odor substances are present in quantities requiring additional treatment by the public water supply to prevent taste and odor problems.

8.5.6 PFOA

The exposure route of concern for PFOA is ingestion of surface water. Drinking water supply waterbodies in the state are subject to a PFOA criterion of 20 ng/L. Source waters having

readily available pollutant datasets containing two or more discrete sample values within a consecutive 3-year period (from the current 10-year assessment period) will be assessed. Discrete samples are those collected at least 30-days apart; multiple samples collected within a 30-day period will be averaged. Source waters with two or more excursions in a 3-year period may be identified as impaired and not supporting the PWS use.

9. Wildlife Use Assessment

Wildlife criteria protect wildlife that consume surface water and aquatic organisms. Table 34 shows the wildlife criteria in NR 105.07(1), Wis. Adm. Code.

Table 34. Wildlife Criteria from NR105.07.

Substance	Criteria (ng/L, except where indicated)	Minimum Data Requirement	Exceedance Frequency
DDT & Metabolites	0.011	2 values within a 3-year period	Criteria not exceeded more than once every 3 years
Mercury	1.3		
PCBs	0.12		
2,3,7,8 – TCDD	0.003 (pg/L)		

10. Decision Making - To List or Delist Waters

Once data have been assessed to determine whether any parameters indicate impairment of a waterbody, a decision to list a waterbody as impaired or to delist a waterbody should be made. There are several nuances to this decision that are discussed in this chapter. These include resolution of conflicting results from different parameters on a waterbody, identification of which Use Designations are impaired, determination of the appropriate EPA category, and identification of "Causes" and "Sources" of impairment.

When minimum data requirements are met, an attainment decision should be made and documented. When a decision is made to not list a waterbody due to insufficient data, where limited data show criteria excursions, the water is identified as a "Watch Water," as defined in section 10.3 Threatened Waters and Watch Waters, and prioritized for future monitoring to collect sufficient data for future assessment. All assessment results and impaired waters listing details are documented in the WATERS database.

10.1 Independent Applicability & Tools to Resolve Data Conflicts

Under Federal guidance, a water shall be listed on the Impaired Waters List if data is reflective of current conditions, data has met minimum data requirements, and the water does not meet WQS, including water quality criteria, designated uses, and/or antidegradation. This decision philosophy is referred to as *independent applicability,* consistent with the CWA that protects biological, chemical, and physical integrity of surface waters. However, EPA recognizes that there are certain situations in which factors beyond a strict interpretation of Independent Applicability should be considered to make the most appropriate listing decision. When assessing whether a water is attaining narrative WQS, for example, a suite of indicators is often used. Accordingly, EPA allows states to formulate specific decision rules pertaining to circumstances under which one type of parameter should be given a greater 'weight' than others.

Wisconsin has developed decision rules that use a hierarchy of indicators for certain parameters, which are described within the Lakes and Rivers & Streams chapters of this guidance document.

If one of the WQS are not met, but multiple data sets produce conflicting results (some indicating impairment and some not), WDNR staff should review all available data to assist in making an attainment decision. There are several factors biologists may use to resolve these differences to arrive at a listing decision. A decision matrix describes the process for not making attainment decisions using independent application (Figure 14). Cases where this process is used will be rare and should be well documented for that wate in the WATERS database.

Independent Application Decision Matrix for Multiple Assessment Indicators

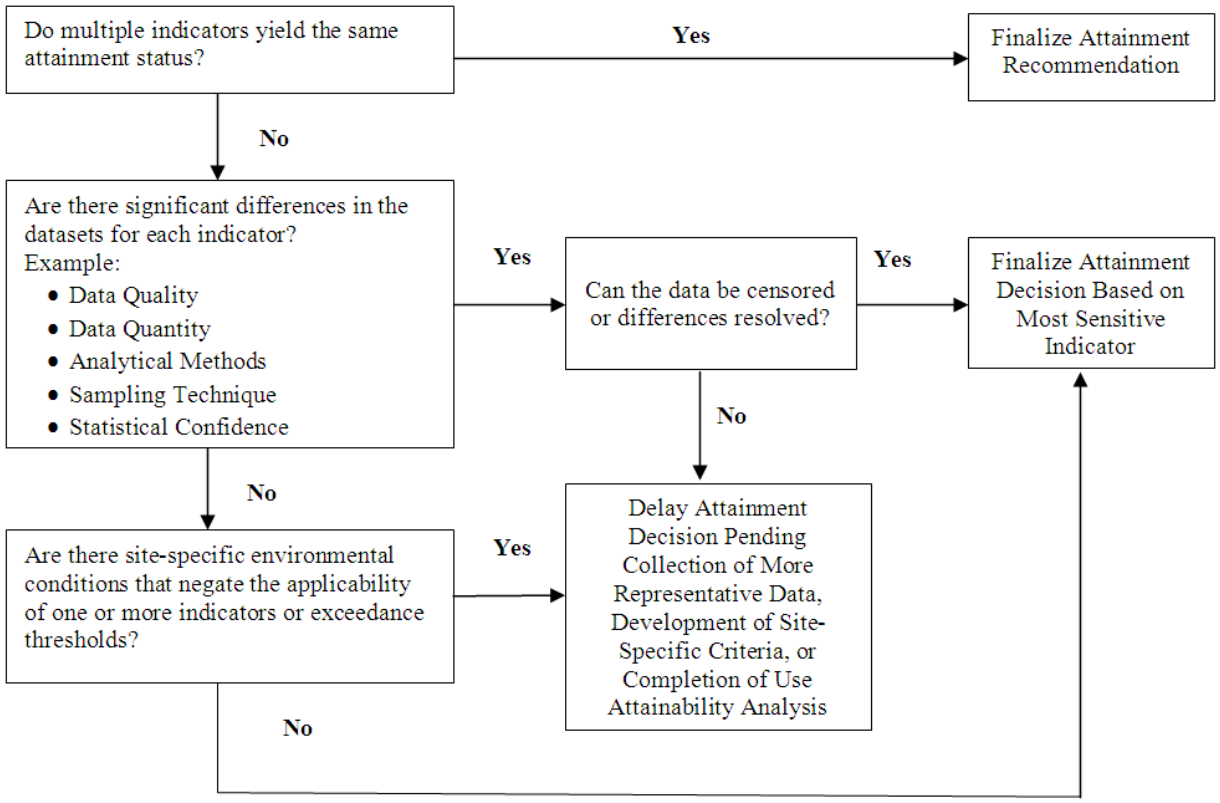


Figure 14. Independent Application Matrix.

10.1.1 Data quality differences

If one parameter indicates impairment but another does not, differences between the two data sets in data quality, data quantity, analytical methods, sampling technique or statistical confidence may provide reason to weight one set of data more heavily than another.

10.1.2 Site-specific factors

Natural background levels of a pollutant may be higher than impairment thresholds or uncontrollable factors may cause an exceedance of WQS. In these circumstances, WDNR will determine whether criteria exceedance are reasonably expected to be due to natural or uncontrollable causes, as defined in the “Six Factors” of Use Attainability Analysis [40 CFR 131.10(g)]. If assessment documentation supports that impairment is due to natural or

uncontrollable factors, a Use Attainability Analysis (UAA) should be pursued to modify the Designated Use and/or associated criteria. However, a water with suspected naturally occurring pollutant levels that exceed applicable water quality criteria should be placed on the Impaired Waters List under Category 5C, until the appropriate designated use and/or site-specific water quality criteria have been approved by WDNR and EPA. Category 5C waters are those that are identified as impaired, but the cause of the impairment may be attributed to natural or uncontrollable source(s).

10.1.3 Weight of Evidence

In certain cases where data sets conflict with one another, states may apply a "weight of evidence" approach. This approach helps define the extent of the problem based on how it impacts the Designated Use and allows biologists to consider aspects of the data that might indicate whether one data set should be weighted more greatly than another.

In all cases, Department staff will look for corroborating information such as the various habitat and biological indices and water chemistry data. If the suite of available data does not suggest an evident impairment, then the water will not be listed but will be recommended for additional monitoring as resources allow. WDNR will provide a rationale for those cases where data are available that show that a water quality criterion has been exceeded, but the water has not been recommended for the impaired waters list. In those cases, the indicator has not reached the magnitude, duration or frequency to warrant placing a waterbody on the list or the available data from a particular indicator are not representative of current conditions.

10.1.4 Hierarchy of Indicators

In some situations*, a hierarchy of the indicators may be appropriate*. For example, biological indicators (e.g., fish or macroinvertebrate IBI) for assessment of the AL use may have precedence over physical or chemical indicators in the impairment decision process because they are direct measures of health of aquatic life. However, this hierarchical approach should be used with caution, knowing that exceedance of chemical indicators may correspond to a more recent event that was not reflected in the biological community data due to differences in collection periods or delays in community response. In such a case, a decision to rely on a hierarchical approach would be inappropriate.

When assessing waters against the applicable phosphorus criteria, biological data are used in combination with phosphorus data to determine whether the AL use is currently impaired. If biological impairment is observed, the water is placed in the standard impaired waters category (5A). If the water exceeds phosphorus criteria but biological impairment is not observed, the water is placed in an impaired water subcategory (5P) that is given a lower priority for management actions until biological impairment is confirmed.

10.2 Professional Judgment

WDNR staff most familiar with a waterbody should be directly involved in the assessment decision. Staff knowledge and experience should be considered along with the factors that influence water quality when reviewing and interpreting available data. Professional staff should explore a myriad of issues to determine the most relevant and appropriate data to use for attainment decisions, including: data quality, frequency and magnitude of exceedances, weather and flow conditions during sample collection, anthropogenic or natural influences on water quality in the watershed, etc. If any available data is not used because of professional judgment, clear documentation of the reasons for doing so should be included in the final attainment decision. Regardless of what listing decision is made, all decisions should be *well documented* within the database and future management recommendations will be noted (for example, a

formal use designation change is needed in order to list the water as impaired, and a recommendation would be made in WATERS to reflect this need).

Two specific review stages occur during the assessment process when regional water resource biologists review the preliminary assessment results. The first review is a data review of the automated database assessment packages. The package results include a series of downloadable reports and spreadsheet outputs for some assessment parameters, which are provided to biologists for review. At that time, reviewers may document justification for a different assessment result based on data quality, additional data and/or waterbody classification errors. After incorporating all assessment and listing modifications from the data review, a team will review the draft assessment results and make recommendations for any needed modifications. The following questions may be considered during the professional judgment review stage:

- Are the data from appropriate weather and flow conditions, or are they limited to critical hydrological regimes (low and high flows)? If data are available only from extreme weather years (as defined in Section 4), should that dataset be supplemented with data from current conditions before making an assessment decision?
- Are data representative of current water quality conditions?
- Have land uses or point sources changed substantially since the data were collected?
- If the minimum data requirements are not met, do the limited data provide overwhelming evidence of impairment (e.g., phosphorus dataset does not meet minimum data requirements, but biological impairment has been documented, or the phosphorus criterion is exceeded by double)?

10.3 Threatened Waters and Watch Waters

Wisconsin recognizes *threatened* waters as defined by the United States Environmental Protection Agency (EPA):

> *Any waterbody of the United States that currently attains water quality standards, but for which existing and readily available data and information on adverse declining trends indicate that water quality standards will likely be exceeded by the time the next list of impaired or threatened waterbodies is required to be submitted to EPA.*

Waters identified as *threatened* waters become a formal part of the Impaired Waters List, with all the ramifications associated with impaired waters. Currently no guidance exists on how to formally list *threatened* waters as impaired, however, waters that fall into this category may be evaluated on a case-by-case basis. A biologist would have to provide sufficient data and information (e.g., 5-10 years of data and multiple samples per year to run a regression analysis) that clearly shows a “declining trend” to predict that the water would be impaired by the next listing cycle. If such significant data exists, the water could be considered for listing as threatened on the Impaired Waters List.

Watch Waters are those for which limited data indicate potential impairment, but insufficient data are available to make a final impairment decision, and, therefore, are identified for further monitoring. These waters are not included on the Impaired Waters List due of circumstances warranting further observation or evaluation.

For example, a water may be designated as a Watch Water if water quality data indicating impairment were collected from unrepresentative “extreme weather” periods, as defined in Section 4, resulting in insufficient data to assess. Watch Water status is also designated when phosphorus data are assessed for a particular water, but a “clear” decision cannot be made

(i.e., 90th percent confidence interval of the phosphorus sample concentration data overlaps the criterion). WisCALM guidance defines a “clear” exceedance of the phosphorus criteria as the lower 90th percent confidence interval of a phosphorus sample concentration dataset that exceeds the applicable criterion. Conversely, the phosphorus criteria are “clearly met” when the upper 90th percent confidence interval of the phosphorus sample concentration data is below the applicable criterion.

10.4 Identifying Sources of Impairment

When a water is deemed impaired, the potential source(s) causing the impairment should be identified. Impairment sources affect which parameters are monitored, what model should be used for analysis, and what type of restoration activities would be best on that individual water. In the WATERS database under the “WDNR Impaired Waters Category,” sources may be entered. Some possible sources of impairment include:

Atmospheric Deposition: This source category includes waters with fish consumption advisories (FCAs) caused by atmospheric deposition of mercury. Atmospheric deposition is currently only applicable to mercury and PCBs but could be identified as a source for other in the future.

Contaminated Sediment: Waters identified through various monitoring activities, sediment core analysis, and collection of fish tissue that exceed ambient water quality criteria for toxics as specified in ch. NR 105, Wis. Adm. Code. In addition, this may include waters where contaminated sediments contain pollutant concentrations that will cause “probable effects” in biological organisms based on guidelines outlined in the “Consensus-Based Sediment Quality Guidelines: Recommendations for Use and Application” (https://widnr.widen.net/s/fkwscvxq26/rr088).

Physical Habitat: Waters where designated uses are not being met due to a physical habitat degradation, including anthropogenic stream channel alterations, such as a dam installation, stream channelization, bank erosion, and riparian zones disturbance.

Point Source Dominated: Waters are categorized as point source dominated when the impairment is a result of a current discharge from an existing point source. The Wisconsin Pollutant Discharge Elimination System (WPDES) Permit Program issues and evaluates permits for point sources to assure the attainment of standards at the time of permit issuance. Existing laws and administrative rules including the WQS and WPDES permit rules preclude the issuance of a permit if it will not attain WQS. Waters in this category are likely between permit cycles or may have obtained a variance to the WQS under current law.

Nonpoint Source (NPS) Dominated: Waters in which the impairment is a result of nonpoint source runoff, including urban stormwater runoff.

Nonpoint Source/Point Source Blend: Waters are placed in this category when impairments exist due to both point source contributions and nonpoint source runoff. Listing a waterbody which is impacted by a point source does not imply that the source is not meeting all the requirements in its discharge permit, but only indicates that a TMDL is needed to determine relative contributions by each of the sources and what additional requirements may be needed.

10.5 Pollutant and Observed Effect (Impairment) Combinations

Pollutant and observed effect (impairment) listings are derived from the parameter assessed for each waterbody type. There are several pollutant-impairment combinations that have been in common use since the 2012 assessment cycle. Table 35 shows the common parameters assessed and the resulting pollutant and/or impairments associated with an exceedance. Table 36 and Table 37 are examples of an entire waterbody assessment.

Table 35. Resulting pollutant and/or observed effect terminology from an exceedance of each parameter. These are not all the possible parameters assessed, but some of the most common.

Parameter	Pollutant	Aquatic Life Use Observed Effect (Impairment)	Recreation Use Observed Effect (Impairment)
Total Phosphorus	Total Phosphorus	--	--
Total Phosphorus (Overwhelming Exceedance)	Total Phosphorus	High Phosphorus Levels[1]	High Phosphorus Levels *
Chlorophyll-*a*	--	Eutrophication	Excess Algal Growth
Benthic Algal Biomass	--	Excess Algal Growth	Excess Algal Growth
Macrophytes	--	Degraded Submerged Aquatic Vegetation (SAV)	--
mIBI	--	Degraded Benthic Macroinvertebrates	--
fIBI	--	Degraded Fish Community	--
Chloride	Chloride	Chronic Aquatic Toxicity; Acute Aquatic Toxicity	--
Temperature	--	Elevated Water Temperature	--
E. coli	*E. coli*	--	Recreational Use Restrictions

1. "High Phosphorus Levels" is a term only used when there are no accompanying biological impariments.

Table 36. Example of assessing a stream for multiple uses with multiple parameters, to determine the overall waterbody listing.

Waterbody Name: Leafy Creek		Uses		
		Recreation	Public Health	Aquatic Life
Parameters	Total Phosphorus	Not Attaining		Not Attaining
	Benthic Algal Biomass	Not Attaining		Not Attaining
	mIBI			Attaining
	fIBI			Attaining
	Chloride			Attaining
	Temperature			Attaining
	E. coli	Attaining		
	Mercury		Attaining	
	PCBs		Attaining	
	PFOS		Attaining	
Assessment	**Use Attainment**	**Not Attaining**	Attaining	**Not Attaining**
	Overall Status	**Impaired for Total Phosphorus and Excess Algal Growth (Category 5A)**		

Table 37. Example of assessing a lake for multiple uses with multiple parameters, to determine the overall waterbody listing.

Waterbody Name: Mud Lake		Uses		
		Recreation	Public Health	Aquatic Life
Parameters	Total Phosphorus	Attaining		Attaining
	Chlorophyll-*a*	Attaining		Attaining
	Chloride			Attaining
	Temperature			Attaining
	E. coli	Attaining		
	Mercury		Not Attaining	
	PCBs		Attaining	
	PFOS		Attaining	
Assessment	**Use Attainment**	Attaining	**Not Attaining**	Attaining
	Overall Status	**Impaired for Mercury in Fish Tissue (Category 5B)**		

10.6 Delisting Impaired Waters

Waters and/or associated pollutants and impairments are delisted from the state's impaired waters list when the state determines, and the EPA approves, that the waters are no longer impaired, or a particular pollutant/impairment combination should be removed. A water will not be delisted until all previously listed pollutant/impairment combinations have been removed because applicable WQS are attained. WDNR proposes to de-list a waterbody and/or associated pollutants and impairments from the Impaired Waters List when contemporary, representative, and high-quality data warrant delisting. However, when a change to a water quality standard (e.g., site-specific criteria) has been approved by EPA and the waterbody now meets the revised criterion, WDNR may propose to remove the water and/or associated pollutants and impairments from future lists.

10.6.1 Water No Longer Impaired

WDNR delists waters that have been restored. New monitoring data will be collected to evaluate the response of the waterbody to some sort of implementation or restoration strategy. Waters will be assessed through the same process identified for listing a waterbody on the 303(d) Impaired Waters List and must meet WQS to be removed from the list.

If a portion of a previously listed water is later determined to be no longer impaired, while other portions remain impaired, the originally listed water may be subdivided into multiple assessment units to account for these differences in attainment status. Guidance on delineating, subdividing and aggregating assessment units is provided in Section 2.6.

10.6.2 Water Listing Validation Found No Impairment

WDNR has identified some waters on historical Impaired Waters Lists that may be inappropriately listed. Common reasons include improper documentation of a past assessment, misidentification of a waterbody, and/or incorrect description of the reach and its specific location within a watershed. In those cases, contemporary information will be documented and WDNR may propose to delist those waters if the most recent assessment indicates all designated uses are achieved.

10.6.3 EPA Approved TMDL or Alternative Restoration Plan

When EPA approves a TMDL or TMDL-equivalent alternative plan (11.3 Alternative Restoration Plans), the pollutants covered by the TMDL or plan are proposed for removal from the state's Impaired Waters List, waters that require a TMDL (Category 5). However, the water is still considered impaired until applicable WQS have been met. Waterbodies with approved TMDLs are moved to Category 4A and ones with TMDL-equivalent alternative plans are moved to Category 4B (Table 38). These Category 4 waters are considered the Waters In Restoration List. Once the water is restored and meets applicable water quality criteria, it may be moved to Category 2 and the Waters Attaining StandardsList.

10.7 Decision Documentation

A primary goal of the WDNR is to document all impaired waters decisions, verify the current impaired waters list, and make this information accessible to the public. It is critical that WDNR staff fully document their impaired waters listing recommendations, supporting materials, and justification of their decisions, including any professional judgment used to support those decisions. As a part of this process, it is also important to document assessment decisions for waterbodies that were evaluated but deemed fully supporting assessed uses. The WATERS

data system for monitoring and assessment data provides WDNR staff with a systematic location and process for documenting assessment decisions.

Data contained in these data systems are available for the public via the WDNR Surface Water Data Viewer. Information such as monitoring stations, Impaired Waters, WPDES permits, etc. can be accessed from this site. WDNR also maintains dynamic webpages created for Impaired Waters where the public can find water quality monitoring data, pollutants/impairments of concern, TMDL status, and possible management solutions for improving the waterbody. The Impaired Waters Search Tool may be accessed at the following website: https://apps.dnr.wi.gov/water/impairedSearch.aspx.

Assessments of non-conventional parameters or those that deviate from standard WisCALM guidance should be documented in the WATERS database or on the standardized documentation form (Appendix B) and include a justification or case-specific reason for diverging from the assessment guidance. An electronic documentation form is available on request; please send requests to DNRWYWaterbodyAssessments@wisconsin.gov.

11. Integrated Report Listing Categorization

One of the elements of the Integrated Report (IR) is defining IR listing categories (Table 38) for each waterbody or assessment unit to communicate work conducted under the use designation, assessment and restoration elements of the WQS program. Wisconsin's IR listing categories loosely follow federal categories identified in the 2008 EPA Integrated Reporting Guidance document. These are the same categories as described in 2.3 Water Quality Condition Categories and Lists and in APPENDIX A. Quick Reference Section.

Table 38. Integrated Report (IR) Listing Categories and associated lists.

List	Category	How Categories Are Used in Wisconsin
	Category 3: There is insufficient available data and/or information to assess whether a specific designated use is being met or if the anti-degradation policy is supported.	
Waters Attaining Standards	Category 1: All designated uses are met, no use is threatened, and the anti-degradation policy is supported.	
	Category 2: Available information indicates one or more designated uses are met. No impairments found.	
	Category 2A	An impairment-level assessment was done for at least two designated uses with at least two total parameters.
	Category 2B	An impairment-level assessment was done for at least one parameter.
	Category 2C	A general-level assessment was done for at least one parameter.
Waters In Restoration	Category 4*: Waters where a Total Maximum Daily Load (TMDL) is approved by EPA or not required.	
	Category 4A	All TMDLs needed for attainment of water quality standards have been approved or established by EPA. This does not mean that all other designated uses have been evaluated and found to be meeting their designated use.
	Category 4B	Required control measures are expected to achieve attainment of water quality standards in a reasonable period of time. Adaptive Management Plans and Environmental Accountability Projects may be proposed as an alternative to TMDL development.
	Category 4C	A waterbody where the impairment is not caused by a pollutant. Pollution is defined by EPA as the human-made or human-induced alteration of the chemical, physical, biological, and radiological integrity of water [Section 502(19)].

Impaired Waters	Category 5: Waters where a TMDL is required.	
	Category 5A	At least one designated use is not met or is threatened, and/or the anti-degradation policy is not supported, and one or more TMDLs are still needed.
	Category 5B	Atmospheric deposition of mercury has caused the impairment of the water. The water is listed for a specific advisory and no in-water source is known other than atmospheric deposition.
	Category 5C	Non-attainment of water quality standards may be caused by naturally occurring or irreversible human-induced conditions.
	Category 5P	Applicable total phosphorus criteria are exceeded; however, biological impairment has not been demonstrated (either because bioassessment shows no impairment or because bioassessment data are not available).
	Category 5W	Water quality standards are not met; however, the development of a TMDL for the pollutant of concern is a low priority because the impaired water is included in a watershed area addressed by at least one of the following 9-Key Element watershed plans: adaptive management plan, adaptive management pilot project, lake management plan, or CWA Section 319-funded watershed plan. EPA identifies these as 5-*alt* listings; like Category 4 waters, the plans and subcategory placement are approved by EPA.

* Listings placed in Category 4 are still considered 'impaired' and are not considered fully restored until the water is place in Category 2.

11.1 Placing Assessment Units in Categories

Evaluated waters are placed in Category 3 unless sufficient data or information is available to move the water from a Category 3 to a different group. Waters that meet one or more designated uses and have no uses impaired will be included in Category 2. For example, if a waterbody was previously listed as impaired, but subsequently restored and removed from the impaired waters list, it may then be placed in Category 2. This category cannot be used for situations in which one or more use designations have been restored but other use designations remain impaired. Waters will be placed in Category 2 after a full assessment determines attainment of WQS through an impaired waters de-listing process.

11.1.1 Moving Assessment Units between Categories

Waters are moved from one category to another during updates to the assessment database by water quality biologists and program coordinators. Once an assessment has been conducted, the water will be moved from Category 3 to the updated category. This process usually occurs once a year during the update of the state's water assessments during basin plan updates.

11.1.2 Assessment Units with multiple pollutant/impairment listings

Wisconsin uses one category per water, as well as a category for each pollutant/impairment listing combination. Because of this, the waterbody is placed in the more protective or restrictive category available. For example, if a waterbody is listed for two use impairments (e.g., Recreation and Aquatic Life) and one of the two remain impaired while the other is restored, the waterbody will remain in an impaired water category (i.e., Category 5).

Table 39. Example of a waterbody assessment with multiple pollutant listings and how that translates into the overall waterbody category listing.

Use	Pollutant	Pollutant-Category	Overall Waterbody Category
Aquatic Life	Total Phosphorus	Category 4A	Category 5A
Recreation	*E. coli*	Category 5A	
Fish Consumption	Mercury	Category 5B	

11.1.3 Impaired Waters List

Listings determined to be in Category 5 are part of the **Impaired Waters List**. Listings covered by a TMDL or an alternative plan, ones in Category 4, are part of the **Waters In Restoration List**. Category 4 waters were considered part of the impaired waters list prior to the 2020 assessment cycle. While Category 4 waters are not yet restored, they are already addressed by an EPA-approved plan. Waters in Categories 1 or 2 are part of the **Waters Attaining Standards List**. These lists were distinguished to better convey the status of assessments, listing, and restoration.

11.2 Priority Ranking for TMDL Development

Waters on the Impaired Waters List will be ranked by priority for Total Maximum Daily Load (TMDL) development. A TMDL is an analysis that determines how much of a pollutant a waterbody can assimilate before it exceeds Water Quality Standards. Federal law requires that TMDLs be developed for impaired waters.

TMDL prioritization is based on Wisconsin's Water Quality Restoration and Protection Prioritization Framework [PDF] document. Prioritization currently focuses on two pollutants, total phosphorus (TP) and total suspended solids (TSS) as these are two of the most commonly identified pollutants on the impaired waters list. Priority areas were determined through systematic and objective modeling analysis that identified parts of the state experiencing the most ecological degradation and vulnerability to future degradation.

On the impaired waters list the 'TMDL Status' is labeled high, medium, or low for a pollutant in Category 5. The categorization for the TMDL Status is defined as follows:

- **High**: A TMDL is currently in development. This could be for any pollutant, but with the current priority framework is most likely addressing TP or TSS. This status is associated with Level 1 Priority in the prioritization framework document.
- **Medium**: These are waters with TP or TSS listings that are in geographic areas identified as either, a) vulnerable based on the Healthy Waters Assessment (HWA); or b) in the top phosphorus priority areas in the Wisconsin's Nutrient Strategy. Vulnerable waters have poor predicted ecological health or high phosphorus yields and instream concentrations. Medium priority is associated with Level 2 Priority in the prioritization framework document.
- **Low**: These are waters with listings that do not fall into High or Medium priority. These listings are likely pollutants other than TP or TSS. It is also possible that an alternative restoration plan is in place for the listing, making it a lower priority for TMDL development.

For more information on the prioritization process please refer to the prioritization document linked above.

The TMDLs outlined in the prioritization framework were completed by 2022; a new version of the prioritization framework will be available in 2024. In the interim, high priority TMDL waters are those within the Northeast Lakeshore TMDL and the Lake Pepin TMDL areas. These are the two TMDLs Wisconsin DNR has committed to completing while a new priority plan is drafted.

11.3 Alternative Restoration Plans

TMDLs are the primary way to remove waters from the Impaired Waters List before complete restoration of the water, but alternative plans can potentially fulfill the CWA's TMDL requirement. A waterbody with a TMDL-equivalent alternative plan will be placed into Category 4B, which also removes it from the Impaired Waters List (Table 38). A TMDL-equivalent alternative plan has the same requirements for pollutant load allocations and permit implementation (Table 40). If a waterbody has an EPA defined 5-*alt* restoration plan it is placed in into WDNR's Category 5W, which gives it lower priority for TMDL development. Category 5W listings remain part of the Impaired Waters List. Qualifying plans include 9-Key Element Watershed Plans and Adaptive Management Plans. These alternatives, whether 4B or 5W (5-*alt*), are reviewed by EPA to confirm they meet all the requirements.

Table 40. Key differences in plan requirements between TMDLs, TMDL-alternatives, and restoration plans. Specifically, in fulfillment of Clean Water Act (CWA) requirements, water quality (WQ) goals, and implications for Point Source (PS) and Non Point Source (NPS) allocations.

Plan Requirements	TMDL (4A)	TMDL Alternative (4B)	Restoration Plan (5W)
Legal (CWA)	Required by the CWA.	Temporarily fulfills CWA TMDL requirement. TMDL again required if WQ does not improve*.	--
Allocations	Pollutant load allocations for PS and NPS. Allocations must be set to meet water quality standards and promulgated criteria.	Pollutant load allocations for PS and NPS. Allocations must be set to meet water quality standards and promulgated criteria.	Estimate of pollutant loading into the watershed and expected load reductions.
Implementation	Implementation schedule not required.	Implementation required; schedule and milestones identified in plan.	A project schedule with interim, measurable milestones; identify progress indicators.
Funding	Identified funding sources not required.	Available funding required.	Estimate amount of financial assistance needed.
WQ Permits	Directly influences permits.	Directly influences permits.	Does not influence permits.
Goal	Restore/Protect WQ	Restore WQ	Restore/Protect WQ
More Information	https://dnr.wi.gov/topic/TMDLs/	https://www.epa.gov/tmdl/category-4b-regulatory-alternative-tmdls	https://dnr.wi.gov/topic/nonpoint/9keyelement/

*A timeline is given within the alternative plan for estimates of WQ restoration. If progress is being shown, then a TMDL will be lower priority within the state's TMDL planning. Time span for complete restoration can reach multiple decades.

11.3.1 9-Key Element Plans

Alternatives to a TMDL can be prepared for waters on the Impaired Waters List. A 9-Key Element Plan covers any plan that includes these nine minimum elements:

1. Identify the causes and sources.
2. Estimate pollutant loading into the watershed and the expected load reductions.
3. Describe management measures that will achieve load reductions and targeted critical areas.
4. Estimate the amounts of technical and financial assistance and the relevant authorities needed to implement the plan.
5. Develop an information/education component.
6. Develop a project schedule.
7. Develop the interim, measurable milestones.
8. Identify indicators to measure progress and make adjustments.
9. Develop a monitoring component.

These nine elements can provide the structure for land and water resource management plans, lake management and protection plans, river protection plans, CWA Section 319-funded watershed plans, and other watershed-based plans. These plans are approved by the EPA. Impairment listings addressed by an EPA approved 9-Key Element plan will be moved to Category 5W (Table 40).

11.3.2 Adaptive Management Plans (AMPs)

Adaptive Management Plans can qualify as a TMDL alternative. Adaptive management is a compliance option that allows owners of point and nonpoint sources of phosphorus to work together to improve water quality and to meet water quality standards. Adaptive management recognizes that excess phosphorus in lakes and rivers is the result of a variety of activities and sources; both point and nonpoint source reductions are often needed to achieve water quality standards.

AMPs that meet the qualifications of a TMDL-equivalent alternative (Table 40) can be used to remove associated waters from the Impaired Waters List. AMPs that meet 9-Key Element plan qualifications can be used to place associated waters in Category 5W (EPA's 5-*alt*, lower priority for TMDL).

11.2.3 Environmental Accountability Projects (EAPs)

Environmental Accountability Projects or EAPs are another potential alternative to a TMDL. These are any planned implementation actions on the impaired water that will result in that water meeting WQS. EAPs are commonly used when the source of an impairment and the appropriate management action are readily identifiable. EAP listings are designated when the sources and pathways of pollutants do not require a TMDL analysis to identify management actions. Listings addressed by an EAP remain in Category 5 unless the EPA determines the plan is a sufficient TMDL equivalent.

12. Quick Link Guide

12.1 Federal Clean Water Act & EPA Guidance

How US EPA Manages the Quality of its Environmental Data:
https://www.epa.gov/quality

Drinking Water Contaminants- Standards and Regulations:
https://www.epa.gov/dwstandardsregulations?_sm_au_=iVVMN2W4PQ7jM2QN

Beaches Environmental Assessment and Coastal Health Act (BEACH Act):
https://www.epa.gov/beach-tech/about-beach-act

Electronic Code of Federal Regulations, Title 40, Ch. I, Subchapter D, Part 131- Water Quality Standards:
https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-131?toc=1

Use Attainability Analysis:
https://www.epa.gov/wqs-tech/use-attainability-analysis-uaa

Integrated Reporting Guidance under CWA Sections 303(d), 305(b) and 314 (EPA IR Memos):
https://www.epa.gov/tmdl/integrated-reporting-guidance-under-cwa-sections-303d-305b-and-314

12.2 Wisconsin State Administrative Codes

Chapter NR1.02(7), Trout Stream Classification:
http://docs.legis.wisconsin.gov/code/admin_code/nr/001/1/02

Chapter NR102, Water Quality Standards for Wisconsin Surface Waters:
https://docs.legis.wisconsin.gov/code/admin_code/nr/100/102

Chapter NR 103, Water Quality Standards for Wetlands:
https://docs.legis.wisconsin.gov/code/admin_code/nr/100/103

Chapter NR 104, Uses and Designated Standards:
https://docs.legis.wisconsin.gov/code/admin_code/nr/100/104

Chapter NR 105, Surface Water Quality Criteria and Secondary Values for Toxic Substances:
https://docs.legis.wisconsin.gov/code/admin_code/nr/100/105

Chapter NR 107, Aquatic Plant Management:
https://docs.legis.wisconsin.gov/code/admin_code/nr/100/107

Chapter NR 207, Antidegradation and Antibacksliding:
https://docs.legis.wisconsin.gov/code/admin_code/nr/200/207

Chapter NR 281, Paint and Ink Formulation:
https://docs.legis.wisconsin.gov/code/admin_code/nr/200/281

12.3 Monitoring Strategies, Protocols, and Standard Operating Procedures

Wisconsin's Water Monitoring Strategy

Wisconsin's Water Monitoring Strategy 2021 - 2025. Wisconsin Department of Natural Resources, Madison, WI

Lake Methods

Lake Sampling Procedures – LTT Water Quality
Citizen Lake Monitoring Network: https://dnr.wisconsin.gov/topic/lakes/clmn
Citizen Lake Monitoring Volunteer Lake Level Monitoring Protocol
Citizen Lake Monitoring Training Manual (Chemistry Procedures)
Citizen Lake Monitoring Training Manual (Secchi Disk Procedures)

Stream/River Methods

Citizen Based Stream Monitoring: https://wateractionvolunteers.org/
Natural Community Stratified Random Sampling
Long Term Trend – Rivers
Long Term Trend – Streams
Flow Monitoring in Wadeable Streams
Guidance for Continuous Temperature Monitoring
Large River Macroinvertebrates Sampling
Guidelines for the Standard Collection of Macroinvertebrate Samples from Wadeable Streams
Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin
Guidelines for Evaluating Habitat of Wadable Streams
Nutrient Chemistry Grab Sampling
Diatom Collections for Calculation of the Diatom Nutrient Index (DNI)
Diatom Collections for Calculation of the Diatom Phosphorus Index (DPI)
Low Level Metals Sampling
Viewing Bucket Method for Estimating Algal Abundance in Wadeable Streams

AIS Methods

Early Detection Monitoring on Lakes
Early Detection Monitoring on Streams
Early Detection Monitoring on Wetlands
Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design and Laboratory Procedures, Data Entry and Analysis, and Applications

Sediment Methods

Consensus-Based Sediment Quality Guidelines, RR-088, 2003;
https://widnr.widen.net/s/fkwscvxq26/rr088

12.4 WDNR Topic Pages

Wisconsin's Riverine and Lake Natural Communities:
https://dnr.wisconsin.gov/topic/Rivers/NaturalCommunities.html

Trout Stream Classifications:
https://dnr.wisconsin.gov/topic/Fishing/trout/streamclassification.html

Water Quality Management Planning:
https://dnr.wisconsin.gov/topic/SurfaceWater/Planning.html

Total Maximum Daily Loads (TMDLs):
https://dnr.wisconsin.gov/topic/TMDLs

Nine Key Element Watershed Plans:
https://dnr.wisconsin.gov/topic/Nonpoint/9keyElement

Wisconsin Beaches:
https://dnr.wisconsin.gov/topic/Beaches

12.5 Data Resources and Tools

Surface Water Integrated Monitoring System (SWIMS):
https://dnr.wisconsin.gov/topic/SurfaceWater/SWIMS

US Drought Monitor
https://www.drought.gov/drought/data-gallery/us-drought-monitor

Federal Water Quality Exchange Network:
https://www.epa.gov/waterdata/water-quality-data-wqx

Palmer Drought Severity Index:
https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/

USGS Surface-Water Data for the Nation:
https://waterdata.usgs.gov/nwis/sw

The R Project for Statistical Computing:
http://www.r-project.org/

Wisconsin Beach Health:
www.wibeaches.us

The Impaired Waters Search:
http://dnr.wi.gov/water/impairedSearch.aspx

1980 Trout Book (Wisconsin Trout Streams – Publication 6-3600(80)

12.6 Additional Resources

World Health Organization:
http://www.who.int/

Choose Wisely, A Healthy Guide for Eating Fish in Wisconsin (PUB-FH-824 2016):

https://dnr.wisconsin.gov/topic/Fishing/consumption

Technical Fact Sheet- Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA): https://www.epa.gov/sites/production/files/2017-12/documents/ffrrofactsheet_contaminants_pfos_pfoa_11-20-17_508_0.pdf

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APPENDIX A. Quick Reference Section

A.1. Acronyms and Terminology

AL: Aquatic Life Use. Designated use category used to indicate whether waters are appropriate for the protection of fish and other aquatic life.

AMCI: Aquatic Macrophyte Community Index. Multi-metric aquatic plant index which decreases with increasing human disturbance. Used to assess aquatic macrophyte communities in lakes.

AU: Assessment Unit.

CBSM: Citizen Based Stream Monitoring. Programs that utilize citizen volunteers to collect data to characterize a stream's biology, chemistry, or physical state.

cfu: colony-forming unit. A unit of measurement depicting the number of viable bacterial or fungal cells in a sample. Results are expressed in the form of cfu/mL for liquids and cfu/g for solids.

Chl-*a*: Chlorophyll A (aka CHL). A green pigment, present in all green plants and cyanobacteria, responsible for the absorption of light to provide energy for photosynthesis, measured to assess productivity in lake systems.

CI: Confidence Interval.

Cold: Coldwater. Sub-category in the Aquatic Life Use Designation for streams. Streams classified at "cold" are capable of supporting a cold-water sport fishery, or serving as a spawning area for salmonids and other cold-water fish species.

CWA: Clean Water Act (aka Federal Water Pollution Control Act). Primary United States federal law governing water pollution and quality.

DO: Dissolved Oxygen. The amount of gaseous oxygen dissolved in water, measured in units of milligrams per liter (mg/L).

EAP: Environmental Accountability Project. Any planned implementation actions on an impaired water that will result in that water meeting water quality standards. Environmental Accountability Projects can be utilized as an alternative to TMDLs when the sources and pathways of pollutants do not require a TMDL analysis to identify management actions.

***E. coli: Escherichia coli*.** Coliform bacterium commonly found in the lower intestine of warm-blooded organisms. Some strains of E. coli pose a human health risk and result in conditions such as gastroenteritis, infection, neonatal meningitis, hemorrhagic colitis, and Crohn's disease.

EPA: Environmental Protection Agency. Independent agency of the United States federal government which oversees the maintenance and enforcement of national standards under a variety of environmental laws.

Epilimnion: top layer of water in a thermally stratified lake, occurring above the hypolimnion.

EPT: Ephemeroptera-Plecoptera-Trichoptera. Common stream invertebrates: mayfly, stonefly, caddisfly. One of several metrics used to determine M-IBI for streams.

ERW: Exceptional Resource Water. Wisconsin's designation under state water quality standards to waters with exceptional quality and which may be provided a higher level of protection through various programs and processes.

FCA: Fish Consumption Advisory. Recommendations issued to notify the public that certain species of fish or shellfish caught from a specific water body or type of water body should not be eaten or should be limited for consumption due to chemical contamination.

F-IBI: **Fish Index of biological integrity (Fish IBI).** An Index of Biological Integrity (IBI) is a scientific tool used to identify and classify water pollution problems. An IBI associates anthropogenic influences on a water body with biological activity in the water and is formulated using data developed from biosurveys. In Wisconsin, Fish IBIs are created for each type of natural community in the state's stream system.

g: gram.

HCC: Human Cancer Criteria. Maximum concentrations of substances established to protect humans from an unreasonable incremental risk of cancer resulting from contact with or ingestion of surface waters and from ingestion of aquatic organisms taken from surface waters.

HTC: Human Threshold Criteria. A threshold dosage or concentration of a toxic substance below which it is estimated that no adverse effect or response is likely to occur.

Hypolimnion: bottom layer of water in a thermally stratified lake, occurring below the epilimnion.

IBI: Index of Biological Integrity. A scientific tool used to identify and classify water pollution problems. Utilizes biological data to analyze anthropogenic influence on a waterbody.

IR: Integrated Report.

Kg: Kilogram.

LAL: Limited Aquatic Life. Sub-category in the Aquatic Life Use Designation

LCL: Lower Confidence Limit.

LFF: Limited Forage Fish. Sub-category in the Aquatic Life Use Designation for streams. Streams designated as "LFF" are capable of supporting small populations of forage fish or tolerant macroinvertebrates that are tolerant of organic pollution.

Metalimnion: layer of water where temperature is shifting, also known as the thermocline, occurring between the epilimnion (top) and hypolimnion (bottom) layers of a thermally stratified lake.

M-IBI: **Macroinvertebrate Index of biological integrity.** In Wisconsin, the MIBI, or macroinvertebrate Index of biological integrity, was developed specifically to assess Wisconsin's macroinvertebrate community (see also Fish IBI).

Meeting Criteria: When comparing to a water quality criterion this means that the value is not exceeding the criteria. Meeting criteria indicates attainment.

µg/L: micrograms per liter.

NC: Natural Community. A system of categorizing water based on inherent physical, hydrologic, and biological assemblages. Streams and lakes are categorized using an array of "natural community" types.

ng: nanogram.

NPS: Nonpoint Source. Pollution derived from diffuse sources, generally caused by rainfall or snowmelt moving over and through the ground. As the rainfall or snowmelt moves it picks up pollutants and deposits them into lakes, rivers, wetlands, coastal waters, and groundwater.

ORW: Outstanding Resource Water- Wisconsin's designation under state water quality standards to waters with outstanding quality and which may be provided a higher level of protection through various programs and processes.

PCBs: Polychlorinated Biphenyls. A group of man-made organic chemicals commercially produced in the United States from 1929 to 1979. They can have effects on the immune system, reproductive system, nervous system, endocrine system and other health effects, such as increased risk of cancer. They do not readily break down in the environment, so can remain for long periods of time.

PFOS: Perfluorooctane sulfonate. Man-made fluorinated compounds that repel oil and water. PFOS are used in a variety of industrial and consumer products, such as carpet and clothing treatments, and firefighting foams. Toxicological studies on animals indicate potential developmental, reproductive and systemic effects.

PPM: Parts Per Million. A measurement of a substance's concentration in water or soil. One part per million is equivalent to one milligram of a substance per liter of water.

PPT: Parts Per Trillion. A measurement of a substance's concentration in water or soil. One part per trillion is equivalent to one nanogram of a substance per kilogram of water.

PWS: Public Water Supply. This is a surface water used to supply public drinking water. Currently there are only three lakes used for this purpose: Lake Superior, Lake Michigan, and Lake Winnebago.

REC: Recreation Use: Designated use category used to indicate whether waters are appropriate for recreational use. Waters will fail this designated use if a sanitary survey has been completed to show that humans are unlikely to participate in activities requiring full body immersion on the waterbody.

SD: Secchi Depth. A measurement of light transparency in lakes collected using a 20-cm (8-inch) diameter disc painted white and black in alternating quadrants. Depth measurements give a general picture of a lake's water clarity and can help determine if changes occur in a waterbody's clarity over time.

SDWA: Safe Drinking Water Act. Federal law that protects public drinking water supplies throughout the United States. Under the SDWA, EPA sets standards for drinking water quality and with its partners implements various technical and financial programs to ensure drinking water safety.

SU: Standard Unit.

SWIMS: Surface Water Integrated Monitoring System. A WDNR information system that holds chemistry (water, sediment), physical (flow), and biological (macroinvertebrate, aquatic invasive) data**.**

SWIMS ID: Surface Water Integrated Monitoring System (SWIMS) Identification Code. The unique monitoring station identification number for the location where monitoring data was gathered.

TCDD: Tetrachlorodibenzodioxin. In this document it is specifically 2,3,7,8-Tetrachlorodibenzo-P-Dioxin. This is a carcinogenic chemical that was a byproduct of producing certain herbicides. This chemical is also formed from metal production and from burning waste, fossil fuels, and wood. It is a developmental toxicant in animals and is linked to several types of human cancer.

Thermocline: layer of water where temperature is shifting rapidly, also known as the metalimnion, occurring between the epilimnion (top) and hypolimnion (bottom) layers of a thermally stratified lake.

TMDL: Total Maximum Daily Load. A technical report required for impaired waters Clean Water Act. TMDLs identify sources, sinks and impairments associated with the pollutant causing documented impairments.

TP: Total Phosphorus. An analyzed chemical parameter collected in aquatic systems frequently positively correlated with excess productivity and eutrophication in many of Wisconsin's waters.

TSI: Trophic Status Index. Commonly used index of lake productivity published by Carlson in 1977. It provides separate but relatively equivalent calculations based on either chlorophyll-*a* concentration or Secchi depth to predict algal biomass in a waterbody.

TSS: Total Suspended Solids. An analyzed physical parameter collected in aquatic systems that is frequently positively correlated with excess productivity, reduced water clarity, reduced dissolved oxygen and degraded biological communities.

UAA: Use Attainability Analysis. A scientific evaluation of factors affecting the attainment of a specific use. (https://www.epa.gov/wqs-tech/use-attainability-analysis-uaa)

WATERS: Waterbody Assessment, Tracking and Electronic Reporting System. A WDNR information system that holds decisions and information regarding the status of rivers, streams, and lakes, as well as Great Lakes shoreline miles including a variety of use designation, assessment, management uses, and linkages to documents or reports supporting decisions about a waterbody.

WATERS ID: The Waterbody Assessment, Tracking and Electronic Reporting System Identification Code. A unique numerical sequence number assigned by the WATERS system, also known as "Assessment Unit ID code" or "AU ID".

WAV: Water Action Volunteer. Statewide program which utilizes individual citizens, environmental groups, students and other volunteer groups to collect data to characterize a stream's biology, chemistry, or physical state.

WBIC: **Water Body Identification Code.** WDNR's unique identification codes assigned to water features in the state. The lines and information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces.

WDNR: Wisconsin Department of Natural Resources. Wisconsin Department of Natural Resources is an agency of the State of Wisconsin created to preserve, protect, manage, and maintain natural resources.

WHO: World Health Organization. Specialized agency of the United Nations concerned with international public health.

WisCALM: Wisconsin Consolidated Assessment and Listing Methodology. Developed by WDNR, provides guidance on assessment of water quality data against surface water quality standards and for Clean Water Act reporting on surface water quality status and trends. WisCALM is updated for each biennial surface water assessment cycle.

WPDES: Wisconsin Pollutant Discharge Elimination System.

WQS: Water Quality Standards.

WSLH: Wisconsin State Laboratory of Hygiene (aka WSLOH). the state's certified laboratory that provides a wide range of analytical services including toxicology, chemistry, and data sharing.

WWFF: Warmwater Forage Fish. Sub-category in the Aquatic Life Use Designation for streams. Streams designated as "WWFF" are capable of supporting a warm water-dependent forage fishery.

WWSF: Warmwater Sport Fish. Sub-category in the Aquatic Life Use Designation for streams. Streams designated as "WWSF" are capable of supporting a warm water-dependent sport fishery.

A.2. Water Quality Criteria & Assessment Quick-Reference Tables

The tables displayed here are meant for quick reference of the most commonly used numeric water quality criteria and do not include detailed assessment methodologies. All numbers outlined in this section are the maximum levels permitted in a waterbody before it is listed as impaired. Please refer to the main body of this document for more information like minimum data requirements and exceedance thresholds; relevant portions are linked in each table's notes. Criteria are for Aquatic Life use unless otherwise noted.

Total Phosphorus & Chlorophyll-a – Lakes & Reservoirs

		Total Phosphorus Criteria (µg/L)	**Chlorophyll-*a* Criteria** (AL: µg/L; REC: % days where Chl-*a* > 20 µg/L)	
Stratification[1]	**Lake Natural Community**[1]	**AL**[2] **& REC**[3]	**AL**[2]	**REC**[3]
Unstratified (Shallow)	Headwater Drainage	40	27	30%
	Lowland Drainage			
	Seepage			
Stratified (Deep)	Headwater Drainage	30	27	5%
	Lowland Drainage			
	Seepage	20		
	Two-Story Fishery	15	8	

1. Natural Community and Stratification definitions can be found in sections 4.4 Lake Classification and 4.6 Stream and River Classifications
2. Fish and Aquatic Life Use (AL). Sampling, data selection, and assessment methods for AL TP are found in section ***6.1 Total Phosphorus (TP)***.
3. Recreation Use (REC). Assessment methods in 7. Recreation Use Assessment.

Total Phosphorus – Rivers & Streams:

Waterbody Type	**Total Phosphorus Criteria (µg/L)** [3]
River[1]	100
Stream	75
Impounded Flowing Water[2]	Criteria of the river or stream associated with the impounded flowing water.

1. A list of waters that have the criteria of 100 µg/L is available in Wisconsin Administrative Code Chapter NR 102.06(3).
2. Impounded Flowing Waters are impoundments that have a water residence time of < 14 days.
3. Assessment protocols can be found in section ***6.1 Total Phosphorus (TP)***.

Chloride

Protection Level	Criteria (mg/L)
Chronic Aquatic Toxicity	395
Acute Aquatic Toxicity	757

Assessment protocols can be found in section 6.6 Chloride and Aquatic Toxins.

Temperature

Acute Temperature Criteria in Fahrenheit for each month by Water Type[1]						
	Rivers & Streams[2]				Lakes[2]	
Month	Cold	Warm Large	Warm Small	LFF	Northern Lake[3]	Southern Lake[3]
Jan	68	76	76	78	76	77
Feb	68	76	76	79	76	78
Mar	69	76	77	80	76	78
Apr	70	79	79	81	78	80
May	72	82	82	84	81	82
Jun	72	85	84	85	85	86
Jul	73	86	85	86	86	87
Aug	73	86	84	86	86	87
Sep	72	84	82	85	84	85
Oct	70	80	80	83	80	81
Nov	69	77	77	80	78	78
Dec	69	76	76	79	76	77

1. This table is a combination of Acute Temperature Criteria found in Wisc. Admin. Code Chapter NR 102 Tables 2 and 4.
2. Temperature assessment protocols can be found in 6.3 Temperature.
3. Northern means North of State Highway 10 and Southern means South of State Highway 10.

Acute Temperature Criteria in Fahrenheit for each month for specific waters[1]					
			Wisconsin River[3]		
Month	Mississippi River	Rock River[2]	Upper	Lower	Lower Fox River
Jan	75	76	76	75	76
Feb	76	76	76	75	76
Mar	76	77	76	77	77
Apr	79	79	78	79	80
May	82	84	82	83	83
Jun	85	85	85	85	85
Jul	86	86	86	86	87
Aug	86	85	85	86	86
Sep	84	84	84	84	85
Oct	81	81	80	80	80
Nov	77	77	77	77	78
Dec	76	76	76	76	76

1. This table was created from Wisc. Admin. Code Chapter NR 102 Tables 2 and 4.
2. Applies to portions of the Rock River downstream of Lake Koshkonong.
3. “Upper” means any part of the Wisconsin River upstream of Petenwell Dam and “Lower” means any part of the Wisconsin River downstream of Petenwell Dam. This does not include impoundments along the Wisconsin River.

E. coli – Recreation Use

E. coli (counts[1] per 100 mL)	
Geometric Mean	Statistical Threshold Value
126	410

[1]For determining attainment or compliance, counts are considered equivalent to either colony forming units (CFU) or most probable number (MPN).
Assessment protocols can be found in section 7.3 Pathogens – *E. coli*.

Dissolved Oxygen

Assessment protocols can be found in section 6.4 Dissolved Oxygen (DO).

Waterbody Type	Waterbody Designation	Criteria (mg/L)
Streams, Rivers	Cold Waters	6.0, and 7.0 during spawning season
	Cold or Warm Water – Class III Trout	6.0
	Warm Waters	5.0
	Limited Forage Fish	3.0
	Limited Aquatic Life	1.0
Lakes	Other than Two-Story	5.0
	Two-Story Fishery	See Oxythermal Criteria

A.3. EPA Five-Part Categorization

The EPA encourages States/Tribes to use a five-category system for classifying all water bodies (or segments) within its boundaries. This classification system is built around designated uses and categorizes waters based on their status in meeting the State's/Tribe's water quality standards. Each waterbody and designated use combination are assigned a condition/reporting category as listed in the table below. More information can be found in section 2.3 Water Quality Condition Categories and Lists.

List	Category/ Subcategory	Description
Waters Attaining Standards	**Category 1**	**All designated uses are supported**, no use is threatened.
	Category 2	Available data and/or information indicate that **some, but not all, designated uses are supported**.
	Category 3	There is **insufficient available data** and/or information to make a use support determination.

Waters In Restoration	**Category 4**	Available data and/or information indicate that at least one designated use is not being supported or is threatened, but **a TMDL is not needed**.
	Category 4A	A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.
	Category 4B	Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time.
	Category 4C	The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.
	Category 5	Available data and/or information indicate that at least one designated use is not being supported or is threatened, and **a TMDL is needed**.

WDNR has further refined Category 5 (waters not meeting water quality standards and a TMDL is needed) waters into subcategories to distinguish among differing types of impaired waters and TMDL priorities.

	Subcategory	Definition
Impaired Waters List	**Category 5A**	Available information indicates that at least one designated use is not met or is threatened, and/or the anti-degradation policy is not supported, and one or more TMDLs are still needed. This is the **default** category for impaired waters.
	Category 5B	Available information indicates that **atmospheric deposition of mercury** has caused the impairment and no other sources have been identified.
	Category 5C	Available information indicates that non-attainment of water quality standards may be caused by **naturally occurring or irreversible human-induced conditions**.
	Category 5P	Available information indicates that the applicable **total phosphorus** criteria are exceeded; however, biological impairment has not been demonstrated (either because bioassessment shows no impairment or because bioassessment data are not available).
	Category 5W	Water quality standards are not met; however, the development of a TMDL for the pollutant of concern is a low priority because the impaired water is included in a watershed area **addressed by at least one of the following 9-Key Element watershed plans**: adaptive management plan, adaptive management pilot project, lake management plan, or CWA Section 319-funded watershed plan. EPA identifies these as 5-*alt* listings; like Category 4 waters, the plans and subcategory placement are **approved by EPA**.

Listing Combinations

Listing determinations for phosphorus and phosphorus response indicators based on attainment.

	Phosphorus Response Indicators	Overall Assessment Result	Pollutant	Observed Effect	EPA Listing Category
Exceeds TP criteria (less than overwhelming exceedance)	One or more indicate impairment	Impaired	TP	Degraded Biology*	Category 5A
	None indicate impairment	Not Impaired	NA	NA	Category 2
	Insufficient Information	Impaired	TP	NA	Category 5P
Exceeds TP criteria by an overwhelming amount	None needed	Impaired	TP	NA or Degraded Biology*	Category 5A

Resulting pollutant and/or impairment from an exceedance of each parameter. These are not all the possible parameters assessed, but some of the most common.

Parameter	Pollutant	Aquatic Life Use Observed Effect (Impairment)	Recreation Use Observed Effect (Impairment)
Total Phosphorus	Total Phosphorus	--	--
Total Phosphorus (Overwhelming Exceedance)	Total Phosphorus	High Phosphorus Levels[1]	High Phosphorus Levels *
Chlorophyll-*a*	--	Eutrophication	Excess Algal Growth
Benthic Algal Biomass	--	Excess Algal Growth	Excess Algal Growth
Macrophytes	--	Degraded Submerged Aquatic Vegetation (SAV)	--
mIBI	--	Degraded Benthic Macroinvertebrates	--
fIBI	--	Degraded Fish Community	--
Chloride	Chloride	Chronic Aquatic Toxicity; Acute Aquatic Toxicity	--
Temperature	--	Elevated Water Temperature	--
E. coli	*E. coli*	--	Recreational Use Restrictions

1. "High Phosphorus Levels" is a term only used when there are no accompanying biological impariments.

APPENDIX B. 2024 Impaired Waters Assessment Documentation Form

2024 Impaired Waters Documentation Sheet

Author:		Date Prepared:
Waterbody Name:		Segment:
WADRS ID:	WBIC:	Use i-SWDV (CRTL + Click) to find ID numbers

Choose from the following to indicate what you are recommending:

☐ Proposed new impaired water listing

☐ Proposed changes for water already on 303(d) list (check type of change below) → TMDL ID #: _____

- ☐ Proposed change to existing list (new pollutants, impairments, mileages, etc.)
- ☐ Proposed for de-listing
- ☐ General 303(d) documentation for water already on list

Description of waterbody segment

Start Mile:	Detail (describe segment using road crossings, convergence with other waterbodies, etc.):
End Mile:	
Total miles:	
Lake Acres:	

Use Designation Categories	List use designation & data source for each category.
Current (Existing) Fish & Aquatic Life Use:	
Attainable (Potential) Fish & Aquatic Life Use:	
Designated (Codified) Fish & Aquatic Life Use:	

Is it supporting its FAL Attainable Use? ○ Fully Supporting ○ Not Supporting ○ Not Assessed

Is it supporting its Recreational Use? ○ Fully Supporting ○ Not Supporting ○ Not Assessed

Does a *Specific* Fish Consumption Advisory Exist? ☐ Yes ☐ No ☐ Don't know

If so, what is the specific advisory:

Pollutants & Impairments

Pollutants: (Place an X next to all pollutants that you are recommending for listing or de-listing, or "watch water" monitoring needs.)

☐ Phosphorus	☐ Sediment	☐ Bacteria	☐ PAHs	☐ PCBs
☐ NH_3 (Ammonia)	☐ Thermal	☐ Hg	☐ Creosote	☐ Metals
☐ Unknown	Other Pollutants:			

Impairments: (Place an X next to all impairments that you are recommending for listing, de-listing, or "watch water" monitoring needs.)

☐ Degraded Habitat	☐ Eutrophication	☐ Temperature
☐ Contaminated Fish Tissue	☐ Chronic Toxicity	☐ Aquatic Toxicity
☐ Unknown	☐ Degraded Biological Community	

Specific causes of impairment: (Describe to the best of your ability what you think is contributing to the impairment.)

Information is based on:

Monitoring data collected on/after January 1, 2009? ☐ YES ☐ NO

If 'NO' then provide justification for using data from the long term record:

Monitoring & Listing Data

Monitoring Study, Date, Results. List water quality exceedances indicating magnitude, duration and frequency (attach additional sheets, if needed).

Monitoring Studies:

Exceedances:

Stations:

Parameters:

Database where data is stored (Fish Database, SWIMS, FishSED, Personal PC):

Narrative on why you are proposing this waterbody to be listed or de-listed?

List and attach any additional reports, updated watershed tables, analyses etc. including use designation survey.

1.
2.
3.
4.

APPENDIX C. Summary of Fish Tissue Criteria for Fish Consumption Advice

Wisconsin fish consumption advisory protocols. Duplicated from *Wisconsin's Fish Contaminant Monitoring and Advisory Program: 1970-2012* article by Candy S. Shrank in *Wisconsin's Contaminant Monitoring Program* of January 2014 except for PFOS values, which were updated in 2020 based on WDNR and WDHS revised PFOS meal threshold values.

Contaminant	Population	Concentration Range	Meal Frequency Recommendation
PCBs	All	≤0.05 ppm	Unlimited consumption
		0.05 – 0.22 ppm	1 meal/week or 52 meals/year
		0.22 – 1.0 ppm	1 meal/month or 12 meals/year
		1.0 -1.9 ppm	6 meals/year
		≥ 2 ppm	Do Not Eat
Mercury: General	Sensitive Groups	≤0.05 ppm	Unlimited consumption
		0.05 – 0.22 ppm	1 meal/week or 52 meals/year
		0.22 – 0.95 ppm	1 meal/month or 12 meals/year
		> 0.95 ppm	Do Not Eat
	Others	≤0.16 ppm	Unlimited consumption
		0.16 – 0.65 ppm	1 meal/week or 52 meals/year
		> 0.65 ppm	1 meal/month or 12 meals/year
Mercury: Site-Specific	All	Species-site panfish average > 0.22 ppm (n > 4), max > 0.33 ppm	Sensitive group: 1 meal/month of panfish, Do Not Eat gamefish
		Species-site gamefish average > 0.65 ppm, max > 0.95 ppm	General group: 1 meal/week of panfish, 1 meal/month of gamefish
Dioxin	All	< 10 ppt	No advice given
		> 10 ppt	Do Not Eat
Chlordane	All	≤ 0.16 ppm	No advice given
		0.16 – 0.65 ppm	1 meal/week or 52 meals/year
		0.66 – 2.82 ppm	1 meal/month or 12 meals/year
		2.83 – 5.62 ppm	6 meals/year
		> 5.62 ppm	Do Not Eat
PFOS (Updated 2020)	All	≤ 10 ppb	Unlimited consumption
		> 10 – 50 ppb	1 meal/week or 52 meals/year
		> 50 – 200 ppb	1 meal/month or 12 meals/year
		> 200 ppb	Do Not Eat

[1]**PCB**s - Species-site specific advisories are provided to protect against reproductive health effects and other potential health effects such as immune suppression and cancer. The same advice is given for women, children, and men. The following values were used in deriving the fish tissue criteria for PCBs:

- Health Protection Value of 0.05 µg PCB/kg/day. Average Meal size = 227 g uncooked fish. Consumer = 70 kg adult for others, meal size is assumed proportional to body size). Meal rates defined in the advisory ranging from unrestricted (>225/yr) to none. Skinning/trimming/cooking reduction factor = 50%. The Health Protection Value is from the "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory. Great Lakes Sport Fish Task Force. September 1993. Since 2000, only specific PCB-based advice is listed for species-sites more stringent than the general statewide advisory.

[2]**Mercury** - Sensitive group includes pregnant women, women of childbearing age, and children under age 15. Others are women beyond childbearing age and men. The HPV for the sensitive group is 0.1 µg/kg/day (EPA RfD) and for others it is 0.3 µg/kg/day (Iraq 1990 RfD). A Protocol for Mercury-based Fish Consumption Advice. Anderson et al., May 2007. Average Meal size = 227 g uncooked fish. Consumer = 70 kg adult (for others, meal size is assumed proportional to body size). Meal rates defined in the advisory ranging from unrestricted (>225/yr) to none. No reduction factor is applied.

- For the statewide general advisory, species were placed in a meal-category considering the distribution of concentrations for each species in the tissue criteria for each meal category, angler harvest, bag and size limitations, and other factors pertinent to consumption.

- In addition to the general advisory, mercury-based special advice is provided for species-sites where higher mercury concentrations have been documented. For special mercury advisories, a number of factors are examined including: maximum and average concentrations for a species in a waterbody or reach, concentration-size relationships, size range of the species expected to be harvested, angler harvest information, and other factors.

[3]Sum of total dioxin equivalence expressed as 2,3,7,8 TCDD based on dioxin and furan congeners and WHO 2005 human health TEFs

[4]Sum of chlordane isomers. Hornshaw 1999 HPV = 0.15 µg/kg/day

[5]MN Rfd (Seacat et al. 2002 Tox Sci 68:249-264) 0.075 µg/kg/day

APPENDIX D. Derivation of Trophic State Index Thresholds

Derivation of TSI General Condition Thresholds

TSI thresholds are used to place a lake into one of four general condition categories of "excellent," "good," "fair," and "poor." These thresholds are not codified as water quality standards and are not used for impairment assessments (i.e., to determine if a use is not supported). However, TSI data may be used to determine that the Aquatic Life use *is* supported, and the lake may be assigned to integrated reporting Category 2 when the lake's general condition is "fair" or better, and when no other supporting or opposing information is available to assess. Below, TSI condition threshold derivation are described in greater detail:

Excellent Condition
To establish the "excellent" range for TSI conditions, WDNR uses "excellent" or "reference" conditions inferred from total phosphorus (TP) values based upon preserved diatom communities from pre-settlement times found in lake bottom sediment cores.

Sediment cores measure fossilized diatom communities, allowing a comparison of historical (pre-settlement) conditions and recent water conditions to observe the changes in algae conditions over time. Diatoms are a type of algae containing siliceous cell walls that fossilize in lake sediments. Diatom taxa are known to prefer narrow ranges of water quality. Therefore, inferences about historical water condition can be made from fossilized diatom communities at the bottom of the sediment core. These inferred water quality conditions, when converted to TSI values using the Carlson equations, can be used as reference values.

This approach will not work for most reservoirs, impounded flowing waters, or raised wetland lakes since these lakes are artificial and pre-settlement conditions do not exist. WDNR has not yet developed criteria specific to these artificially created waterbodies.

Sediment cores are not available for small lakes or spring ponds. Since adequate sediment core data from two-story lakes is not available, the 75th percentile value for deep seepage lakes was used for the threshold between excellent and good condition (Table 10). Ideally, sediment core data should be collected whenever monitoring is conducted on two-story lakes.

WDNR has sediment core data spanning each of the 6 natural lake community types (Table 8) and derives excellent TSI thresholds from these data (Garrison *et al*. 2008*).* The transition between "excellent" and "good" for each natural community is based on the 75th percentile of the TSI values calculated from sediment core bottom inferred phosphorus concentrations. The bottom sediment core values represent reference lake conditions and using the 75th percentile gives some margin for lakes to have changed since the bottom of the sediment core accumulated (Table 41).

Table 41. Mean and median inferred TP values calculated from top and bottom segments of sediment cores from 87 Wisconsin lakes (Garrison, unpublished data).

Lake Class	Natural Community	N	Mean TP (µg/L)		Median TP (µg/L)		75th Percentile (µg/L) (Bottom)	TSI Threshold
			Top	Bottom	Top	Bottom		
1	Shallow Headwater	17	27	24	26	19	30.3	53
2	Deep Headwater	19	24	18	21	14	20.5	48
3	Shallow Lowland	11	28	25	28	24	30.5	53
4	Deep Lowland	43	25	19	20	15	20.0	47
5	Shallow Seepage	15	17	16	16	14	17.0	45
6	Deep Seepage	29	15	13	12	11	15.3	43

Poor Condition

Setting the TSI threshold for "Poor Condition" was approached differently for each lake type, as most appropriate for the specific conditions exhibited by those lakes:

> *Shallow Lakes:* The transition between a "fair" and "poor" condition for shallow lakes was set at a TSI of 71 (corresponding to TP concentration of 100 µg/L) because this approximates TP concentrations that lead to a switch from aquatic plant dominated to algal dominated ecosystems in shallow lakes (Jeppesen et al. 1990). This represents a major ecosystem change and once it occurs, it is very difficult to restore to the aquatic plant dominated state.
>
> *Deep Lakes:* The "fair" to "poor" transition threshold for deep lakes was set using a TSI value known to cause increased frequency of algal blooms, high amounts of blue-green algae, and/or hypolimnetic oxygen depletion. A TSI of 63 (corresponding to TP of 60 µg/L) was chosen because it represents the threshold between eutrophic and hyper-eutrophic lakes (Carlson 1977).
>
> *Two-Story Lakes:* TSI values that correspond to significant hypolimnetic oxygen depletion should be used as the threshold for two-story lakes, since this habitat component is critical for maintaining coldwater fisheries. This value will be highly dependent upon the lake's morphometry, making it very difficult to set the TSI threshold. Hypolimnetic oxygen demand is largely from the sediment; therefore, the greater the ratio of sediment area to hypolimnetic water volume, the higher the hypolimnetic oxygen demand. A conservative TSI value of 53 (corresponding to a TP of 30 µg/L) is recommended. Further research on these relationships is needed to derive accurate values for two-story lakes.

Good and Fair Condition

The transitional TSI value between the condition of "fair" and "good" for each natural community was selected as a mid-point between the "excellent" and "poor" TSI values (Table 10).

APPENDIX E. Assessment Parameter Documentation

Parameter Names and Numbers

Each parameter in an assessment package has a specific ID; the following table outlines all parameters used in automated calculations.The ID and type are determined by data source: DNR STORET means it came from a lab and SWIMS means that the parameter is a value or calculation created in the database. DNR STORET parameters are analyzed at the State Lab of Hygiene or an equivalent. Lab data comes to the SWIMS database through the Lab Data Portal System (LDES) or through a batch upload done by the database manager. An upload template spreadsheet is available on the water quality public participation webpage.

Parameter Name	Parameter ID #	Parameter Type
CHLORIDE	940	DNR STORET
CHLOROPHYLL A	99171, 32211	
E COLI	98929, 98930, 98933, 99069, 99132, 99188, 99743, 99824, 99826, 99962, and 99964	
PHOSPHORUS TOTAL	665	
Water Clarity - Predicted Secchi Depth Derived from Satellite Imagery	90880	SWIMS
Macroinvertebrate Index of Biological Integrity (IBI), Wadable	80027	
Macroinvertebrate Index of Biotic Integrity (IBI), Non-Wadable	80060	
Calculated Maximum Daily Temperature	80002	

Assessment Parameter Names and Numbers

Once the assessment cycle is completed the assessment results are uploaded to SWIMS as time allows. The following table outlines the parameter names and IDs; all are SWIMS parameters.

Parameter Name	Parameter ID #
10 Year Chloride Chronic Assessment Value	80418
10 Year Chloride Acute Assessment Value	80419
Lake 10 Year Mean Chla FAL Assessment Value	80408
Lake 10 Year Chla Upper 80% Percentile Assessment Value	80409
Lake 10 Year Chla Lower 80% Percentile Assessment Value	80410
Lake 10 Year Mean Chla REC Assessment Value,	80411
Lake 10 Year Chla REC Upper 80% Percentile Assessment Value	80412
Lake 10 Year Chla REC Lower 80% Percentile Assessment Value	80413
5 Year E-coli Assessment Impairment Flag	80427
Lake 10 Year Mean TP Assessment Value	80414
Lake 10 Year TP Upper 80% Percentile Assessment Value	80415
Lake 10 Year TP Lower 80% Percentile Assessment Value	80416
River Stream 10 Year Median TP Assessment Value	80401
River Stream 10 Year TP Upper 80% Percentile Assessment Value	80402
River Stream 10 Year TP Lower 80% Percentile Assessment Value	80403
Lake 10 Year TSI Chla Assessment Value	80423
Lake 10 Year TSI TP Assessment Value	80424
Lake 10 Year TSI Secchi Assessment value	80425
Lake 10 Year TSI Satellite Secchi Assessment Value	80426
Non-Wadeable Stream 10 Year Mean mIBI Assessment Value	80406
Wadeable Stream 10 Year Mean mIBI Assessment Value	80404
River Stream Annual Temperature Exceedance Value	80422