Minnesota Pollution Control Agency

Guidance Manual For Assessing the Quality of Minnesota Surface Waters

for the Determination of Impairment

305(b) Report and 303(d) List

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Guidance Manual for Assessing the Quality of Minnesota Surface Waters For Determination of Impairment. 305(b) Report and 303(d) List

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Foreword

Since the Clean Water Act became law in 1972, very significant and often dramatic improvements in the water quality of the nation's surface waters have been accomplished. Notable Minnesota examples include the Mississippi River below the Twin Cities, the Rainy River below International Falls, and the lower St. Louis River near Duluth, to name just three. Most of these gains can be attributed to vast improvements in domestic and industrial wastewater treatment, due largely to the Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit program, and the Construction Grants program. Point source discharges have been significantly "cleaned up" as a result of these two programs (which is not to say that all point source pollution problems have been solved). The contribution of pollutants from nonpoint sources, from agriculture, construction and development sites, forestry, urban runoff, etc., is now the major reason that many of Minnesota's waters are considered impaired. The prevention and control of nonpoint source pollution remains one of the Minnesota Pollution Control Agency's, and the public's, greatest pollution challenges.

It is the responsibility of the Pollution Control Agency to monitor Minnesota's rivers and lakes, to assess water quality, and to report the results to the public. This task extends to documenting the water quality "success stories", as well as documenting those rivers and lakes that still need improvement. Providing support for an adequate monitoring program for a state so blessed with water resources is an ongoing challenge. This guidance manual deals with the need to assess water quality with available data, which may be plentiful in places but is often just enough to satisfy minimum data requirements. The methodologies in this guidance are designed to reap the most information, value and benefit possible from limited data.

This guidance manual was developed to help federal, tribal, state, and county staff, and the public in general, understand the water quality assessment process. It will be updated as assessment methods improve and as new pollution problems emerge that require assessment. Comments and suggestions from readers are encouraged and will be used to help improve the guidance.

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Tables

Figures

Abbreviations, Acronyms and Symbols

DELT	Deformities, eroded fins, lesions or tumors
ch.	Chapter
Chl-a	Chlorophyll-a
CLMP	Citizens Lake Monitoring Program
CSMP	Citizens Stream Monitoring Program
CWP	Clean Water Partnership
DO	Dissolved oxygen
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
FAV	Final Acute Value
GLI	Great Lakes Water Quality Initiative
IBI	Index of Biotic Integrity
L	Liter
LAP	Lake Assessment Program
MDH	Minnesota Department of Health
MFCA	Minnesota Fish Consumption Advisory
μg/L	microgram per liter or ppb
mg/L	milligram per liter or ppm
MPCA	Minnesota Pollution Control Agency
NCHF	North Central Hardwood Forest Ecoregion
ng/L	Nanogram per liter or parts per trillion
NGP	Northern Glaciated Planes Ecoregion
NHD	National Hydrographic Data
NLF	Northern Lakes and Forests Ecoregion
NTU	Nephelometric turbidity units
PCB	Polychlorinated biphenyls
pg/L	Picogram per liter or parts per quadrillion.
ppb	Parts per billion or microgram per liter
ppm	Parts per million or milligram per liter
ppq	parts per quadrillion or picogram per liter
ppt	Parts per trillion or nanogram per liter
pt.	Part
QA/QC	Quality Assurance/Quality Control
R.	Rule
STORET	EPA water quality data STOrage and RETrieval system
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
USGS	U.S. Geological Survey
WCBP	Western Corn Belt Plain Ecoregion
≥	Greater than or equal to
≤	Less than or equal to

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Preface to the 2006 Revision of the Guidance Manual

In this edition of the Guidance Manual for Assessing the Quality of Minnesota Surface Waters, the Minnesota Pollution Control Agency (MPCA) made a number of changes. Some of the changes are editorial in nature, while others reflect substantive changes in the manner in which the MPCA conducts the assessment and reporting processes. In several areas, especially, MPCA wants to highlight the 2006 changes – relating to use of transparency tube data in assessments; changes in lake assessments; and a proposal to use outside-of-Minnesota data in the next assessment cycle (2008).

Use of transparency tube (T-tube) data in stream assessments

In the 2006 assessment process, the MPCA used citizen-collected transparency tube data for the first time. Over the past several years, MPCA staff and others have conducted studies to determine the relationship between T-tube readings of stream clarity and turbidity measurements and identified correlations between the two factors. MPCA staff developed specific criteria for using T-tube data in the turbidity assessment process, including requiring corroboration of volunteer-collected observations for 303d listing. In 2006, just over half of the new turbidity assessments statewide are proposed to be listed based entirely or in-part on T-tube data. A further description of the criteria used is found in Section VII.E.1.c.

Changes in lake assessments

MPCA staff made a few changes in lake data requirements for the 2006 assessment process. The changes allow the use of fewer observations for assessment in certain situations, allow consideration of blue - green algae toxicity events in assessments, and clarify how determinations will be made on whether a water body is a lake or wetland. A discussion of the changes is found in Section IX.A.

Proposal for the future: use of outside-of-Minnesota data

For the 2008 assessment cycle, the MPCA is proposing to use monitoring data collected just outside Minnesota's borders or on border waters. As an example, South Dakota environmental department staff has collected samples on border streams as part of an existing South Dakota TMDL. Such data, collected by non-Minnesota entities will be considered for use in the assessment cycle on a case-by-case basis by the professional judgment groups. A description of the MPCA's proposed strategy is found in Section IV.D.

I. Introduction

A. BACKGROUND

Minnesota is blessed with abundant water resources. Our lakes, rivers and streams play a vital role in the state's economy and the richness of the quality of life residents and visitors enjoy. The enormous opportunities for water related recreation these resources provide, such as aesthetic enjoyment, swimming, fishing, boating and canoeing depend, to a great extent, on good water quality. Within Minnesota's borders lie the headwaters of three major continental watersheds, the Great Lakes/St. Lawrence River, the Mississippi River, and the Red River of the North/Hudson Bay watersheds. Thus, Minnesotans have the privilege and, with that, the huge responsibility of living "upstream" of millions of downstream users of these major waterways. Minnesota's water resources include about 92,000 river miles, and 3.3 million acres of lakes and reservoirs, not counting the approximately 1.4 million acres of Lake Superior in Minnesota.

The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's lakes, rivers, streams and wetlands. With the exception of mercury contamination of fish, a widespread problem throughout much of the lake-rich upper Midwest, the water quality of many Minnesota surface waters meets or exceeds most water quality standards. The goal of the MPCA is to maintain the existing high quality of waterbodies that are meeting standards. However, too many surface waters receive enough pollutant loading from point and nonpoint sources that they do not meet one or more water quality standard. If the extent of the violations of standards exceed the guidelines spelled out in this Guidance Manual (Guidance), those surface waters are considered to be "impaired". The goal of the MPCA is to improve the water quality of impaired waters so water quality standards are met and beneficial uses are restored, where these uses are attainable.

B. PURPOSE AND SCOPE

Rivers, streams and lakes determined to be not supporting beneficial uses (i.e., impaired) are listed in one or both of the two federally mandated compilations of assessed waters, the **305(b) report** and the **303(d) list** [Note: Throughout this Guidance certain terms or phrases are in **bold** for emphasis.]. Under the "integrated" approach to the preparation of these two documents, as described in Section VI, the distinctions between them have mostly disappeared.

The MPCA began assessing waters for use support in the mid 1970s for the 305(b) report, and has developed guidance and protocols for interpreting water quality data and information used to determine impaired conditions. The **purpose of this Guidance** is to consolidate the existing protocols into one document, to define the data and information requirements needed to determine impairment for the various categories of pollutants, and to provide a rationale for the thresholds selected that indicate impairment.

The **scope of this Guidance** includes methods for assessing surface waters for the following categories of pollutants:

- Those having toxicity-based standards (in Section II.B.)
- Those having human health-based standards (in Section II.B.)
- Conventional pollutants and water quality characteristics
- Fecal coliform bacteria
- Eutrophication of lakes (effects of excess nutrients)
- Impairment of the biological community
- Fish tissue contaminants

The assessment of waters, both surface and ground, for drinking is outside the scope of this Guidance. Most surface water monitoring programs are not geared to assessing quality for drinking. The Minnesota Department of Health monitors municipal finished water supplies for compliance with drinking water standards. Also, aquatic life standards may be more stringent than drinking water standards for the pollutants for which the MPCA has surface water data (e.g., mercury and most other trace metals), or the pollutant is not relevant to drinking water (e.g., dissolved oxygen, ammonia, excess nutrients). The level of contaminants in bottom sediments is not used in water quality assessments by the MPCA at the time this Guidance was prepared. The local nature of sediment contaminant data and the lack of statewide sediment criteria hinder the use of these data. Finally, setting priorities for the remediation of impaired waters is outside the scope of the Guidance.

In lieu of an executive summary, the minimum data requirements and the use support and impairment determination thresholds used in water quality assessments for both the 305(b) report and 303(d) list, are summarized in **Tables 17 and 18** (in Section XII). These tables were prepared to help the reader visualize and compare in one place the basic assessment methods. Definitions of terms, a complete discussion of data requirements, assessment protocols and supportive discussion for each pollutant category can be found in the appropriate Sections of the Guidance.

Table 1. Assessment Methods that Have Changed or Are New in this Guidance. (See appropriate Section of Guidance for Details.)

Pollutant Category	**Location of details**
Use of transparency tube (T-Tube) data in stream assessments	A further description of the criteria used is found in Section VII.E.1.c. and the Preface.
Changes in lake assessments	Lake assessments are discussed in Section IX.A. and the Preface.
Use of out-of-state data	Use of out-of-state data is discussed in Section IV.D. and the Preface.

C. DISCLAIMERS AND FUTURE CHANGES TO GUIDANCE

To people not part of water quality assessments, the determination of an impaired condition would seem to be a straight-forward process; waters are either impaired or not impaired. However, the assessment process can be very complex and it includes a certain amount of uncertainty. The MPCA must consider many different types and sources of data, different categories of pollutants, different uses of surface waters, the variability in natural systems, and many other variables. The **goal of this Guidance** is to accurately and completely describe the assessment methods, and to make the assessment process as clear and understandable to all parties as possible. Nevertheless, questions about the assessment process will invariably arise that the Guidance fails to answer. Readers are encouraged to access the many resources listed in Section XI, including MPCA staff, for additional information. Two MPCA products which may be especially useful and related to this guidance are the *Volunteer Surface Water Monitoring Guide* (MPCA 2003) and the *Data Access Website*. The *Monitoring Guide* provides information on planning a monitoring program, as well as data quality and management. The *Website* allows Minnesotans to access environmental data on surface waters statewide and is found at http://www.pca.state.mn.us/data/eda .

This Guidance does not affect the rights and administrative procedures available to all affected or interested parties. The Guidance is not part of any water quality rule – it does not have the force of law. It serves to guide the interpretation and application of current water quality standards that are in water quality rules. If any party feels that an MPCA decision based on the Guidance is not supported by the facts, or they have any issue related to the MPCA's use of the Guidance, that party can comment or challenge the MPCA's actions in the following ways:

- Directly contact MPCA staff, management or the Commissioner, orally or in writing.
- Request that the issue be brought before the MPCA Citizen's Board for hearing.
- Request a contested case hearing if the issue involves a MPCA permit action, or any other MPCA action for which a contested case hearing is an appropriate forum to resolve the concern.
- Challenge the MPCA action in the appropriate legal jurisdiction.

The MPCA plans to update this Guidance periodically, possibly every two years since that is the current EPA mandated schedule for preparation of both the 305(b) report and the 303(d) list. The MPCA intends to involve the public when major changes to the Guidance are being considered.

II. Water Quality Standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters is measured. It is the water quality standards that are used to determine impairment. Water quality standards have been adopted into Minnesota's administrative rules beginning in the late 1960s.

The term "water quality standards" is commonly used in both a broad and narrow sense. Broadly speaking, water quality standards include all the provisions and requirements in water quality rules, including minimum wastewater treatment requirements and effluent limits for point source dischargers. In the more narrow sense, water quality standards are the entities, both numeric and narrative, that define acceptable conditions for the protection of the uses we make of waters of the state. Included in the narrow sense are nondegradation provisions. The term "water quality standards" is used in the more narrow sense throughout this document.

A. BENEFICIAL USE CLASSES FOR SURFACE WATERS

Minnesota R. ch. 7050 identifies seven beneficial uses for which surface waters are protected, as listed below. The use class numbers 1 – 7 are not intended to imply a priority rank to the uses.

Use Class	Beneficial Use
Class 1	Drinking water
Class 2	Aquatic life and recreation
Class 3	Industrial use and cooling
Class 4A	Agricultural use, irrigation
Class 4B	Agricultural use, livestock and wildlife watering
Class 5	Aesthetics and navigation
Class 6	Other uses
Class 7	Limited resource value waters (not fully protected for aquatic life due to lack of water, lack of habitat or extensive physical alterations)

Class 2 waters are further divided into subclasses as follows:

Class 2A	Cold water fisheries, trout waters
Class 2Bd	Cool and warm water fisheries, in addition these waters are protected as a source of drinking waters
Class 2B	Cool and warm water fisheries (not protected for drinking water)
Class 2C	Indigenous fish and associated aquatic community
Class 2D	Wetlands

All surface waters in Minnesota, including lakes, rivers, streams and wetlands, are protected for aquatic life and recreation where these uses are attainable, **unless** the waterbody has been individually assessed and re-classified as a limited resource value water. Protection of aquatic life means the maintenance of healthy, diverse and successfully reproducing populations of aquatic organisms, including invertebrates as well as fish. Protection of recreation for all surface waters, except wetlands and limited resource value waters, means the maintenance of conditions suitable for swimming and other forms of water recreation. Recreation in wetlands (Class 2D) means boating and other forms of aquatic recreation for which they may be usable (this does not preclude swimming if that use is suitable). This is consistent with the goal in the Clean Water Act that the nation's waters should be "fishable and swimable" wherever attainable. Limited resource value waters (Class 7) do not support swimming, but they may support wading, nature study, or other forms of recreation that do not involve immersion in the water. Class 7 waters support a very limited fishery and aquatic community due to lack of water, habitat and usually extensive human alterations. Most limited resource value waters are headwater channelized ditches. Class 7 waters make up about one percent (~ 900-950 miles) of Minnesota's 92,000 miles of rivers and streams.

Both Class 2 and Class 7 waters, i.e., **all surface waters of the state**, are also protected for industrial (Class 3A,B&C), agricultural (Class 4A&B), aesthetics and navigation (Class 5), and other uses (Class 6). For example, the St. Croix River from the dam in Taylors Falls to its mouth is classified as 1C, 2Bd, 3B, 4A, 4B, 5 and 6; and is therefore protected for all uses defined by these use classes (Minn. R. pt. 7050.0470, subp. 6). If a pollutant has numeric standards for more than one beneficial use class, the most stringent applies.

All ground waters, but only **selected surface waters**, such as the St. Croix example cited above, are protected as a source of drinking water (Class 1). The federal drinking water standards apply to these waters (Minn. R. pt. 7050.0221). Again, the assessment of surface or ground water for potential impairment of the drinking water use is outside the scope of this Guidance.

B. NUMERIC WATER QUALITY STANDARDS

A numeric water quality standard is a safe concentration of a pollutant in water, associated with a specific beneficial use. Numeric standards are associated with all use classes except Class 6 (other uses). Ideally, if the standard is not exceeded, the use will be protected. However, nature is very complex and variable, and the MPCA may use a variety of tools, such as chemical and biological monitoring, to fully assess beneficial uses. The assessment of surface waters for impairment could include a review of any of the applicable beneficial uses and associated standards. But, in practice, waters are typically assessed only with respect to aquatic life and aesthetic uses and standards. However, compliance with the Class 2 standards will, with few exceptions, protect the usually less sensitive Class 3, 4, 5 and 6 beneficial uses. Aquatic life standards are more stringent than drinking water standards for many pollutants. Therefore, application of Class 2 standards may "protect" drinking water as well. For example, the drinking water and aquatic life standards for selenium are 50 and 5 μg/L, respectively..

All Class 2 standards for toxic pollutants have three parts, except un-ionized ammonia, di-2-ethylhexyl phthalate, hexachlorobenzene, and vinyl chloride, which have only a chronic standard and no maximum standard or final acute value.

- Chronic standard
- Maximum standard, and
- Final Acute Value (FAV)

The **chronic** standard is the highest concentration of a toxicant to which aquatic organisms can be exposed indefinitely with no harmful effects to the organism itself, or to human or wildlife consumers of aquatic organisms. The **maximum** standard protects aquatic organisms from potential lethal effects of a short-term "spike" in toxicant concentrations. The maximum standard is always equal to one half the Final Acute Value (FAV). The **FAV** is most often used as an "end-of-pipe" effluent limit to prevent an acutely toxic condition in the effluent or the mixing zone. The Class 2 numeric standards for toxic pollutants are found in Minn. R. chs. 7050 and 7052. They are listed in Appendix A.

Class 2 **chronic** standards are based on one of three "end points", as listed below.

- **Toxicity-based**. The chronic standard is based on the direct toxicity of the toxicant to fish and other aquatic life.
- **Human Health-based**. The chronic standard is based on the protection of people that eat fish from Minnesota waters (and drink the water, if the surface water is also a Class 1 water).
- **Wildlife-based**. The chronic standard is based on the protection of wildlife species that eat aquatic organisms (At the time this Guidance was prepared, only Minn. R. ch. 7052 has wildlife-based standards, Minn. R. ch. 7050 does not).

The usual practice for the MPCA is to calculate both a toxicity-based and a human health-based criterion, and the more restrictive of the two is adopted into Minn. R. ch. 7050 as the applicable chronic standard. The standards for some pollutants can change from toxicity-based to human health-based or vise versa depending on the subclass of Class 2 waters. See Tables A-3 and A-6 in Appendix A. Wildlife-based criteria have not been calculated outside of those adopted in Minn. R. ch. 7052. **Maximum standards and FAVs are always toxicity-based**, never human health or wildlife-based.

Most of Minnesota's aquatic life (Class 2) standards are based on EPA aquatic life criteria. This is true for most states. EPA develops and publishes the criteria as required by section 304(a) of the Clean Water Act. MPCA has developed a few standards on its own in the absence of an EPA criterion (e.g., atrazine and cobalt).

In the development of aquatic life criteria and associated guidance, the EPA and MPCA have addressed some of the many toxicological, water chemistry and practical realities that affect the impact a toxicant has on aquatic life. For example, pollutant concentrations and flow volumes vary in effluents and in receiving streams over time, aquatic organisms can tolerate higher concentrations of toxicants for shorter periods of time, and the sensitivity of aquatic organisms to toxicants often varies over their life span. EPA's approach for expressing water quality standards addresses varying toxicant concentrations, length of an averaging period for the standard, and the number of acceptable exceedances over time. These concepts are highly relevant to the interpretation of water quality standards and the assessment of waterbodies for impairment. They are referred to as:

- Magnitude,
- Duration, and
- Frequency

Magnitude refers to the concentration for a given pollutant represented by the numeric standard. For example, the chronic, maximum and FAV standards for cyanide are 5.2, 22 and 45 µg/L, respectively. This is the “magnitude” of cyanide that, if not exceeded in the water, will protect the aquatic community from chronic and acute toxic effects.

Duration refers to the period of time the measured water concentrations of a toxicant can be averaged and still provide the desired level of protection to the aquatic community, or to the human or wildlife consumers of aquatic organisms. In the context of toxicity to aquatic organisms, it would be over-protective and toxicologically unrealistic to consider a standard as an instantaneous maximum concentration (no averaging period). On the other hand, concentrations averaged over too long a time could be under-protective, if it allowed unacceptably high concentrations to be “masked” by the average. In general, toxicant concentrations can persist for a longer period of time at the level of the chronic standard than at the level of the maximum or FAV standards and still be protective. This is because chronic effects generally are only manifested after an extended exposure at concentrations above the chronic standard. In contrast, lethal or sublethal effects could occur after a relatively short exposure at concentrations equal to the maximum or FAV standards.

EPA recommends the following averaging periods for chronic and maximum standards (EPA 1991).

- Toxicity and human health-based standards:
    - Chronic – 4 day average
    - Maximum – 1 hour average

The MPCA has expanded these concepts and modified the durations of the averaging periods for various types of standards as shown below (Minn. R. pt 7050.0222, subp 7).

- Chronic Standards:
    - Toxicity-based: four-day average
    - Human Health or Wildlife-based: 30-day average
- Maximum Standard: one-day average (specified as a one-day maximum in Minn. R. pt. 7052.0200, subp. 5 for purposes of calculating a daily maximum effluent limit)
- Final Acute Values: one-day average

The 30-day averaging period for human health and wildlife-based chronic standards recognizes the longer life spans of humans and wildlife species relative to aquatic invertebrates, but it is short enough to address the possible impacts that might occur during sensitive periods of early fetal development, for example. The selection of a one-day averaging period for the maximum and FAV standards, in lieu of the EPA recommended one-hour average, is based almost entirely on the practicalities of monitoring frequencies. It is very rare that sampling is frequent enough to determine a one-hour average value either in ambient waters or in effluents. Also, the one-day duration for the maximum standard, which may be the basis for setting daily maximum effluent limits, matches the period for these limits.

Frequency refers to the number of times a standard may be exceeded over a period of time and still provide the desired level of protection. EPA guidance specifies that standards should not be exceeded more than once in three years. The three year time frame for acceptance of one exceedance is based on studies of the time it takes the aquatic community to recover from a major perturbation.

The MPCA reviewed the exceedance frequency question and concluded that EPA's one exceedance in three years recommendation can be overly stringent (Maschwitz 1990). A recognized deficiency in the EPA guidance is that the magnitude of the exceedance is not addressed. For example, two exceedances of 1.5 times the chronic standard in three years is not likely to have the same impact on aquatic organisms as two exceedances of 15 times the chronic standard; but EPA treats both cases equally. Considered without application of professional judgment, two exceedances of 1.5 times the chronic standard could result in a false conclusion of impairment. Another potentially overly protective aspect of the 3-year frequency is the way this time period was determined. A detailed review of studies that measured the time it takes aquatic communities to recover following a major perturbation, indicates that three years was adequate time for most members of the aquatic communities to return to pre-perturbation status (invertebrates recover faster, fish take longer) (Niemi et al. 1988). But, most of these studies of recovery times followed major spills or other catastrophic events that destroyed or had major impacts on the entire resident community. Small exceedances of a chronic standard are not likely to have the same impact as a major spill, resulting in toxicant concentrations in the stream well above acute standards, for example. These considerations went into the selection of the threshold percent exceedances discussed in Section VII.

A more complete discussion of duration and frequency can be found in EPA (1991). A complete description of how Class 2 standards are determined by the MPCA can be found in MPCA (2000e).

C. NARRATIVE WATER QUALITY STANDARDS

A narrative water quality standard is a statement that prohibits unacceptable conditions in or upon the water, such as floating solids, scums, visible oil film, or nuisance algae blooms. Narrative standards are sometimes called 'free froms' because they help keep surface waters free from very fundamental and basic forms of water pollution. The association between the standard and beneficial use is less well defined for narrative standards than it is for numeric standards; however, most narrative standards protect aesthetic or aquatic life beneficial uses. Because narrative standards are not quantitative, the determination that one has been exceeded typically requires a "weight of evidence" approach to data analysis showing a consistent pattern of violations. There is an unavoidable element of professional judgment involved in using narrative standards to determine impairment. As such, the descriptions of the methodologies for determining impairment due to violations of narrative standards requires more discussion than determining impairment of numeric standards. The narrative standards most relevant to this Guidance are found in Minn. R. pts. 7050.0150 and 7050.0222 subp. 7. These standards protect surface waters and aquatic biota from:

- Eutrophication (particularly lakes)
- Impairment of the biological community
- Impairment of fish for human consumption

The narrative standards in Minn. R. pt. 7050.0150, subp. 3 contain terminology, the interpretation of which in the context of the standards will be aided by the definitions that follow. Additional relevant narrative rule language is quoted in Section IX A, B, and C.

“Altered materially”, “material increase”, “material manner”, “seriously impaired”, and “significant increase” mean that pollution of the waters of the state has resulted in degradation of the physical, chemical or biological qualities of the waterbody, such that attainable or previously existing beneficial uses are threatened or lost.

“Fish and other biota”, “normal fishery” and “lower aquatic biota” mean the aquatic community including but not limited to game and non-game fish, minnows and other small fish, mollusks, insects, crustaceans and other invertebrates, submerged or emergent rooted vegetation, suspended or floating algae, substrate-attached algae and microscopic organisms. “Other biota” includes aquatic or semi-aquatic organisms that depend on the aquatic community for food or habitat such as amphibians, water fowl and certain wildlife species.

“Normal fishery” and “normally present” mean, the fishery and other aquatic biota expected to be present in the waterbody in the absence of pollution of the water, consistent with any variability due to natural hydrological, substrate, habitat, or other physical and chemical characteristics. Expected presence is based on comparing the aquatic community in the waterbody of interest to the aquatic community in representative reference waterbodies.

D. NONDEGRADATION

A third element of water quality standards, in addition to numeric or narrative standards and the beneficial uses they protect, is nondegradation. The fundamental concept of nondegradation (equivalent to the federal term, antidegradation) is the protection of waterbodies whose water quality is better than the applicable standards, so that the existing high quality is maintained and not allowed to degrade down to the level of water quality standards. This Guidance deals with assessing, listing and ultimately restoring waters that do not meet water quality standards, and does not describe the application of nondegradation provisions (see MPCA 1988a and 1988b). However, the nondegradation concept is a very important aspect of pollution control, because preventing the degradation of surface waters is usually less costly to society than the restoration of waters once they have become degraded. That is, it is almost always less costly to prevent clean waters from becoming polluted in the first place, than it is to clean them up after they no longer support designated uses. Also, once degraded, it may not be possible to restore some polluted conditions to health in the foreseeable future (e.g., heavily contaminated bottom sediments).

Federal guidance establishes three levels or tiers of nondegradation (EPA 1994). The first level is, at a minimum, waters should be in compliance with water quality standards, and that beneficial uses should be protected. Level two is the protection of waters that have water quality better than standards so the existing high quality is maintained, unless there is a social and economic need to degrade the waters down to the level of the standards (Minn. R. pt. 7050.0185). The third level, which provides the highest level of protection from pollution, are waters designated as outstanding, very sensitive or unique resources (Minn. R. pt. 7050.0180). The MPCA has specifically designated a number of waters that are special for a variety of reasons. In Minnesota these special waters are called **Outstanding Resource Value Waters** (ORVW).

ORVWs, are placed into one of two categories "prohibited" or "restricted". New or expanded point and nonpoint sources of pollution are entirely prohibited to the first category (examples are waters in the Boundary Waters Canoe Area Wilderness and Voyageurs National Park). New or expanded point and nonpoint sources of pollution are not allowed to the restricted category unless the discharger can demonstrate there is no "prudent or feasible alternative" to allowing the increased pollutant loading (examples in the restricted category are Lake Superior and federal and state designated scenic and recreational river segments such as the St. Croix River).

In addition to designated ORVWs, which are located statewide, all surface waters in the Lake Superior basin that are not ORVW's or not Class 7 Limited Resource Value Waters are designated as **Outstanding International Resource Waters** (OIRW) (Minn. R. pt 7052.0300). Implementation of nondegradation for OIRW waters focuses on reducing the loading of bioaccumulative pollutants to the Lake Superior basin because of the sensitivity of the Lake Superior ecosystem to these pollutants. Guidance on how to implement nondegradation for ORVWs and for all surface waters can be found in MPCA (1988a and 1988b), respectively. Information on implementation of nondegradation for OIRWs is included in Minn. R. pts. 7052.0300 – 7052.0330.

III. Listing of Impaired Waters and TMDLs

A. LISTS OF IMPAIRED WATERS REQUIRED

The 1972 amendments to the federal Clean Water Act require the MPCA to assess the water quality of rivers, streams and lakes in Minnesota (Code of Federal Regulations, title 40, part 130). Waters determined to be not meeting water quality standards and not supporting assigned beneficial uses are defined as "**impaired**". Impaired waters are listed and reported to the citizens of Minnesota and to EPA in the **305(b) report** and the **303(d) list**. Both listings are named after the relevant sections of the Clean Water Act. The beneficial uses assessed in this context are **aquatic life, aquatic consumption, and recreation** (swimming), and **aesthetics** (Classes 2 and 5). The relationship between the 305(b) and 303(d) assessments is discussed further in Section VI.

The 305(b) reports are state by state reports to the U.S. Congress of the condition of the nation's waters and the progress states are making toward cleaning up surface waters to protect beneficial uses and meet water quality standards. An important difference between the 305(b) report and 303(d) list is that the former **treats all waters** that have been assessed with water quality data or other information, including waters that are fully supporting all beneficial uses as well as those that are considered impaired. The 305(b) reports are used by states, other agencies, basin planners, citizens, and other parties interested in water quality. The listing of a waterbody as non-supporting or partially supporting in the 305(b) report does not carry regulatory consequences; it is simply a report on status and progress. However, assessment of waters for the 305(b) report identifies candidates for listing on the 303(d) list of impaired waters.

Unlike the 305(b) report, the 303(d) list is a tabulation only of waters considered to be impaired. "Impaired water" or "impaired condition" is defined in Minn. R. pt. 7050.0150 as follows:

> *… a water body that does not meet applicable water quality standards or fully support applicable beneficial uses, due in whole or in part to water pollution from point or nonpoint sources, or any combination thereof.*

The listing of a waterbody on the 303(d) list triggers a regulatory response on the part of the MPCA to address the causes and sources of the impairment. This process is called a **Total Maximum Daily Load** (**TMDL**) analysis. The purpose of the TMDL is to focus attention and resources on impaired waters to ultimately bring them back into compliance with water quality standards. The tables in this Guidance that show the exceedance thresholds and standards used to determine an impaired condition for the 303(d) list use the terms "**Listed**" or "**Not Listed**." This is because listing (or not listing) is the end result of the assessment process. The terms "impaired" or "not impaired" was not used because it is possible that not every waterbody listed on the 303(d) list is impaired due to anthropogenic causes. For example, subsequent monitoring and data analysis carried out as part of the TMDL study may determine that the exceedances of standard(s) are due to natural causes.

Fundamentally the 303(d) list and TMDLs are federal programs. Most states, including Minnesota, choose to carry out the assessments and prepare the 303(d) list themselves; but if states fail to act, EPA is obligated to act for them. Currently both the 305(b) report and the 303(d) list are updated every two years, but possible changes to the federal TMDL regulations may lengthen this interval for the 303(d) list. This guidance manual reflects the most current approved EPA guidance available at the time of assessments, which were performed in the spring of 2005. The EPA recently issued a new integrated guidance on the water quality assessment and 305(b)/303(d) reporting process in 2001 and an updated guidance in 2003 for 2004 reporting (EPA 2005).

The EPA guidance more closely aligns 305(b) and 303(d) assessments and it provides greater flexibility to states to place impaired waters in one of five categories depending on the pollutant(s), the nature of the impairment, and the time frame needed for appropriate corrective actions. The MPCA has incorporated the integrated approach into its assessment process, and this Guidance reflects the integrated approach.

B. TMDL ANALYSIS

As stated, each waterbody put on the 303(d) list triggers a total maximum daily load (TMDL) analysis. The TMDL determines the capacity of the impaired waterbody to assimilate pollutant loadings and still meet water quality standards. A TMDL is the sum of the individual waste loads from point sources, nonpoint sources and natural background, with an additional loading allowance for a margin of safety. This is generally described by the following equation:

$$TMDL = AC = \sum WLA + \sum LA + MOS$$

Where:

AC = assimilative capacity of the waterbody
WLA = waste load allocation, quantification of pollutant loads from point sources discharging to the waterbody
WL = load allocation, quantification of pollutant loads from nonpoint sources to the waterbody
MOS = margin of safety, reflects uncertainty in the analysis, a desire to provide an extra margin of protection for the beneficial uses, or allowance for future growth.

The 303(d) list and the TMDL process are the bridge connecting designated uses, water quality standards and water quality data. Because of the regulatory ramifications of being placed on the 303(d) list, it is important for the MPCA to make fair and consistent decisions. The protocols described in this Guidance are designed to facilitate that.

The first steps in the TMDL process ares identifying local partners and initiating further monitoring. Monitoring should determine the source(s) of the pollution, including point, nonpoint and contributions from natural sources. Next a plan is developed to reduce the pollutant loading to bring the waterbody back into compliance with water quality standards. The EPA must approve the 303(d) list, so the lists prepared by states are draft until public comments are reviewed and the list is approved by EPA. When new lists are prepared, all previously listed reaches remain on the new list unless new data or a significant change in the reach supports de-listing the reach (see Section X).

C. PUBLIC PARTICIPATION AND EPA APPROVAL OF 303(d) LIST

Public involvement in the TMDL process is very important because ultimately the public must be part of the solution. Indeed, public involvement is required to obtain EPA approval of the 303(d) list. The public has several opportunities to comment on the TMDL list as it is developed:

- Informal meetings – may be with multiple interested parties or "one on one".
- Draft 303(d) list noticed in *State Register* with request for comments. This provides an opportunity to comment on this Guidance too.
- Comments sent directly to EPA about the MPCA list at anytime in the process.

The EPA must approve each state's 303(d) list. They look for adherence to federal TMDL guidance as well as adherence to the state's own guidance, and for consistency with the letter and intent of the Clean Water Act. Once the 303(d) list is approved by EPA, the TMDL process can start. At this stage, there are additional opportunities for the public to comment as the TMDL process moves forward. Most TMDL projects will have an advisory committee that includes local citizen and interest groups. Completed TMDLs in draft must be published in the *State Register* for comment. Interested parties are encouraged to contact MPCA staff at the appropriate MPCA Regional Office for more information on active TMDLs in their area of interest (see Section XI).

IV. Monitoring and Data Management

Water quality and other types of data are the most important component of impairment determinations. Data collection and analysis involves sampling, laboratory analysis, quality assurance/quality control (QA/QC), data storage and, finally, data analysis. Most water quality data used in this process are a result of monitoring by the MPCA, but comparable data collected by others are used too, as long as the data meet acceptable QA/QC requirements.

A. THE BASIN APPROACH

The MPCA surface water monitoring program is implemented on a major basin (watershed) approach. The assessment by basin concept, part of a major switch to a "Basin Management" approach to the MPCA water quality programs in 1995, focuses monitoring and assessment planning on a subset of the state's 10 major drainage basins at a time. The 10 major basins are listed below:

1. Minnesota River
2. Red River of the North
3. Lake Superior
4. Lower Mississippi River (from confluence of the St. Croix to the MN/IA border)
5. Upper Mississippi River (from Lake Itasca to confluence of the St. Croix)
6. St. Croix River
7. Rainy River
8. Missouri River
9. Des Moines River
10. Cedar River

The MPCA core monitoring programs (condition monitoring, see Section IV.C) rotate through the 10 basins to produce data, balanced over time, for the 10-year assessment period (Table 2). Monitoring and assessment planning by basin maximizes the information that can be obtained from very limited monitoring resources. Greater attention can be focused on the problems or issues in individual basins than can be done if monitoring resources are always stretched statewide.

There is more opportunity to utilize sources of data outside the MPCA and get public involvement with the basin approach. Also, it facilitates the assessment of the combined effects of point and nonpoint sources and integration of data and programs to address both. This reporting schedule forms the basis for the scheduled starting and completion dates for developing TMDLs on the list submitted to EPA for approval. The schedule for the MPCA's long-term chemical monitoring program at Milestone stations (see Section IV.C) in the 10 basins is shown in Table 2.

Table 2. Schedule for the Rotation by Basin of MPCA's Long-term Chemical Monitoring at Milestone Stations. ("X" Means Basin is Scheduled for Sampling that Year.)

Basin	**Year**															
	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Red	x			x		x		x			x		x			x
Lake Superior	x			x		x			x		x			x		x
Minnesota			x		x		x			x		x			x	
Upper Mississippi		x		x		x		x			x		x			x
Lower Mississippi		x			x		x		x			x		x		
St. Croix		x			x			x		x			x		x	
Rainy	x			x		x			x		x			x		x
Missouri, Cedar And Des Moines			x		x		x			x		x			x	

B. SAMPLE COLLECTION

It is outside the scope of this Guidance to describe in detail the sampling procedures, but some highlights are discussed below. For more detail, see MPCA Grab Sampling Protocol Document (MPCA 2000a).

Rivers and streams are sampled at a point where the water is well mixed, in such a way as to avoid contamination from surface film or flotsam, bottom sediments, and airborne particulates from sampling equipment or bridge decks. Sampling frequency is often once per month but will vary with the type and purpose of the monitoring. Samples requiring preservation are preserved in the field. Samples are cooled to 4 degrees C for transport to the analytical lab. In-field measurements may be made of pH, dissolved oxygen, temperature, conductivity and turbidity. Decisions about the number and timing of samples and field measurements consider the effects of season and flow conditions on water quality.

The “clean” technique, is used to collect samples for trace metal analyses. This involves special bottle preparation, sampling procedures, and special handling, storage and lab analysis. Teflon sample bottles are cleaned by the analytical lab and double bagged. In the field two people take the sample. One “ dirty hands” person handles the outside bag and other equipment not specially cleaned. The second “clean hands” person handles the inside bag, the sample bottle and takes the sample. In the lab, low detection level trace metal analyses are performed in a special “clean room”.

Lake samples used for 305(b) and 303(d) assessments are collected during the summer growing season, usually from about mid-May through the end of September. The sample site is most often located over the point of maximum lake depth. Multiple sample sites are needed if the lake is “bayed” or has a complex shoreline. Each lake sampling date, which may include data averaged together from one or more sampling sites on a lake, is considered a single sample for assessment purposes. Surface water samples are typically collected from the upper, well-mixed layer of water with an “integrated” sampler, which is a PVC tube with an inside diameter of 3.5 cm (1.4 inches) and a length of 2 meters (6.5 feet). The tube is lowered vertically into the water until it is submerged, allowed to fill and the top end is stoppered. This procedure obtains an “integrated” 2-liter sample of the upper 2 meters of the epiliminion, which provides a representative sample of lake water quality in the summer. The sample is subset into individual bottles and preserved as per lab requirements for nutrient and chlorophyll-a analyses. If needed, near-bottom samples are collected with a 2-liter Van Dorn sampler. Near-bottom samples may be needed if hypolimnetic conditions could affect the trophic status of the whole lake; for example, if internal loading of nutrients from bottom sediments to the hypolimnion was suspected. Dissolved oxygen and temperature readings may be taken through the water column from surface to bottom to ascertain the depth of the thermocline and hypolimnetic oxygen conditions. Secchi disk and any other pertinent field measurements are taken. Further details may be found in the Minnesota Lake and Watershed Data Collection Manual (Heiskary et al. 1994), which is available in hard copy from the Minnesota Lakes Association or online (see Section XI).

C. TYPES OF MONITORING

A common thread linking most types of surface water monitoring is measurement of a waterbody’s condition. These data are used to determine if the waterbody is meeting water quality standards and to help guide resource management decisions. The MPCA surface water monitoring can be categorized by purpose as follows:

- Condition monitoring – status and trends in water quality,
- Problem investigation monitoring – description of causes and sources of impairment,

- Effectiveness monitoring – the extent to which remedial activities had an effect on water quality,
- Targeted monitoring – investigation of specific events such as a fish kill.

Condition monitoring of rivers and lakes is the primary source of data used in the 305(b) and 303(d) assessments. Data from the other types of monitoring are used only if they are amenable to being compared to water quality standards and suited to the assessment process generally. For example, in most cases the data should provide an unbiased representation of water quality during the overall period of time under consideration, rather than just water quality under certain conditions. Data sets from problem investigation monitoring projects that are designed to measure total pollutant loads can sometimes be used for condition assessments with additional data analysis steps, as described below. Data should be entered into EPA's water quality data storage and retrieval system (called STORET, in Section IV.F.).

Condition monitoring is carried out by several MPCA programs and includes routine chemical monitoring, biological monitoring, and citizen lake monitoring. MPCA samples a network of approximately 80 "fixed" monitoring stations on rivers and streams throughout the state, called "Milestone" stations. This program provides basic water chemistry data, particularly useful for trend analysis. The MPCA has been monitoring some Milestone stations continuously since the 1950s. Currently, Milestone stations are sampled once per month except for two winter months, on a basin rotation basis (Table 2). The program provides about 50 measurements for each variable monitored over a 10-year assessment period.

Biological monitoring (bio-monitoring) assesses the health and condition of fish and macroinvertebrate communities and habitat quality. Most of the MPCA's biomonitoring is done through a statistically based approach that collects data from randomly selected sites. By doing this, the MPCA can, in contrast to other types of monitoring, obtain a statistically valid representation of the water quality of a given area with relatively few stations. Statistically based monitoring was started in 1996 as a complement to the Milestone and special studies monitoring.

Condition monitoring also includes lake monitoring as part of the Citizens Lake Monitoring Program (CLMP) (Secchi disk readings), and stream monitoring as part of the Citizens Stream Monitoring Program (CSMP) (transparency tube readings). CLMP data are used as part of the database for assessing lakes (in Section IX). However, no lakes are placed on the 303(d) list based solely on CLMP data. Through the CSMP and other agency monitoring that incorporates the transparency tube measurements, there is now a data set of sufficient scope and record to establish a relationship between transparency tube and turbidity measurements. Starting in the 2006 assessment cycle, transparency tube results are used as a surrogate for turbidity. See VII.E.1.c for a more detailed description of the relationship and corroboration required.

As indicated, data from the other types of monitoring are usually not used in water quality assessments by the MPCA with some exceptions. A brief description of these types and the exceptions follow.

Problem investigation monitoring includes monitoring as part of Clean Water Partnership (CWP), Lake Assessment Program (LAP), load allocation or TMDL studies. As the name implies, problem investigation monitoring investigates potential sources of pollution, nutrient loading, etc., to rivers or lakes and recommends appropriate remedial measures. Local governments and other entities have important roles in these programs. Quality-assured data from CWP and LAP projects can be used by the MPCA in impairment assessments. Waste load allocation studies may be part of an overall TMDL analysis or a separate intensive monitoring effort to assess the impact of a point source discharge on a low-flow stream.

Problem-investigation monitoring often has as its purpose the determination of pollutant loads carried by streams. To do this, the monitoring is often focused on certain periods of time or certain events (such as rainfall or high flows), and is thus not necessarily representative of overall conditions. In addition, the monitoring is often done through flow-weighted composite samples, which are not necessarily amenable to the determinations of pollutant concentrations over time that are required for water quality standards assessments.

In some cases, specialized statistical analysis can take these two factors into account and make the adjustments necessary for accurate condition assessments. A prerequisite of the analysis is adequate knowledge of the hydrology of the particular stream and watershed as well as of various characteristics of the pollutant. MPCA has used load-design data sets for assessments in a number of instances. Examples are the North Shore Loading Project turbidity data, collected and analyzed by MPCA staff; the Metropolitan Council Watershed Outlet Monitoring Program turbidity data, collected and analyzed by MCES staff; and the atrazine data, collected by MDA and analyzed by MPCA staff in consultation with MDA. The number of such analyses performed each assessment cycle is dependent on the availability of the necessary data regarding stream and pollutant characteristics and on agency resources.

Effectiveness monitoring includes special studies designed to assess the results of pollution reduction or remedial actions. An example would be the monitoring up and down stream of a new or expanded wastewater treatment plant, or follow-up monitoring after the implementation phase of a CWP project.

Targeted monitoring provides information about a particular point of interest and is limited in space and time. Examples include the monitoring associated with spills, emergency bypasses, suspected illegal discharge, or fish kills.

For further details on all types of monitoring see MPCA (1995).

D. USE OF DATA FROM OTHER SOURCES

Involvement of local units of government and other governmental agencies in the monitoring of water quality is always encouraged, and the MPCA actively seeks data from all sources utilizing appropriate quality assurance and quality control (QA/QC). The MPCA has solicited data from outside sources through a notice published in the *State Register*. In the future such notices will probably be published to coincide with the integrated reporting cycle for the 305(b) and 303(d) assessments.

Analytical labs providing data must be certified under the lab certification program operated by Minnesota Department of Health, and the data to be used in assessments should be entered into STORET. Criteria used to determine whether to use data from other sources are outlined in MPCA (2003). A major aspect of monitoring the MPCA must consider when reviewing outside data for use in assessments is the purpose for which the data were collected in the first place. For example, samples collected to characterize "events" such as the effects of storm runoff on a river may not be suitable, if used alone, to characterize the overall water quality of the river. It is important that outside data be used and interpreted correctly.

The screening and entry of data from outside sources into STORET can be very labor intensive, and this often becomes a barrier to utilizing "outside" data. Thus, there is a much greater chance that valuable outside data will be used if the outside parties enter the data into STORET themselves. In general, data under consideration from any source that has been reviewed and found to satisfy QA/QC requirements will be used in water quality assessments following the priority listed below:

1. Data collected through the MPCA monitoring programs.
2. Data collections funded by state or federal money (e.g., CWP or LAP data), for which STORET entry is required.
3. Data from any source readily accessible through STORET.
4. Data in an electronic format from which assessments can be made directly, or in a form easily entered into STORET (e.g., data collected by governmental or other major entities that provide monitoring data in places where MPCA has little or no monitoring).
5. Data in a form amenable to STORET entry that fills an important gap in MPCA data.
6. Data in a form not amenable to STORET entry, or from an area where other data exist.

Sources of water quality data outside the MPCA that have been used in water quality assessments include:

- Metropolitan Council Environmental Services
- United States Geological Survey
- Upper Mississippi River Headwaters Board
- Big Fork River Watch
- Hennepin County Conservation District River Watch
- South Dakota Environment and Natural Resources Department
- North Dakota Health Department
- Wisconsin Department of Natural Resources
- Western Lake Superior Sanitary District
- National Forest Service
- Minnesota Department of Agriculture

Data obtained through projects the MPCA funds must be the result of a clearly defined and documented purpose and it must satisfy specific data needs. This documentation is called an information protocol, and it has proven to be very useful to MPCA staff considering the broad range of types and purposes of monitoring programs carried out by agencies and other organizations.

Occasionally, the MPCA receives monitoring data collected on border waters just outside of Minnesota. The MPCA believes that use of such data, assuming they meets data standards, are another source of data that should be included in the state's assessment process. For the 2008 assessment cycle, the MPCA is proposing that professional judgment groups, on a case by case basis, may consider monitoring data taken just outside the border or from border waters collected by entities outside of Minnesota. In determining whether to use the data in assessments, the professional judgment groups will consider proximity of the collection point to Minnesota, including any intervening tributaries between the monitoring location and the Minnesota border that may affect the ability of the monitoring site to represent the Minnesota waterbody. In addition, MPCA staff will use such data where it is made available through our calls for data, but will not actively seek out non-Minnesota-collected data. Data from non-Minnesota sources will have to meet all the existing data standards for consideration in assessments, including entry into STORET.

E. QUALITY ASSURANCE/QUALITY CONTROL AND LABORATORY ANALYSIS

The data used in impairment decisions must be of reliable quality. From field sampling to lab analysis to data assessment and all the steps in between, there are many opportunities for the introduction of errors. Therefore, it is difficult to overstate the importance of spelling out quality assurance and quality control (QA/QC) protocols for each step along the way, and the careful adherence to them. This applies to the data generated by the MPCA and data used from outside parties. It is important to recognize, however, that no mater how rigorous the QA/QC procedures employed, errors in data will occur. This simple fact alone emphasizes the need for professional judgment in the process to spot these errors (see Section V.E).

Monitoring and data management at the MPCA are performed in accordance with the requirements specified in a Quality Management Plan (MPCA 2000a) approved by the EPA and available for public review on the MPCA Web site (in Section XI.B.). Each monitoring program within the MPCA administers quality control checks and data quality assessments.

Most water samples collected by the MPCA are analyzed by the Minnesota Department of Health analytical laboratory. Laboratory analyses of samples strictly follow appropriate QA/QC procedures, as outlined in (MPCA 2000a).

River and lake samples taken at Milestone stations are routinely analyzed for a standard set of chemicals and water quality characteristics, which are listed below. Trace metals are often added to the list of variables monitored at Milestone stations. Other monitoring programs will sample for a variety of additional chemicals consistent with the purpose of the monitoring.

River and stream samples collected at the Milestone stations are routinely analyzed for:

Laboratory	Field
pH	dissolved oxygen
nitrite/nitrate nitrogen	temperature
ammonia nitrogen	
conductivity	
turbidity	
fecal coliform bacteria and/or E. coli (collected for special programs and when sample holding times can be met)	

The following variables are added at Milestone stations for the months of June, July, August and September, and where continuous flow data are available:

total phosphorus
chlorophyll-a
pheophytin
5-day biochemical oxygen demand
residue, total non-filterable (total suspended solids)
suspended volatile solids
stream flow

Lake samples are typically analyzed for:

Laboratory	Field
total phosphorus	pH
total Kjeldahl nitrogen	conductivity
nitrate/nitrite nitrogen	Secchi disk
residue, total non-filterable (total suspended solids)	temperature (profile)
alkalinity	dissolved oxygen (profile)
chloride	
color	
turbidity	
chlorophyll-a	

F. DATA STORAGE AND RETRIEVAL - STORET

As a rule, MPCA surface water monitoring data are stored in the EPA's water quality data STOrage and RETrieval system (STORET). STORET is designed to be a central repository for data from all agencies that monitor water quality. Data in STORET can be easily shared with other agencies and any interested party. STORET also provides a broad range of tools for the analysis of data.

Before data can be entered into STORET, geographic and hydrographic identifiers for sampling locations must be established. When a sampling location is established, the type of waterbody is identified, such as lake, stream, wetland, well, or treated effluent. This step has implications for sampling and future assessments because stations identified as "lake stations", for example, will be sampled following lake sampling methods and the samples will be analyzed for variables pertinent to lakes, and similarly for river stations. For example, Milestone station UM-826, while located in navigation pool number 2 of the Mississippi River, is identified and sampled as a river station. As such, the data from UM-826 are evaluated based on water quality standards pertinent to rivers and not lakes. Also, specific collection and lab methods associated with the data are required for data to be entered into STORET.

The STORET database is open to the public for retrievals using a request application on the EPA Web site. The use of STORET by other agencies, like the Minnesota District of the USGS, enhances the practicality of incorporating their monitoring results into water quality assessments. Using data from external sources require a careful review of methods and location information. The common database format in STORET ensures that much of this information is included with the data. A common data location also allows other agencies to simply direct MPCA staff to an appropriate data set already accessible to all users.

V. General Aspects of Data Assessment

A. DELINEATION OF RIVER REACHES AND DEFINITION OF LAKES

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river system assessments is the river reach or lake, called the “assessment unit”. A river reach extends from one significant tributary to another and is typically less than 20 miles in length. The reach may be further divided into two or more assessment reaches when there is a change in the use classification (as defined in Minn. R. ch. 7050), or when there is a significant morphological feature such as a dam, or a lake within the reach. In the past, Minnesota used EPA’s Reach File 1 to define reaches. Many of our current assessment reaches are Reach File 1 reaches, or subsegments of Reach File 1 reaches.

MPCA is now using the National Hydrography Data Set to identify stream segment locations for Geographical Information Services purposes because it provides a much more complete accounting of all the streams in the State. All of our assessment reaches will be indexed to the National Hydrographic Data set (NHD). Each waterbody is identified by a unique waterbody identifier code, comprised of the USGS eight digit hydrologic unit code plus the three digit assessment reach. It is for these specific reaches that the data are evaluated for potential use impairment. The MPCA consults with border states during the assessment process and documents reasons for any discrepancies in assessment determination between Minnesota and the specific border state.

The MPCA has routinely relied on Bulletin 25 (MDNR 1968) as the primary basis for identifying lakes and reservoirs. However, some "lakes" listed in Bulletin 25 are really wetlands. If a "lake" basin in Bulletin 25 is listed as a wetland on the MDNR Public Waters Inventory, it will be considered a Class 2D wetland [unless it is being used as a lake, for example, if it is being managed for fishing], and it will be protected for the maintenance of a healthy aquatic community and for boating and other forms of aquatic recreation for which they are suitable. This may exclude swimming because the shallow water, soft bottom substrates and plentiful vegetation make many wetlands unattractive for swimming. Waterbodies identified as wetlands will not be assessed using the eutrophication factors discussed in Section IX.A.

Also, to help define reservoirs for assessment of the impacts of excess nutrients the MPCA will use a minimum hydraulic residence time of 14 days. Reservoirs with residence times less than 14 days will not be assessed as lakes. For this purpose, residence times are usually determined under conditions of low flow. A mean flow for the four-month summer season (June – September) with a once in ten year recurrence interval is normally used. The MPCA may establish a minimum residence time of less than 14 days on a site-specific basis if credible scientific evidence shows that a shorter residence time is appropriate for that reservoir. The 14-day residence time was originally established as part of the "Phosphorus Strategy" to guide the MPCA in the application of the 1 mg/L phosphorus effluent limit in Minn. R. pt. 7050.0211 (MPCA 2000d). The 14-day residence time is consistent with EPA's current guidance, which recommends that reservoirs with residence times less than 14 days be included with rivers for the purposes of nutrient criteria development (EPA 2000a, Kennedy 2001).

The application of residence time is relevant in the assessment of eutrophication described in this Guidance, since the nutrient impairment threshold values are applied to lakes and reservoirs rather than rivers. The eutrophication of rivers is a concern, but the assessment of rivers will require the development of separate river-specific eutrophication thresholds. The professional judgment teams will consider residence time as part of their "weight of evidence" review.

Bulletin 25 provides unique identification numbers for all lakes greater than 10 acres in size in Minnesota (15,291 listed). The Bulletin 25 numbers serve as the STORET station numbers; for example, 27-0104 is Medicine Lake in Hennepin County. In addition to the 6-digit numbers, a 2-digit suffix may be added as a basis for defining distinct bays in a lake (e.g., 27-0133-01 = Grays Bay in Lake Minnetonka). The bay suffixes are assigned consecutively, starting with the most downstream (outlet) bay as "-01", and so on.

Bulletin 25 also provides surface acreage and location information for each lake listed. Lake acreage used by MPCA in lake assessments are drawn from Bulletin 25 or bathymetric maps, whichever source is most current at the time the lake sampling station is established in STORET. The MDNR public waters inventory, which encompasses Bulletin 25, is an additional source of identification numbers and is updated routinely as new waterbodies are identified (e.g., mine pit lakes). While the Public Waters Inventory may include waterbodies less than 10 acres in size, MPCA assessments for the 303(d) list will only consider lakes of 10 acres or greater.

Typically, the listing of impaired waters is by individual NHD reach or individual lake. The major exception to this is the listing of river reaches for contaminants in fish tissue. Over the time it takes fish, particularly game fish, to grow to "catchable" size and accumulate pollutants to unacceptable levels there is a good chance they have moved considerable distance from the site where they were sampled. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach. Thus, the impaired reaches often include several NHD reaches.

B. PERIOD OF RECORD

The MPCA uses data collected over the most recent 10-year period for all the water quality assessments considered for 303d impairments, except in the case of fish contaminated with mercury. There is no age limit for the use of mercury fish tissue data (see Section IX.C.7). Years of record are based on the USGS **water year**. Water years are from October 1 of one year through September 30 of the following year. It is preferable to split the year in the fall, when hydrological conditions are usually stable, than to use calendar years. Data for all 10 years of the period are not required to make an assessment.

Generally, the most recent data from the 10-year assessment period is reviewed first when assessing toxic pollutants, eutrophication, and fish tissue contaminants. Also, the more recent data for all pollutant categories may be given more weight by members of the professional judgment teams if, for example, trends are indicated or if conditions impacting water quality are known to have changed in the reach during the 10-year period (e.g. wastewater treatment plant upgrades). The goal is to use data from the 10-year period that **best represents** the current water quality conditions.

The MPCA uses a period as long as 10 years in its assessments for several reasons. It provides reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented. For example, the 10-year period is likely to include some samples collected during critical periods such as during a rain storm or drought. On the other hand, data collected over 10 years are less likely to only represent an unusually wet or dry period and it reduces the chance that one or two samples will distort the rest of the data, if they happened to have been collected during very atypical conditions. From a practical standpoint, the 10-year period means there is a better chance of meeting the minimum data requirements.

C. VALUES BELOW DETECTION

The concentrations of some pollutants in surface waters, particularly the highly bioaccumulative pollutants, may be below standard analytical detection limits. That is, the true concentration may be below the ability of the analytical method to measure. Examples of method detection limits for some toxicants are shown in Appendix B. It may be difficult to determine in advance of monitoring whether ambient concentrations will be below detection. Thus, data sets that include values below the level of detection, or "less than values" are a possibility. Best professional judgment will be used in the assessment of these data sets, taking into account such information as:

- The relative number of less-than values compared to the number of "detects,"
- The extent the "detects" are above the method detection limit,
- The magnitude of the difference between the method detection limit, the chronic standard and expected ambient concentrations, and
- Information from data in other media such as fish tissue or sediment data.

Re-sampling in these situations may be necessary if new analytical methods with lower method detection limits have become available. Values below the level of detection, even if greater than the standard, will not be considered an exceedance of the standard. Values below the level of detection will be considered a data point for the purposes of meeting the minimum data requirement.

Fish tissue analytical results below detection are assigned a value equal to one half the method detection limit for use in assessments. For other pollutant categories, if values below the level of detection must be assigned a number in order to include them in the calculation of an average, the formula shown below is used. A geometric or log mean is used to calculate a mean for data sets that include "less thans" when the data are not normally distributed. This formula adjusts the assigned value downward as the number of "less thans" goes up, relative to the total number of values, and vice versa.

$$\text{Value assigned to "less thans"} = \text{LOD}\left(1 - \frac{\text{Number of values} < \text{LOD}}{\text{Total number of values}}\right)$$

Where LOD = level of detection

D. UNCERTAINTY IN WATER QUALITY ASSESSMENTS

The MPCA is very conscious of the hazards of making assessments with limited data. The selection of the minimum data requirements for water quality assessment is clearly a compromise between the need to assess as many waterbodies across the state as possible (a 305b consideration), and the importance of minimizing the probability of making an erroneous assessment. The methods described in this Guidance all deal with this problem in a variety of ways, depending on the pollutant category. For example, the minimum of five values required for part of the analysis of fecal coliform data are aggregated by month over a 10 year period before the geometric mean is determined for comparison to the standard (Section VIII.B). In another example, lakes assessed for eutrophication are screened first using ecoregion-based total phosphorus thresholds that represent the "high end" of the range of total phosphorus values that will support swimming use in a given ecoregion (Section IX.A.5). Again, the purpose is to minimize the chance of incorrectly labeling a waterbody as impaired.

Nonetheless, some level of uncertainty is part of every analysis of water quality data. There is always a chance that a waterbody will be assessed as impaired when in fact it is not or assessed as un-impaired when in fact it is. The number of data points the MPCA requires as a minimum for 305(b) or 303(d) water quality assessments is small in the context of statistical analyses of uncertainty. The approach used by the MPCA to make impairment decisions, which is a screening of the data using the impairment thresholds, followed by a review by professionals, makes the best use of limited data. This is the approach recommended by EPA.

With this approach, the probability of making an incorrect impairment decision of either type – a determination of impairment when the waterbody is not, or a determination that the waterbody is not impaired when it is – are roughly equal. Some states use an approach that requires more data and statistical tests that significantly reduce the probability of making an erroneous determination that a waterbody is impaired (when it's not), but at the cost of significantly increasing the probability of an erroneous determination that the waterbody is not impaired (when it is).

Essentially all assessments are subject to review by a team of professional water quality experts (next Section). Review of the data by professionals is a very important part of minimizing erroneous impairment determinations, and this review would be required whether or not statistical tests are used. The possible erroneous placement of a waterbody on the 303(d) impaired list is a concern because of the regulatory and monetary implications of 303(d) listing. In essentially every case where MPCA placement of a waterbody on the 303(d) list was followed by additional monitoring, the subsequent data has supported the initial determination of impairment. Thus, it has been the experience of the MPCA that very few waterbodies have been incorrectly determined to be impaired.

The results of the assessment process for each pollutant category are summarized in "basin information documents" maintained by the MPCA. These documents reflect data stored in the MPCA assessment database in summary tables, which are available on the MPCA Web site http://www.pca.state.mn.us/water/basins/305briver.html . Future plans call for the MPCA to maintain a list of waterbodies that need additional data and further assessment before an impairment decision can be made. These are waterbodies that lack sufficient data for a complete 303d impairment assessment, but for which the available data suggest some impairment.

E. PROFESSIONAL JUDGMENT, WEIGHT OF EVIDENCE AND INDEPENDENT APPLICATION

1. *Professional Judgment*

It is important to recognize the value and necessity of including professional judgment as a "formal" step in the assessment process. Professional judgment must enter into the impairment decision making process. No assessment guidance and protocol, no matter how detailed, can address all the unforeseen aspects of the multi-step assessment process. Also, the variety and variability found in nature means that professional judgment must enter into the process. Aquatic ecosystems, including biological communities and the natural cycles in water chemistry, are very complex and are always reacting to a changing environment. Professionals must have the latitude to interpret the protocols in the context of their knowledge and experience with the factors that influence water quality and biology. Professionals include the people that take water samples and measurements in the field as well as the biologists, hydrologists and statisticians that analyze the data. A professional review of available data can extract the most value from small data sets. Without professional review, assessments are more likely to result in an incorrect impairment decision.

A professional judgment team is formed for each basin. The team is made up, for example, of regional MPCA basin coordinators knowledgeable about local water quality issues, MPCA monitoring and data assessment staff, and staff from organizations outside the MPCA whose data were used in the assessments, if appropriate. The professional judgment teams meet to review how the data were used and interpreted, and whether outside data were used appropriately. They determine whether the data (possibly data combined from more than one source) are adequate and appropriate for making statements about use-support and about causes of impairment (such as low dissolved oxygen or high phosphorus, etc.).

2. *Independent Application*

MPCA staff and a professional judgment team compare monitoring data from all sources to the water quality standards for a specific stream reach or lake to assess protection of beneficial uses. If data are available to assess more than one type of standard that protect the same beneficial use, exceedance of any applicable standard normally indicates impairment. This concept is called "independent application". In general, independent application means that a water body should meet multiple assessment tests (standards) to be considered un-impaired for a given use. This is consistent with the national and state goal to protect the "chemical, physical and biological integrity" of surface waters, and it is consistent with EPA guidance. EPA's discussion of independent application is the integration of assessments of, 1) chemical-specific data, 2) biological assessments, and 3) whole effluent toxicity testing (EPA 1991). The independent tests must apply to the **same beneficial use**. Independent application does not apply when assessing different uses, such as aquatic life (toxicity), fish consumption (human health), swimming or aesthetics. Assessments for different uses are carried out separately.

In the context of surface water assessments, a typical example of where independent application applies is when both chemical and biological data are available for the same waterbody. Both the chemical (numeric) and biological (narrative) standards protect aquatic life. Both standards should be met for the waterbody to be considered un-impaired for aquatic life. A second example is when both fecal coliform and trophic status data are available for a lake being assessed for swimming use. In both examples the applicable standards are evaluated independently in the context of "weight of evidence" to assess the single beneficial use.

It is not appropriate to apply independent application when one or more of the data sets do not represent a true exceedance of the applicable standard, for example if the conditions listed below can be demonstrated. Professional judgment will be part of the assessment.

- More than half of the values are below the method detection limit (less than values).
- Data were collected at a time or under circumstances that make them unrepresentative of true water quality conditions (e.g. during a rain storm or after a chemical spill).
- Data are old and do not represent current conditions.

3. *Weight of Evidence*

The professional judgment team's first step in making impairment decisions is to review the results of an "automated" pre-assessment of the available chemical and biological data. The pre-assessment is a computerized screening of the data which identifies waterbodies meeting minimum data requirements, appropriate periods of record, and showing the necessary exceedances of impairment thresholds. Following a review of the pre-assessment results, the team considers a wide range of factors that can affect water quality, and use impairment. For examples the team may consider:

- The quality and quantity of all available data,
- The magnitude, duration and frequency of exceedances,
- Timing of exceedances,
- Naturally occurring conditions that affect pollutant concentrations and toxicity,
- Weather and flow conditions,
- Consistency of the preliminary assessment with information on other numeric or narrative water quality standards,
- Known influences on water quality in the watershed, and
- Any changes in the watershed that have changed water quality.

Based on all the relevant information, a final impairment decision is made regarding a given water quality standard and the associated beneficial use. These decisions are based on a "**weight of evidence**" concept, which simply means that when all the readily available data and information is considered together, and in the appropriate context (e.g., ecoregion, known pollution sources, etc.), a convincing pattern emerges on the condition of the waterbody.

The MPCA assembles the professional judgment teams and chairs the meetings; and the MPCA takes responsibility for all team decisions regarding impairment. While consensus of opinion on impairment decisions is the goal, and is normally achieved, if consensus can't be obtained, the MPCA will make the final decision. All professional judgment decisions are recorded on a "Professional judgment group transparency form for assessed streams". New for 2006 reporting the transparency form is now part of a database that captures and documents the proceedings of the professional judgment meetings. An example of the types of information placed on the form for four assessed waterbodies is included as Appendix C.

F. DETERMINATION OF FOUR- AND THIRTY-DAY AVERAGE CONCENTRATIONS FOR POLLUTANTS WITH TOXICITY- AND HUMAN HEALTH-BASED STANDARDS

The calculation of average pollutant concentrations can be complicated by the fact that concentrations can vary significantly during any given period of time. This is particularly true for nonpoint-source pollutants, which generally enter streams through stormwater or spring snowmelt and fluctuate greatly with flow. Limited discrete grab samples, as are often used in condition monitoring, may be inadequate to characterize average conditions over time.

Continuous sampling would be the ideal method for determining average concentrations in such cases. As a practical matter, composite samples taken at high flows, supplemented with grab samples taken at base flows, can provide very good estimates of overall conditions. The composite samples are taken by stage-activated automated samplers; time-based composite samples give precise average concentrations over the period of collection, but in some cases, where there is adequate knowledge of the hydrology of the particular stream and watershed as well as of the characteristics of the pollutant, flow-based composite samples may be judged to be acceptable. The concentrations of all samples taken during the four- or thirty-day period are weighted for their respective flow periods to calculate the average concentration.

When automated composite samples are not available, grab samples alone, if they adequately represent the different flow conditions, may be used to determine average concentrations. Again, concentrations are weighted for their respective flow periods to calculate the average concentration. It should be noted that this is only possible when concentrations can be tied to flow and there is adequate knowledge of the flow during the period.

VI. Relationship of 305(b) Report to 303(d) List

A. INTRODUCTION

As discussed in Section III, the purpose of the 305(b) report is to convey the use-support status of all surface waters statewide, while the purpose of the 303(d) list is to identify impaired waterbodies for which a plan will be developed to remedy the pollution problem(s) (the TMDL).

Based on this difference, when discussing waterbodies that do not meet water quality standards, the term “non-support” is associated with the 305(b) report and the term “impaired” with the 303(d) list.

Beginning in 2004 an integrated 305(b) reporting and 303(d) listing process, known as the integrated process, was initiated. It followed the, Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, provided by EPA in July, 2003. For 2006 Minnesota again used the above guidance in their integrated assessment process, since an updated guidance was not available at the time of the assessment process.

The integrated reporting process establishes that a list of impaired waters be generated on April 1 of every even-numbered year. This time frame coordinates submittal of 303d TMDL lists with 305(b) reporting and paves the way for using categorization of surface waters as the means for developing a 303(d) list. The categorization of surface waters ties listing of impaired waters to the assessment of the waters of the State and is described in the following section. The integrated process has changed how impaired waters are determined.

In the past, waterbodies were considered impaired based on a commonly held conceptual model about the link between 305(b) and 303(d) that the 305(b) report contained the complete and comprehensive list of all waterbodies impaired for any reason. This list of waterbodies, assessed as “not supporting” and “partially supporting” in the 305(b) report, were then passed through a “303(d) filter” which screened out certain waterbodies. The waterbodies that made it through the “filter” constituted a shorter 303(d) (TMDL) list of impaired waters. The 303(d) “filter” was composed of any additional data or information required for the 303(d) assessment to arrive at an impairment determination.

Under this model the 303(d) list was always a subset of the 305(b) list of non- and partially supporting waters. Generally, this model held true for the assessment of lakes for nutrient enrichment, but it did not hold true for the assessment of rivers and streams. This model broke down for rivers mainly because waterbodies could be determined to be impaired and listed on the 303(d) list, based on data not used in the 305(b) assessments. This difference reflected the use of local or site-specific data, as well as statewide data, in 303(d) assessments versus the use, in general, of mostly statewide data in the 305(b) assessments. For example, data for bioaccumulative pollutants collected in St. Louis Bay was used just in 303(d) but not 305(b) assessments (MPCA 1999).

The integration of 303(d) listing and 305(b) reporting has changed the assessment process for rivers and streams by considering all available data during the 305(b) assessments. Since the 303(d) list of impaired waters comes directly from the categorization of assessed waters there is no separation of mostly statewide data used for 305(b) assessments and local or site-specific data used in the past for 303(d) listing. All available data are used. This integration does not change how lakes are assessed for nutrient enrichment because the methodology requires a certain amount of data be available to consider a lake impaired for the purposes of 303(d) listing. See Section IX.A.7 for minimum data requirements.

Integration does affect how surface waters are categorized for purposes of 305(b) reporting. Data used for both the 305(b) report and the 303(d) list need to be adequate both with respect to quality and quantity. However, as indicated, waterbodies may be categorized in the 305(b) report to reflect non- and partial support, where additional data must to be collected before a definitive impairment categorization for the 303(d) list can be made. Table 3 summarizes, in general, the types and sources of data used in the two assessments. The reader is advised to see the appropriate Sections of this Guidance for details. Note in Table 3 that the same **types** of data are used to identify both candidates and "finalists" for the 303(d) list.

Table 3. Generalized Summary of Data and Information Used in Use Support Assessments for the 305(b) Report and Determination of Impairment for the 303(d) List. (See Appropriate Section of Guidance for Details.)

Type or Source of Data or Information	**Used in Assessments for:**		
	305(b) Report	**Candidate for 303(d)**	**303(d) List**
Milestone stations, and other chemistry data	Y	Y	Y
Clean water partnership - rivers	Y	Y	Y
Clean water partnership - lakes	Y	A	A
Lake Assessment Program	Y	A	A
Citizens lake monitoring program (Secchi disk)	Y	A	A
Citizens stream monitoring program (Transparency tube)	Y	Y	Y
Bio-monitoring (indices of biotic integrity)	Y	Y	Y
Chemistry data which is part of bio-monitoring	A	A	A
Fish tissue contaminants (fish consumption advise)	Y	Y	Y
Metals data obtained using clean technique	Y	Y	Y
Lakes – single data point = 1-0-0, 0-1-0 or 0-0-1***	Y	N	N
Lakes – minimum data = 12-12-12***	Y	Y	Y
Local studies for specific pollutants	Y	Y	Y

Y = Yes, data can be used independent of other data in assessments
N = No, data is not used
A = Associated, data is used only in association with other data/information
***1-0-0 and 12-12-12 mean data points for total phosphorus, chlorophyll-a and Secchi disk, respectively. The single data point may be for any one of the three variables (Section IX.A.7). Some lakes may be determined to be impaired with slightly less data, on a case-by-case basis.

B. INTEGRATION OF 305(b) AND 303(d)

As alluded to in the previous section the process of 303(d) listing and 305(b) reporting of assessed surface waters has been integrated following the guidance provided by EPA (EPA 2003). It begins with the collection and assessment of all available data using the guidelines in this guidance to make determinations of impaired, not impaired, insufficient information, or not assessed for each assessment unit based on use support assessments. An assessment unit is defined as a surface water body or portion thereof for which monitoring data are available. See Section V.A. for a description of how the extent of an assessment unit is determined.

Once an assessment has been made, the assessment unit is categorized into one of the five main categories or sub-categories. The categorization of an assessment unit occurs automatically within the Assessment Database (Version 2.1) (ADB) provided by EPA and is based on the data provided. Since the 2004 Guidance from EPA indicates states may elect to add additional sub-categories to those provided with the Assessment Database, assessments in 2006 were placed in one of the following categories or subcategories.

Category/ Subcategory	Description
1	All designated uses are met and no use threatened.
2	Some uses are met, none are threatened and insufficient data to assess other uses.
3A	No data or information to determine if any designated use is attained.
3B	Sufficient data are available for a 305(b) assessment of non- or partial support, but insufficient data and information to determine TMDL impairment.
3C	Data available that currently has no assessment tools to allow its use in assessing.
3D	Sufficient data are available for a 305(b) assessment of full support, but insufficient data and information to assess for category 1 or 2.
4A	Impaired or threatened but all needed TMDLs have been completed.
4B	Impaired or threatened but doesn't require a TMDL because it is expected to attain standards in the near future.
4C	Impaired or threatened but doesn't require a TMDL because impairment not caused by a pollutant.
4D	Impaired or threatened but does not require a TMDL because impairment is a result of natural causes.
5A	Impaired or threatened by multiple pollutants and no TMDL plans approved.
5B	Impaired or threatened by multiple pollutants and some TMDL plans approved but not all.
5C	Impaired or threatened by one pollutant.

All assessment units falling into category 5 become the 303(d) TMDL list. This list is subject to review and public comment before submittal to EPA, which may result in the reassessment of a particular assessment unit into one of the other categories.

C. LEVELS OF USE SUPPORT – 305(b) AND 303(d)

The purpose of meeting water quality standards is to protect the beneficial uses associated with the standards. See Section II.A. for a description of the beneficial uses. As stated in Section

II.A., all surface waters in Minnesota are protected for aquatic life and recreation. To accomplish this in the integrated process, three use supports are assessed. These use supports are called aquatic life, aquatic consumption, and aquatic recreation.

The aquatic life use support assessments are aimed at protecting the organisms that reside in the surface waters of the State, while the aquatic consumption use support's goal is to protect consumers of the aquatic life. This allows the integrated process to include in the 305(b) portion site specific data formerly used only in the 303(d) listing process such as fish consumption advisories.

The aquatic recreation use support is assessed for protection of recreation in surface waters as described in Section II.A. The combined assessments of these three use supports are aimed at being consistent with the goal in the Clean Water Act that the nation's waters should be "fishable and swimmable" wherever attainable.

Based on the assessment of the water quality data and other relevant information compared to the standards for a given pollutant or water quality characteristic, the use supports may be assessed as:

- Fully supported,
- Partially supported,
- Not supported (= non-support) or
- Not assessed.

As stated previously, an assessment unit's overall integrated assessment is impaired, not impaired, insufficient information, or not assessed based on the worst case use support assessment. An overall not impaired assessment implies that no use support was assessed as partially or not supported and at least one use support was assessed as fully supporting. An overall impaired assessment indicates that at least one use support is not supported or at least one use support was assessed for 305(b) purposes as partially supported and secondary analysis indicated enough data were available to assign an overall impairment assessment. A not assessed overall assessment occurs when no data are available to make any use support assessment, subcategory 3A. An insufficient information assessment generally was reserved for assessment units placed in either subcategory 3B, 3C, or 3D.

The categorization of an assessment unit is an added step that occurs in the integrated process. It does not change the way assessments are reported in the 305(b) process. Assessment units **fully supporting** all assessed use supports are listed as "fully supporting" in the 305(b) report and they do not appear on the 303(d) list. Generally, a determination of **partial support** of a use means that the river reach or lake is listed as "partially supporting" in the 305(b) report, and it **may** be listed as "impaired" on the 303(d) list. A determination of **non-support** indicates an impaired condition and the waterbody is placed on the "not supporting" list for the 305(b) report, and it may go on the 303(d) list. Generally a waterbody is listed unless a secondary analysis determines there are insufficient information for listing, in which case the waterbody is placed in subcategory 3B.

A use is considered **not assessed** if there are insufficient or no data to determine support. For some assessments, lake eutrophication for example, the "partial support" category is a trigger for further analysis of that waterbody before an impairment decision is made (if it meets minimum data requirements). The term **potentially supporting** may be initially used in assessing impairment of aquatic recreation use (fecal coliform bacteria), where a two step screening process is applied to determine whether there is adequate data to make an assessment of partial or non-support (See Section VIII.B). The MPCA plans in the future to maintain a list of waterbodies for which insufficient data are available to make a complete assessment, but the available data suggest some impairment. This list will help establish priorities for allocating future monitoring resources.

D. DATA USED FOR BOTH 305(B) AND 303(D) ASSESSMENTS

In general, assessment of data for conventional water quality characteristics of streams, such as dissolved oxygen, turbidity, and fecal coliform, and for two frequently measured toxic pollutants, un-ionized ammonia and chloride, requires the same quantity and quality of data for a determination of impairment for both the 305(b) report and the 303(d) list. New to the 2006 assessment process was citizen stream monitoring data. These data are transparency tube readings used as a surrogate measure for turbidity (see Section VII.D.1.c.

Data for trace metals (arsenic, cadmium, chromium, copper, lead, nickel, selenium and zinc) must be collected using "clean" techniques for both the 305(b) and 303(d) assessments. Metals data collected without the use of the more rigorous clean techniques may be used as a screening tool to identify sites where additional monitoring may be needed.

The biological monitoring program includes limited chemical monitoring as well as habitat assessment. The chemical data are rarely used for either 305(b) or 303(d) assessments because of the small amount of data provided. Habitat data are used to support the biological data. These data are taken into consideration during the professional judgment phase of the 303(d) listing process (Table 3).

E. DATA USED ONLY FOR 305(b) ASSESSMENTS

EPA encourages states to assess as many waterbodies as resources permit when preparing the 305(b) report, recognizing that there are various levels of confidence associated with assessments involving varying quantities of data. To that end, and to facilitate the integrated assessment process, all available data are considered initially for 305(b) including site-specific data formerly used only for 303(d) assessments.

Assessments for lake eutrophication for the 305(b) report can be based on fewer observations and data for fewer variables than are required for 303(d) listing. In fact, a preliminary 305(b) assessment may be based on a single value for total phosphorus, chlorophyll-a or Secchi disk.

Similarly, a preliminary 305(b) assessment for turbidity can be based upon 20 observations of any combination of transparency, TSS and turbidity when professional corroboration of stream transparency tube data is not available. This information provides a useful screening tool for persons concerned about a particular lake or stream.

F. DATA USED ONLY FOR 303(d) ASSESSMENTS

As indicated in Section E, all data are considered for 303(d) reporting in the integrated assessment process.

G. DATA QUALITY

The integrated assessment process requires a quality rating or confidence level be assigned to the data used to make use support assessments. The rating options available in the ADB (Version 2.1) are low, fair, good, or excellent for each type of data (physical/chemical, biological, pathogens, etc.) In an effort to use "all available data" in the integrated process Minnesota conducted a public call for data in 2004 to obtain data from stakeholders who normally do not provide the State with monitoring data. Collected data were incorporated in with data from the MPCA and from other groups who routinely provide data, and were used for the 2006 integrated assessment process. Public calls for data in the future are dependent upon budget restraints and availability of staff to compile the data. Use support assessments are carried out separately for lakes and streams and the rating process for each type of assessment is as follows:

1. Data quality for lake assessments

The data used in these assessments was derived from STORET, so we assume that certain "quality control" thresholds were already established for the data. Hence our definition of "quality" will focus on the relative amount of information available for the assessment. In the case of our aquatic recreational use assessments, TP is the primary variable used so we place the greatest emphasis on the amount of TP data available for the assessment. The "quality" terms were drawn from USEPA guidance. In general we feel that assessments based on multiple measurements are more reliable than those based on only a few measurements. The rationale for assigning the respective "quality" definitions corresponds roughly to typical lake-monitoring regimens (e.g. monthly sampling during the summer season), whereby four TP samples often represent one summer; eight samples two summers and 12 samples two-three summers. In the case of 303(d) assessments 12 or more TP, chlorophyll-a and Secchi measurements are usually required to determine if a lake should be placed on the 303(d) list and was considered "excellent" quality data for assessment. In general the thresholds were similar for the "monitored" (recent) and the "evaluated" (old) data with the exception that there would be no "excellent" evaluated data as these data are more that ten years old.

Data quality characterizations for 305(b) and 303(d) assessments.

Quality	“Monitored data”	“Evaluated data”
Poor	< 4 TP measurements	**< 4 TP measurements**
Fair	4 ⩽ TP < 8, some chl-a & Secchi	**4 ⩽ TP < 8, some chl-a & Secchi**
Good	8 < TP < 12, some chl-a & Secchi	**8 < TP < 12, some chl-a & Secchi**
Excellent	**12 TP, 12 chlorophyll-a & 12 Secchi**	**NA**

2. Data quality for stream assessments

The data for stream assessments include data drawn from STORET as well as other data that are made available through a specified cut off date. The cutoff date will depend on when the date of the first professional judgment group assessment meeting is scheduled and will occur early enough to allow for the compilation of pre-assessment data before the meeting.

The quality of data used in these assessments is based on the four tiered rating system available in the ADB with a rating assigned to each type of data used in each use support assessment. For aquatic life use support data quality ratings are:

- Excellent – both biological and physical/chemical data available;
- Good – either biological or physical/chemical data available in sufficient quantities, which the professional judgment group deems enough to make a good assessment;
- Fair – physical/chemical data available in sufficient quantities, which the professional judgment group deems enough to make a fair assessment;
- Low – only a few physical/chemical parameters available in minimum quantities needed to make an assessment.

Aquatic consumption use support assessments at this time use fish consumption advisory data from the Minnesota Department of Health, which we have assigned a ‘good’ quality rating.

For aquatic recreation use support data quality ratings, some general guidelines are given below.

- Excellent – 6-7 months of data with at least 5 observations;
- Good – ~3-5 months of data with at least 5 observations;
- Fair – ~1-2 months of data with at least 5 observations;
- Low – no months with at least 5 observations, very few additional data points above the minimum 10 required.

In addition, other factors considered in rating the quality of aquatic recreation data include looking at the dates when samples were collected (years and months). A lower quality rating is generally given where all the data are collected in one calendar year and/or where the dataset does not include months that typically have higher fecal coliform counts (June – September).

VII. Assessment Based on Numeric Standards for Protection of Aquatic Life

A. POLLUTANTS WITH TOXICITY-BASED WATER QUALITY STANDARDS

Protection of "aquatic life" with applicable Class 2 chronic standards means protection of the aquatic community from the direct harmful effects of toxic substances, and protection of human and wildlife consumers of fish or other aquatic organisms. This Section of the Guidance deals with the former, the assessment of water quality for pollutants that have toxicity-based chronic standards.

Surface waters are assessed to determine if they are of a quality needed to support the aquatic community that would be found in the river or stream under natural conditions. The concepts of present-day "natural conditions" and "reference conditions" are discussed in Section IX.B.3. In general, two types of data are used in toxicity-based assessments: water chemistry data, which is the subject of this Section, and biological data, which is the subject of Section IX.B. Pre-assessments based on chemistry data and biological data are combined into a preliminary combined assessment for aquatic life use-support determinations.

1. *Pollutants*

The pollutants that have toxicity-based standards most often included in MPCA water quality assessments are briefly discussed. Pollutants other than those mentioned here may be assessed also, as data allow.

a) <u>Trace Metals</u>

Trace metals with toxicity-based standards used in water quality assessments include cadmium, chromium, copper, lead, nickel, selenium and zinc (numeric standards for metals are listed in Appendix A). Mercury is discussed in the next Section because it has a human health-based standard.

The MPCA water quality standards for trace metals are listed as "total" metal in both Minn. R. chs. 7050 and 7052, but they are applied to ambient waters as "dissolved" metal standards. The total standard is multiplied by the appropriate conversion factor to convert it to a dissolved standard (Appendix A, Tables A-1 and A-5). The difference between total and dissolved metal is that the sample for the latter is filtered through a 0.45 micron pore filter to remove most suspended particulates before analysis. The sample for total metal is not filtered. The change from total to dissolved metal standards is based on substantial evidence that particulate bound metals are generally not as toxic to aquatic organisms as the ionic or weakly bound forms of metal. The dissolved analysis better estimates the toxic fraction of metals in most natural waters. It is EPA policy that metal standards should be in the form of dissolved metal (EPA 1993).

Both total and dissolved "clean" technique metals data are available at most sampling locations throughout the state except in the Lake Superior basin where most of the data are total. Total and dissolved metal data will be used in the assessments for both the 305(b) report and the 303(d) list until there are adequate data to switch completely to dissolved. Total metal data will be compared to total metal standards and dissolved data will be compared to dissolved standards.

The standards for cadmium, chromium III, copper, lead, nickel, and zinc vary with ambient total hardness. Thus, the standards for these metals are in the form of formulas that reflect the hardness/toxicity relationship (Appendix A. Tables A-4 and A-7). To calculate the appropriate metal standard, a sample is collected for total hardness along with the metal sample. Each measured value for a hardness dependent metal is compared to an individually calculated standard based on the hardness at the same time and place the metal sample was taken.

b) Un-ionized Ammonia

Ammonia at elevated levels in the un-ionized form (NH_3) is toxic to aquatic life. When water column concentrations of un-ionized ammonia exceed water quality standards, sensitive species, and particularly the sensitive early life stages of fish (post-hatch fry) will show sublethal adverse effects. At higher concentrations, death can occur. The chronic un-ionized ammonia standards are shown below:

- Class 2A. 0.016 mg/L un-ionized ammonia
- Class 2Bd, B, C, D. 0.04 mg/L un-ionized ammonia

The fraction of total ammonia in the un-ionized form in water is dependent on ambient pH and temperature. Therefore, pH and temperature as well as total ammonia must be measured at the same time and place to determine the un-ionized ammonia concentration. Beyond its toxic properties, excess ammonia can have an indirect adverse impact on aquatic life also. The oxidation of ammonia to nitrite and water require significant dissolved oxygen resources. Too much ammonia in the water, such as might occur after a spill of high ammonia strength wastewater, can reduce dissolved oxygen levels to the point that fish kills occur.

c) Chloride

Elevated levels of chloride in surface waters are usually an indication of pollution from a wide range of potential sources. Point sources include the discharge of process water from some industries as well as municipal wastewater treatment plant effluents. Nonpoint sources include runoff from urban streets where road salt has been applied. Besides being a general indicator of man's impacts on water quality, high levels of chloride can harm aquatic organisms, possibly by interfering with the organism's osmo-regulatory capabilities. The Class 2 chronic standard for chloride is 230 mg/L

2. *Data Requirements and Determination of Impaired Condition*

Water quality data available through STORET for the most recent 10 year period is used in waterbody assessments for the 305(b) report and the 303(d) list. Exceedances of standards for toxic pollutants are assessed over consecutive three year periods, consistent with the once in three-year exceedance frequency, discussed in Section II.B.. One exceedance of the **chronic** standard in three years is not considered impairment (two or more is). One exceedance of the **maximum** standard in three years indicates impairment. A minimum of five data points is needed for each three-year period. If more than one sample was taken within a **four-day** period the values are averaged (usually an arithmetic mean is appropriate) and the four-day average is counted as one value in the assessment.

The protocol for assessing three-year intervals is to look first for exceedances in the most recent three years of available data. This is followed by a search for exceedances in any three-year interval containing the minimum five data points. The three-year intervals may overlap but the years must be consecutive. In other words, the three-year intervals used in the assessment are determined by available data and not by the calendar (except they must be within the most recent 10-year period). The selection of appropriate three-year intervals may be made by a professional judgment team. Most, if not all, impairment determinations for toxic pollutants will be reviewed by an appropriate professional judgment team.

River or stream reaches with fewer than five data points, but with one exceedance of the chronic or, especially, the maximum standard, will be given a high priority for follow-up sampling. These will be flagged by the professional review teams, and placed on an internal MPCA list of waters needing further monitoring and assessment.

The protocol for impairment determinations is the same for the 305(b) use support and 303(d) impairment assessments (Table 4).

Table 4. Summary of Data Requirements and Exceedance Thresholds for Assessment of Pollutants with Toxicity-based Standards.

Impairment Assessment For	**Period of Record**	**Minimum No. of Data Points***	**Use Support or Listing Category Based on Exceedances of Chronic Standard****	
Chronic Standard Exceedance Threshold →			**No more than 1 in 3 yrs.**	**2 or more in 3 yrs.**
305(b) Report	Most recent 10 years	5, within a 3-yr. period	Fully Supporting	Not Supporting
303(d) List (TMDL)	Most recent 10 years	5, within a 3-yr. period	Not Listed	Listed

* 4-day central (mean or median) values

** One exceedance of the maximum standard in three years is considered Not Supporting

B. POLLUTANTS WITH HUMAN HEALTH-BASED WATER QUALITY STANDARDS

As stated, protection of aquatic life includes the protection of human (and wildlife) consumers of fish as well as the protection of the aquatic community itself. This Section of the Guidance deals with the assessment of water quality for pollutants that have human health-based chronic standards.

1. *Bioaccumulation*

Chemicals that persist in the environment and "build up" in the tissues of aquatic organisms to higher concentrations than the concentrations in the surrounding water are called **bioaccumulative** chemicals. Chemicals bioaccumulate in biota by direct uptake of the chemical through the skin and gill tissues, and also by uptake through organism's diet (food chain). Uptake through the food chain means that at each step up the chain, from plants to prey to predator, the concentrations in the biota increase at each step. This "biomagnification" as it is called is a concern because many game fish (e.g., walleye and northern pike) are at the top of the aquatic food chain and they typically carry the highest tissue concentrations of the chemical in the aquatic system. The bioaccumulation factor is the ratio between the concentration of the chemical in the biota and the concentration of the chemical in the water. Bioaccumulation factors can exceed one million for very highly bioaccumulative chemicals. A bioaccumulation factor must be determined to calculate a human health-based water quality standard. (MPCA 2000e). Most highly bioaccumulative chemicals have human health-based water quality standards (Appendix A, Tables A-2, A-3 and A-6).

Chemicals are said to be **persistent** in the environment if they only slowly degrade to their nontoxic components. Many chlorinated organic chemicals like DDT and PCBs are both persistent and highly bioaccumulative, but not all persistent chemicals are bioaccumulative. Some chemicals never lose their potential to be toxic, such as elements like mercury. The MPCA has implemented several special programs or strategies for reducing environmental release of these chemicals, even at very low concentrations. Minnesota R. ch. 7052, the Great Lakes Initiative, focuses many of its provisions on the reduction of bioaccumulative toxic chemicals in the Great Lakes ecosystem as a whole.

2. *Pollutants*

The pollutants that have human health-based standards that are most often included in MPCA water quality assessments are briefly described. Pollutants other than those mentioned here may be assessed also, as data allow.

a) <u>Mercury</u>

Mercury is the classic example of a bioaccumulative element; it never degrades, it can bioaccumulate through the food chain to toxic levels from benign water concentrations, and it can cause serious health effects. To make the situation worse, it is unusually mobile in the environment and it readily moves from one medium to another. Atmospheric transport of mercury can be over short (meters) or long (around the world) distances. Mercury numeric water quality standards are based on total concentrations and thus, total mercury measurements are used in assessments. Minnesota has two human health-based Class 2 water quality standards for total mercury, the statewide standard in Minn. R. ch. 7050 and the standard applicable to just the waters of the Lake Superior basin in Minn. R. ch. 7052. These standards are shown below:

- 6.9 ng/L. chronic standard, Minn. R. pt. 7050.0222
- 1.3 ng/L. chronic standard, Minn. R. pt. 7052.0100

(ng/L = nanogram per liter, or parts per trillion)

The MPCA began using clean sampling techniques for mercury and other trace metals in 1996, and only data collected in this manner will be used (EPA Method 1631 or equivalent). Mercury levels are assessed by comparing concentrations in water to the ambient standards shown above, and by assessing the mercury in fish tissue directly, as outlined in Section IX.C where mercury is further discussed.

b) <u>Polychlorinated Biphenyls</u>

Polychlorinated Biphenyls (PCBs) constitute a group of chlorinated organic compounds distributed world-wide. Their extensive use combined with their persistence, bioaccumulative properties, cancer and non-cancer toxicity, make them very serious environmental pollutants. PCB residues are found globally in animal tissues, including humans. The manufacture and distribution of PCBs was banned in Minnesota in 1976, and they are no longer manufactured in the United States. PCBs were used extensively in the electrical industry as transformer and capacitor fluids; they were also used as hydraulic fluids, plasticizers and lubricants.

PCBs elicit a variety of toxic effects on animals and humans, including birth defects, reproductive failure, developmental impairment, liver damage and death. Concentrations of PCBs in water are very low (typically less than 1 part per trillion) and difficult to measure. But, because they bioaccumulate as much as a million fold or more in fish and other animals, they are readily measured in animal tissues. Thus, PCBs are usually assessed for the 303(d) list on the basis of their presence in fish, resulting in advice to anglers to limit their consumption of certain fish (see Section IX.C). The MPCA has adopted human health-based water quality standards for total PCBs. Statewide standards are in Minn. R. ch. 7050 and standards applicable only to waters of the Lake Superior basin are in Minn. R. ch. 7052, as listed below:

Minn. R. pt. 7050.0222

- 14 pg/L, Class 2A chronic
- 29 pg/L, Class 2Bd, 2B, 2C and 2D chronic

Minn. R. pt. 7052.0100

- 4.5 pg/L, Lake Superior chronic
- 6.3 pg/L, Class 2A chronic

- 25 pg/L, Class 2Bd, 2B, 2C and 2D chronic

(pg/L = picogram per liter, or parts per quaddrillion)

c) Dioxins and Chlorinated Pesticides

Dioxins, particularly 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, are probably the most toxic chemicals the MPCA has dealt with. Dioxins are similar to PCBs in may respects. Both represent a family of chlorinated organic chemicals, some of which are very persistent, bioaccumulative and toxic, as well as global in their distribution. The major difference between the two groups of chemicals is that, unlike PCBs, dioxins were never intentionally manufactured. The major sources of dioxins are combustion, chlorine bleaching of pulp wood (now largely phased out), and trace contaminants in other manufactured organic compounds, included PCBs. 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD) has been shown to be carcinogenic in animals at extremely low doses. The EPA completed an exhaustive review of TCDD toxicity in 2000 which confirmed its developmental and reproductive toxicity and carcinogenicity at low exposure rates. The MPCA has Class 2 human health-based water quality standards for 2,3,7,8-TCDD in Minn. R. ch. 7052, applicable only to waters in the Lake Superior basin. The only 2,3,7,8-TCDD standard in Minn. R. ch. 7050 is the EPA drinking water standard of 30 pg/L. These are shown below:

- 0.0014 pg/L, Lake Superior chronic
- 0.0020 pg/L, Class 2A chronic
- 0.0080 pg/L, Class 2Bd, 2B, 2C and 2D chronic

Organochlorine pesticides, such as DDT, dieldrin and toxaphene are the classic examples of the "good and bad" associated with the widespread use of this class of pesticides in the 20th century. The extensive use of DDT for the control of lice and mosquitoes during and in the years just following World War II is credited with saving millions of lives from typhus, malaria and other diseases. Yet, their persistence, bioaccumulative characteristics and reproductive toxicity to non-target organisms represented an environmental disaster, as foretold in Rachel Carson's *Silent Spring*. The role these insecticides played in the population declines of many species of birds of prey has been well documented. The use of most organochlorine pesticides is banned in the United States and in most countries world-wide (EPA 2001b). Like PCBs, concentrations of these pesticides in the Great Lakes have declined since the early 1970s.

The MPCA evaluates waters for dioxins or organochlorine pesticides only at site-specific locations where contamination is suspected or where data are needed to support remedial efforts. Measuring concentrations in water requires special sampling procedures and analytical capabilities. The MPCA human health-based water quality standards for chlordane, DDT, dieldrin, heptachlor (and its primary metabolite, heptachlor epoxide), lindane, and toxaphene are listed in Tables A-2 and A-6 in Appendix A.

3. <u>Data Requirements and Determination of Impaired Condition</u>

The data requirements for assessing waterbodies for exceedances of human health-based standards are essentially the same as for chemicals with toxicity-based standards (Section VII. A). The major difference is that data compared to the chronic standard are “averaged” over a 30-**day** period (rather than 4-day), if more than one sample was taken in the 30-day period. Samples taken in a once-per-month sampling regime occasionally result in two samples collected within 30 days. Such samples should be considered separately and not be averaged together unless the samples were taken within 21 days of each other, in which case they are averaged. A 30-day arithmetic mean is used, unless the data are not normally distributed, in which case a geometric mean, log mean or median should be used.

Water quality data in STORET for the most recent 10 year period is used. Exceedances are assessed over consecutive three year periods. Two exceedance of the chronic standard, or a single exceedance of the **maximum** standard, in three years indicates impairment. A minimum of five data points is needed for each three-year period.

The data requirements and protocol for assessments are the same for the 305(b) report and 303(d) list (Table 5). However, in practice, waterbodies are seldom assessed for support of human health-based standards for the 305(b) report. Data for these pollutants are typically too site-specific to suit the purpose of this report. Data collected as part of a site-specific study of toxicant concentrations in the Lake Superior and Duluth Harbor (MPCA 1999) will be used in assessments for 303(d) listing. River or stream reaches with fewer than five data points, but with one exceedance of the chronic or, especially, the maximum standard, will be given a high priority for follow-up sampling. These will be flagged by the professional review teams, and placed on an internal MPCA list of waters needing further monitoring and assessment.

Table 5. Summary of Data Requirements and Exceedance Thresholds for Assessment of Pollutants with Human Health-based and Wildlife-based Standards.

Impairment Assessment For:	**Period of Record**	**Minimum No. of Data Points***	**Use Support or Listing Category Based on Exceedances of Chronic Standard****	
Chronic Standard Exceedance Threshold →			**No more than 1 in 3 yrs.**	**2 or more in 3 yrs.**
305(b) Report***	Most recent 10 years	5, within a 3-yr. period	Fully Supporting	Not Supporting
303(d) List (TMDL)	Most recent 10 years	5, within a 3-yr. period	Not Listed	Listed

* 30-day central values
** One exceedance of the maximum standard in three years is considered Not Supporting
*** Data for human health or wildlife-based pollutants typically not assessed for the 305(b) report see text.

C. POLLUTANTS WITH HUMAN HEALTH-BASED AND TOXICITY-BASED STANDARDS OR CRITERIA VALUES

As described in the Water Quality Standards Section of this guidance, the MPCA calculates both a toxicity-based and a human health-based criterion, and the more restrictive of the two is adopted into Minn. R. ch. 7050 as the applicable chronic standard. For some pollutants, the aquatic toxicity-based and human health-based values are similar, but only the most stringent is established as the chronic standard. Because of the different averaging times used when comparing human health-based or aquatic toxicity-based standards to monitoring data, a complete impaired waters assessment would require comparisons of monitoring data to both values. Minn. R. chs. 7050 and 7052 will only list the more stringent chronic standard, but MPCA retains a record of all calculated criteria values.

1. *Pollutants*

Table A-3 lists three pollutants - atrazine, cobalt, and pentachlorophenol - that have human health-based and toxicity-based standards or criterions that have similar values. Cadmium, lindane, and 2,4,6-trichlorophenol are other pollutants in this category.

a) <u>Atrazine</u>

Of the pollutants in this category, atrazine data are collected by the Minnesota Department of Agriculture (MDA) for assessments for some stream reaches. The chronic standard for atrazine is 3.4 µg/L for Class 2A and 2Bd waters. While this human health-based standard is lower than the aquatic toxicity-based criterion of 10 µg/L, the aquatic-toxicity value is applicable to all waters to ensure protection of aquatic organisms. Because Class 2B waters are not protected for drinking water, the aquatic toxicity criterion of 10 µg/L becomes the most stringent value and is the basis for the chronic standard. The human health-based criterion value for Class 2B waters is 100 µg/L to protect people who eat fish.

Monitoring data available on atrazine often includes atrazine degradates. In most cases, not enough information is available to determine a water quality standard for degradates, but available human health and aquatic toxicity reviews are considered by the Professional Judgment Group when assessing waters for impairment. Pesticide reviews by MDH and EPA have provided guidance on factoring in toxicity of degradates.

2. *Data Requirements and Determination of Impaired Condition*

The data requirements for assessing waterbodies for exceedances of pollutants like atrazine are the same as those for human health-based standards and toxicity-based standards (Section VII. A & B). Thirty-day and four-day averages are calculated for those periods where exceedances of the standard are observed and compared against the human health-based standard and aquatic toxicity-based standard/criterion, respectively.

Water quality data for the most recent 10 years is assessed over consecutive three-year periods. Two exceedances of the human health-based standard or the aquatic toxicity-based standard within three years indicates impairment. Based on additional information on the timing and magnitude of an exceedance, the Professional Judgment group would evaluate on a case-by-case basis the appropriateness of listing waters with one exceedance of each standard at different times within a three-year period. One exceedance of the maximum standard indicates impairment.

D. POLLUTANTS WITH WILDLIFE-BASED WATER QUALITY STANDARDS

Protection of the aquatic life use includes the protection of wildlife consumers of aquatic organisms. Minnesota has four wildlife-based water quality standards – all in Minn. R. ch. 7052. Minnesota R. ch. 7052 is the Great Lakes Water Quality Initiative (GLI). The GLI was mandated by a 1987 amendment to the Clean Water Act; it was promulgated as a federal rule by EPA in 1995 and adopted in Minnesota in 1998. The GLI has been adopted by all six Great Lakes States. The GLI rule focuses on the reduction of bioaccumulative toxic chemicals in the Great Lakes ecosystem as a whole. The standards in Minn. R. ch. 7052 are applicable only to the surface waters of the Lake Superior basin in Minnesota. The GLI chronic wildlife-based standards are listed below:

- DDT – 11 pg/L
- Mercury – 1300 pg/L

- PCBs – 122 pg/L (GLI human health-based standards for PCBs are more stringent than the wildlife based standard)
- 2,3,7,8-TCDD – 0.0031 pg/L (GLI human health-based standards for dioxin are more stringent than the wildlife based standard for Lake Superior and Class 2A waters, but not for Class 2Bd and 2B,C&D waters)

The assessment of waterbodies for compliance with the GLI wildlife-based standards follows the same protocols used to assess waterbodies for human health-based standards, as described in the previous Section (Table 5). The pollutants that have wildlife-based standards were also discussed in the previous Section.

E. CONVENTIONAL POLLUTANTS

Conventional pollutants or water quality characteristics assessed include dissolved oxygen, pH, temperature, and turbidity. Turbidity is measured directly or estimated from transparency tube and/or total suspended solids measurements.

1. *Pollutant or Water Quality Characteristic*

The conventional pollutants most often included in MPCA water quality assessments are briefly described. Pollutants other than those mentioned here may be assessed also, as data allow.

a) Low Dissolved Oxygen

Dissolved oxygen (DO) is required for essentially all aquatic organisms to live. DO is not a toxicant, and in general, the more DO in the water, up to about 110 percent of saturation, the better, as far as aquatic organisms are concerned. If DO drops below acceptable levels, desirable aquatic organisms such as fish can be killed or harmed. Dissolved oxygen standards differ depending on the use class of the water.

- Class 2A. Not less than 7 mg/L as a daily minimum
- Class 2Bd, 2B, 2C. Not less than 5 mg/L as a daily minimum
- Class 2D. Maintain background
- Class 7. Not less than 1 mg/L as a daily average, provided that measurable concentrations are present at all times

DO concentrations go through a daily cycle in most rivers and streams; concentrations reach their maximum in late afternoon and their minimum just after sunrise. Photosynthesis by green plants during the day gives off oxygen to the water which increases DO concentrations. At nightfall photosynthesis stops, but the continued respiration of living things, including green plants and bacteria, use oxygen faster than it is replaced. This causes a gradual decline in DO levels throughout the night that usually culminates an hour or so after sunrise. For this reason, measurements of dissolved oxygen to be compared to the daily minimum standard are best taken no later than two hours after sunrise. Dissolved oxygen measurements taken later in the day are not likely to represent the low point in the daily dissolved oxygen cycle. Timing is not as critical in the winter because daily DO cycles are not as pronounced as they are in the summer.

b) pH

The pH of water is a measure of the degree of its acid or alkaline reaction. A pH of 7.0 is neutral; pH below 7 is acid, above 7 is alkaline. The applicable pH standard for most Class 2 waters is a minimum of 6.5 and a maximum of 8.5, based on the more stringent of the standards for the applicable multiple beneficial uses. pH values that are either too high or too low can be harmful to aquatic organisms; however, natural waters can exhibit a very broad range of pH values. pH values that are outside the range of the standard because of natural causes are not considered exceedances.

c) Turbidity

Turbidity in water is caused by suspended soil particles, algae, etc., that scatter light in the water column making the water appear cloudy. Excess turbidity can significantly degrade the aesthetic qualities of waterbodies. People are less likely to recreate in waters degraded by excess turbidity. Also, turbidity can make the water more expensive to treat for drinking or food processing uses. Turbidity values that exceed the standard can harm aquatic life. Aquatic organisms may have trouble finding food, gill function may be affected, and spawning beds may be covered.

Turbidity is measured in nephelometric turbidity units (NTU). The standards are shown below:

- 10 NTU, Class 2A waters
- 25 NTU, Class 2Bd, B, C, D waters

Large data sets indicate that TSS and transparency values reliably predict turbidity. Paired TSS and turbidity samples were taken in the Minnesota, Lower Mississippi, Cedar, Des Moines and Missouri River basins. Correlation analysis shows a strong relationship between turbidity and TSS measurements. Using data from all five basins combined resulted in a correlation coefficient (r) of 0.86. Paired transparency tube and turbidity samples were taken across the state, and resulted in a correlation coefficient (r) of 0.77.

These correlations allow the MPCA to use TSS and transparency as surrogates for turbidity at sites where there are an inadequate number of turbidity observations. The TSS values selected as the surrogate thresholds are 58 and 66 mg/L in the Western Corn Belt Plains and Northern Glaciated Plains ecoregions, respectively. These are the 75th percentile values in the distribution of TSS values measured at the less impacted sites in the two ecoregions (Fandrei et al. 1988). The MPCA has used this concept of comparing monitoring data to "ecoregion expectations" in assessments for a variety of pollutants. For transparency, a water body is in violation of the 25 NTU turbidity standard if a transparency tube value is less than 20 centimeters. The MPCA feels that by applying these TSS and transparency thresholds, only a few truly impaired waters will be missed, while minimizing the number of waterbodies falsely identified as impaired.

Turbidity is a highly variable water quality measure. Because of this variability, and the use of TSS and transparency as surrogates, a total of 20 independent observations (rather than 10) are now required for a turbidity assessment. If sufficient turbidity measurements exist, only turbidity measurements will be used to determine impairment. If there are insufficient turbidity measurements, any combination of independent turbidity, transparency, and total suspended solids observations may be combined to meet assessment criteria. If there are multiple observations of a single parameter in one day, the mean of the values will be used in the assessment process.

If there are observations of more than one of the three parameters in a single day, the hierarchy of consideration for assessment purposes will be turbidity, then transparency, then total suspended solids. For a water body to be listed as impaired for turbidity, at least 3 observations **and** 10% of observations must be in violation of the turbidity standard. This is an increase in the number of violations required , which was previously 10% of 10 required observations. Volunteer collected transparency tube observations must be corroborated by the judgment of MPCA staff and by local resource and / or watershed project staff, if available.

The MPCA has not analyzed enough data on Class 2A waters to determine a transparency threshold for violation of the 10 NTU standard. If t-tube data indicates impairment on a Class 2A water (based on the 25 NTU standard), the water body is assessed as impaired for turbidity. If t-tube data indicates a Class 2A water is in full support, the water body is considered "not assessed" since it is based on the transparency threshold for the 25 NTU, and not the 10 NTU standard.

d) Temperature

High water temperatures, or rapid elevations of temperature above ambient, can be very detrimental to fish. The actual temperature that is harmful depends on the kind of fish, the time of year, and the life stage of the fish at the time. Cold water fish such as trout are particularly intolerant of high temperatures. The temperature standard for Class 2A cold water sport fish is a narrative nondegradation statement of "no material increase". This standard is interpreted in a straight forward quantitative way. A demonstration of a "material increase" means that temperature data must show a statistically significant increase when measured, for example, upstream and downstream of a stream modification, upstream and downstream of a point or nonpoint heat source, or before and after a modification that might impact stream temperature. Temperatures must be for similar time frames such as weeks or seasons. Normally the Student's t-test is used to test for significance of the temperature change over time. Specifically, the Student's t-test tests the hypothesis that the means of two groups of observations are equal. This test assumes that each of the two groups consists of independent and normally distributed observations. If either set of temperature data is not normally distributed, an appropriate analogous test, such as the Mann-Whitney U test, will be used. The larger the data set, the finer the precision in determining whether a material increase in stream temperature has occurred.

Currently the MPCA is evaluating only cold water fisheries for temperature caused impairment because of the special sensitivity of cold water fish to elevations in temperature, and because increases in temperature appear to be a major factor in the degradation of stream trout populations.

2. ***Data requirements and determination of impaired condition***

The same information is used to assess conventional pollutants for both 305(b) use support and 303(d) impaired waters determinations (Table 6). Reaches assessed using the impairment thresholds listed in Table 6 as partially supporting or not supporting for the 305(b) report are identified as candidates for the 303(d) list. These reaches are presented to the appropriate professional judgment team for the basin in which the reach is located. The professional judgment team reviews the monitoring data for the most recent 10 years, and any information they have about actions taken in the watershed that might invalidate earlier data. They also consider the times of year and the number of years monitoring was done, and the magnitude and duration of any violations noted, and information about naturally occurring conditions known to influence water quality (see Section V.E). The MPCA makes a final determination on use support for 305(b) reporting, and for inclusion on the 303(d) list.

The 10 percent and 25 percent exceedance thresholds for conventional pollutants (Table 6) are based on EPA guidance (EPA 1997) and have been used by the MPCA in assessments for many years. The MPCA feels these thresholds are appropriate for the "conventional" category of pollutants for several reasons. None is "toxic" (or bioaccumulative) in the traditional sense, unlike the toxicants discussed in Sections VII.A-C. All are subject to periodic "exceedances" due to natural causes. For example, turbidity typically increases in streams after a rain event even in relatively undisturbed parts of the state and dissolved oxygen can drop below the standard in rivers and streams for reasons that have nothing to do with pollution. These potential pollutants are also natural characteristics of surface waters, the fluctuations of which aquatic organisms have adapted to cope with over eons of time. The extent of these natural exceedances will be considered by the professional judgment teams as part of the assessments.

In the 2006 assessment, the judgment teams solidified an approach to assessing full support on streams with data sets that are limited to only one or a few types of data. Subject to the judgment of the team considering all the usual factors, an IBI score, or a turbidity* or dissolved oxygen dataset will each be sufficient alone to make an assessment of full support. Temperature, pH, ammonia, chloride, etc. are each not enough alone. Any combination is sufficient if it includes an IBI score, or turbidity or dissolved oxygen. If the PJG is aware that the timing of collection in a particular dataset might not well represent the conditions for that parameter, it could decide to "not assess".

This approach improves both consistency and efficiency as the number of reaches under consideration has increased dramatically. In order to use all readily accessible and credible data, the assessment process includes data sets that contain any one of the measurements for which water quality standards are in place. Data sets with few, or only one type of measurement, such as ammonia, are valuable for recognizing impairments, but are relatively independent of other influences, and may not be adequate alone to make an assessment of supporting simply because there are not many exceedances. Some types of water quality better reflect overall aquatic biota health in a stream, while others are usually inadequate alone. In general, a fully supporting IBI score, or turbidity or dissolved oxygen data set can reflect a complex of common degradation factors in Minnesota streams.

* "Turbidity" includes transparency tube data with corroboration and total suspended solids data for WCP and NGP eco-regions.

Table 6. Summary of Data Requirements and Exceedance Thresholds for Assessment of Conventional Pollutants and Water Quality Characteristics.

Impairment Assessment For	**Period of Record**	**Minimum No. of Data Points**	**Use Support or Listing Category Based on Chronic Standard Exceedances**		
Chronic Standard Exceedance Thresholds →			**≤ 10 %**	**10 – 25 %**	**> 25 %**
305(b) Report	Most recent 10 years	20	Fully Supporting	Partially Supporting	Not Supporting
303(d) List (TMDL)	Most recent 10 years	20	Not Listed	Listed	Listed

na = Not applicable

F. OTHER NUMERIC WATER QUALITY STANDARDS

Other toxic or conventional pollutants that are found to exceed water quality standards will be assessed following equivalent methodologies discussed in this Guidance, depending on the type of pollutant. Chloride, for example, did not appear in a 303(d) list until 1998, at which time adequate data were available to support impairment assessments for waterbodies.

VIII. Assessment Based on Numeric Standard for Protection of Recreation

A. POLLUTANT – FECAL BACTERIA

Maintaining Minnesota's lakes, rivers and streams in a swimmable condition, where this use is attainable, is the other half of the national Clean Water Act goal of providing fishable/ swimmable waters. To protect surface waters for water recreation, it is useful to divide recreational activities into two categories, **primary** and **secondary** body contact. Primary body contact includes swimming, diving, water skiing, windsurfing, or any form of water recreation where immersion in the water and the possibility of inadvertently ingesting some water is likely.

Secondary body contact recreation includes forms of water recreation where the likelihood of ingesting water is much smaller. Secondary body contact recreation typically includes boating, fishing, sailing, canoeing, and wading by adults. Wading in surface waters by children can be considered primary body contact recreation because children are more likely to put their hands in their mouths, wade in "too far" or fall in. Whitewater kayaking and riding personal water craft are usually considered secondary body contact even though the chances of ingesting water is probably greater than it is with typical boating or canoeing.

The single numeric standard in Minn. R. ch. 7050 that directly protects for primary and secondary body contact are the fecal coliform standards shown in Table 7 . Fecal coliform standards are applicable only during the warm months since there is very little swimming in Minnesota in the winter. Exceedances of the fecal coliform standard mean the recreational use is not being met. In practice, Class 7 waters are rarely assessed to determine if secondary body contact use is being supported.

The MPCA will be proposing to replace the fecal coliform standard with the EPA *Escherichia coli* criterion in a future rulemaking. In anticipation of this change, the MPCA analyzes most bacteriological samples for both fecal coliform and *E. coli*. Research is underway in Minnesota and elsewhere in the U.S. on the use of DNA "fingerprinting" techniques to identify the source of fecal bacteria. The goal of this work is an affordable method to determine if the fecal bacteria in surface waters originated from humans or from animals. If this tool can be perfected, it will be very valuable in helping to direct fecal contamination reduction efforts where they will be most effective.

Given the fact that the fecal coliform standard is a geometric mean of not less than five samples collected in a month, and that typical monitoring programs very rarely sample more often than once per month, a method of data assessment was needed that maximized the usefulness of the available data. An analysis of all fecal coliform data was done to determine the impact of collecting fewer than five samples per month (Markus 1999). This analysis showed that, for any given monitoring site, there was less variability for a given month across years than there was for all months within a year. The conclusion was that although the most desirable approach was to collect at least five samples per month, we could reflect the intent of the standard using our current resources by **aggregating data for a given month across all years**.

Table 7. Fecal Coliform Water Quality Standards for Class 2 and Class 7 Waters.

Use Class	**Standard No. of Organisms Per 100 mL of Water**		**Applicable Season**	**Use**
	Monthly Geometric Mean*	**10 % of Samples Maximum****		**Body Contact**
2A, trout streams and lakes	200	400	April 1 – October 31	Primary
2Bd, 2B, 2C, non-trout (warm) waters	200	2000	April 1 – October 31	Primary
2D, wetlands	200	2000	April 1 – October 31	Primary, if the use is suitable
7, limited resource value waters	1000	2000	May 1 – October 31	Secondary

* Not to be exceeded as the geometric mean of not less than 5 samples in a calendar month.
** Not to be exceeded by 10% of all samples taken in a calendar month, individually.

B. Data Requirements and Determination of Impaired Condition

The MPCA uses fecal coliform data collected by MPCA, other government agencies and by volunteers. All data used must satisfy QA/QC requirements, meet EPA guidelines and be analyzed using the membrane filter technique. The data must be entered into STORET. The assessment of swimming impairment using fecal coliform data is carried out in two steps.

Table 8. Step One of Assessment of Waterbodies for Impairment of Swimming Use - Data Requirements and Exceedance Thresholds for Fecal Coliform Bacteria.

Impairment Assessment For	**Period of Record**	**Minimum No. of Data Points**	**Use Support or Listing Category Based on Exceedances of 200 orgs/100mL**	
Standard Exceedance Thresholds →			**< 10 %**	**≥ 10 %**
305(b) Report	Most recent 10 years	10	Fully Supporting	Potentially Impaired, go to step 2
303(d) List (TMDL)	Most recent 10 years	10	Not Listed	Potentially Impaired, go to step 2

The first step, outlined in Table 8 above, is a screening process which identifies waters with potential fecal coliform problems. At least 10 data points are needed over the most recent 10 years for the assessment. Individual fecal coliform values for the applicable season (April – October) are each compared to the 200 organisms per 100 ml standard. If fewer than 10 percent of the values exceed the standard, the waterbody is fully supporting of the swimming use and no further evaluation is done. If 10 percent or more of the values exceed the standard, the waterbody is considered **potentially impaired**, and it moves on to step two in the assessment process. Even if more than 25 percent of the values exceed the standard, step two must be completed before an impairment decision is made.

The second step is applied to the potentially impaired waters identified by step one. Data over the full 10-year period are aggregated by individual month, as mentioned above (e.g., all April values for all 10 years, all May values, etc.). A minimum of five values for each month is ideal, but is not always necessary to make a determination. If the geometric mean of the aggregated monthly values for three or more months exceed 200 organisms per 100 ml, that reach is placed on the 305(b) not supporting list and on the 303(d) impaired list. If the geometric mean for one or two months exceeds 200 organisms per 100 ml, that reach is assessed as partially supporting for 305(b) and is placed on the 303(d) impaired list. Also, a waterbody is considered impaired if more than 10 percent of individual values over the 10-year period (independent of month) exceed 2000 organisms per 100 ml (400 organisms per 100 ml if the reach is a Class 2A water). Again, step two more closely approximates the five-samples-per-month requirement of the standard while recognizing typical sampling frequencies, which rarely provide five samples in a single month and usually only one. Table 9 summarizes step two.

Table 9. Step Two of Assessment of Waterbodies for Impairment of Swimming Use - Data Requirements and Exceedance Thresholds for Fecal Coliform Bacteria.

Impairment Assessment For	**Period of Record**	**Minimum No. of Data Points**	**Use Support or Listing Category Based on Exceedances of The Fecal Coliform Standard**		
Standard Exceedance Thresholds → ***Monthly geometric mean > 200 orgs/100 ml***			**No months**	**1 or 2 months**	**More than 2 months**
305(b) Report	Most recent 10 years	see text	Fully Supporting	Partially Supporting	Not Supporting
303(d) List (TMDL)	Most recent 10 years	see text	Not Listed	Listed	Listed
Standard Exceedance Thresholds → ***Exceeds 2000 orgs/100 ml****			**< 10 %**	**10 - 25 %**	**> 25 %**
305(b) Report	Most recent 10 years	10	Fully Supporting	Partially Supporting	Not Supporting
303(d) List (TMDL)	Most recent 10 years	10	Not Listed	Listed	Listed

* In full data set over 10 years. Maximum of 400 orgs./100 ml for Class 2A waters

Professional judgment review of the data provides a further evaluation in the second step. If at least five values are available for each month, the determination directly follows the assessment methodology outlined in the previous paragraph. When fewer than five values are available for most or all months, the individual data are reviewed. Considerations in making the impairment determinations include the following:

- Dates of sample collection (years and months)
- Variability of data within a month
- Magnitude of exceedances
- Remark codes associated with individual values
- Previous assessments and 303d listings

In some circumstances where four values are available for some or all months, a mathematical analysis is done to determine the potential for a monthly geometric mean to exceed the 200 organisms / 100mL standard. All step 2 assessments are reviewed by a subset of the professional judgment team for each basin.

Step 2 for large datasets:
Aggregating data by month across years for very large datasets diminishes the value of the data and assessment, making it less likely that periodic fecal coliform exceedances will be identified that indicate impairment. Data aggregation should be held to a minimum, no more than necessary to have sufficient data to satisfy the requirements for determining exceedances.

Alternative methods of data analysis may be used based on a professional judgment review of the data. Where there are five values per individual month or 30 day time period, the data will not be aggregated and individual monthly or 30 day geometric means may be calculated. Alternatively, data may be aggregated by month across consecutive two year or five year time periods. If more than ten percent of the geometric means calculated exceed the 200 org/100mL standard, the AUID is assessed as partially supporting for 305b and is placed on the 303d impaired list. If more than 25 percent of the geometric means calculated exceed the 200 org/100mL standard, the AUID is assessed as not supporting for 305b and is placed on the 303d impaired list.

IX. Assessment Based on Narrative Standards

A. LAKE EUTROPHICATION

1. *Introduction*

In Minnesota, as is the case nationwide, excess plant nutrients (nitrogen and phosphorus) from anthropogenic sources contribute to cultural eutrophication of lakes. Eutrophication of waters caused by excessive nutrient loads is one of the primary causes of non-attainment of swimmable

uses in lakes across the nation. Excessive nutrient loads, in particular total phosphorus (TP), lead to increased algae blooms and reduced transparency – both of which may significantly impair or prohibit the use of lakes for swimming. In Minnesota this led the MPCA to develop assessment methodologies, conduct extensive sampling of lakes, and ultimately derive **ecoregion-based lake eutrophication guidelines**, starting with guidelines for TP. In turn, the TP guidelines have been used as the basis for assessing swimmable use support for lakes. Given the emphasis on
nutrients and eutrophication issues in the Clean Water Action Plan (EPA 1998**)**, it is appropriate that lakes impaired due to excess nutrients from anthropogenic sources be included on the lists of impaired waters. Assessment of lakes for the 305(b) report is based on all available data, but partly because Minnesota has so many lakes to assess, the evaluation of swimmable use can be based on as little as one data point for TP or other relevant indicator of trophic status. Listing of a lake as impaired on the 303(d) list, however, requires a much more robust data set.

The factors used to assess lake trophic status can be roughly divided into two categories: those relating to **causal** factors and those relating to **response** factors. Causal factors are the plant nutrients, TP and nitrogen. Total phosphorus is nearly always the primary causal factor in the eutrophication of Minnesota lakes, because nitrogen is usually present in abundance and does not limit the growth of algae. Thus, the addition of more nitrogen to lakes usually has little impact on the abundance of algae. The "response" factors are indicators of the response of the system to the excess nutrients, and they are usually measured by chlorophyll-a concentrations and Secchi disk readings.

2. *Basis for Assessment of Lakes – Narrative Standards*

The basis for assessing lakes for impairment due to eutrophication are the narrative water quality standards and assessment factors in Minn. R. pt. 7050.0150. The most relevant part, Minn. R. pt. 7050.0150, subp. 5 is quoted below:

> *Subp. 5.* ***Impairment of waters due to excess algae or plant growth****. In evaluating whether the narrative standards in subpart 3, which prohibit any material increase in undesirable slime growths or aquatic plants including algae, are being met, the commissioner will use all readily available and reliable data and information for the following factors of use impairment:*
>
> *A. representative summer-average concentrations of total phosphorus and total nitrogen measured in the water body throughout the summer growing season;*
>
> *B. representative summer-average concentrations of chlorophyll-a measured in the water body throughout the summer growing season;*
>
> *C. representative measurements of light transparency in the water body, as measured with a Secchi disk in lakes or a transparency tube in rivers and streams, throughout the growing season; and*

D. any other scientifically objective, credible, and supportable factor.

A finding of an impaired condition must be supported by data showing elevated levels of nutrients in item A, and at least one factor showing impaired conditions resulting from nutrient over-enrichment in items B and C. The trophic status data described in items A to D must be assessed in light of the magnitude, duration, and frequency of nuisance algae blooms in the water body; and documented impaired recreational and aesthetic conditions observed by the users of the water body due to excess algae or plant growth, reduced transparency, or other deleterious conditions caused by nutrient over-enrichment.

Assessment of trophic status and the response of a given water body to nutrient enrichment will take into account the trophic status of reference water bodies; and all relevant factors that affect the trophic status of the given water body appropriate for its geographic region, such as the morphometry, hydraulic residence time, mixing status, watershed size, and location. The factors in this subpart apply to lakes and, where scientifically justified, to rivers, streams, and wetlands.

In addition, Minn. R. pt. 7050.0211, subp.1a, requires a TP effluent limit for point sources that discharge to or affect a downstream lake or reservoir. This provision was added to Minn. R. ch. 7050 in the early 1970s, and it established early on the link between excess nutrient loading and cultural eutrophication. A portion of this provision is quoted below:

Subp. 1a. Total phosphorus effluent limits. Where the discharge of effluent is directly to or affects a lake or reservoir, phosphorus removal to one milligram per liter shall be required. …

In addition, removal of nutrients from all wastes shall be provided to the fullest practicable extent wherever sources of nutrients are considered to be actually or potentially detrimental to preservation or enhancement of the designated water uses. …

In the absence of numeric nutrient and eutrophication standards in Minn. R. ch. 7050, these narrative standards are used to protect the recreational, aquatic life and aesthetic uses of surface waters. Because of the importance of lake eutrophication to the state, the MPCA undertook an extensive planning and research effort to develop a strategy for addressing TP in point source discharges. The "Phosphorus Strategy" (MPCA 2000d) provides a consistent framework for making decisions about whether a discharger should have a phosphorus limit, based on Minn. R. pt. 7050.0211, subp. 1a.

The implementation of narrative standards, in general, requires the review of all readily available and reliable data and information relevant to the assessment. It is necessary to show a consistent pattern of exceedances of the stated unacceptable conditions in the narrative standard. That is, a sufficient "weight of evidence" must be established with the available data to show that the waterbody is impaired due to nutrient enrichment from anthropogenic sources. The "weight of evidence" concept is discussed in Section V.E.3. Ecoregion-based in-lake TP guidelines, developed by the MPCA using Minnesota lake data and discussed more fully below, provide an objective and useful tool in the assessment of lake trophic status. Similar guidelines for streams and wetlands are under development.

3. *Ecoregions*

Lakes across the state vary widely due to different morphometry (size, depth, etc.), watershed characteristics and other relevant factors. Accordingly, we cannot expect the same level of water quality for all lakes. The ecoregion framework can serve as a basis for evaluating lake condition and setting preliminary water quality goals. Ecoregions have been mapped by the EPA for the lower 48 states based on overlaying maps of land form, soil type, land use, and potential natural vegetation (Omernik 1987). Ecoregions are areas where these features and surface water resources are similar. Minnesota is characterized by seven ecoregions, four of which contain 98 percent of Minnesota's lakes (Figure 1). These four are:

- Northern Lakes and Forests (NLF)
- North Central Hardwood Forests (NCHF)
- Western Corn Belt Plains (WCBP)
- Northern Glaciated Plains (NGP)

Major drainage basins within the state may include one or more of these ecoregions. For example, the Lake Superior basin drains a portion of just one ecoregion, Northern Lakes and Forests, while the Red River Basin drains portions of five ecoregions. Lake condition may vary substantially across a basin because of these underlying patterns in land use, soil type, landform, and potential natural vegetation vary as well. Thus, an ecoregion-based, rather than watershed-based, approach to assessing the trophic status of lakes is appropriate.

There are very few lakes in the remaining three ecoregions in Minnesota. For this reason no TP guidelines were developed for the Red River Valley, Northern Minnesota Wetlands and the Driftless Area (SE Minnesota) ecoregions. Rather, lakes from these ecoregions can be reviewed individually and guidelines from adjacent ecoregions can be used for comparison purposes; i.e., NCHF or WCBP guidelines can be used for Red River Valley lakes, NLF for Northern Minnesota Wetlands lakes, and NCHF or WCBP for Driftless Area lakes. Decisions on which guidelines are most appropriate would be based on considerations of lake depth, lake user perception data (if available) and local characteristics, such as land use.

Because each lake is unique and lakes vary in quality due to natural circumstances, all lake data will be analyzed in the context of the ecoregion in which the lake is located. Also, the lake's mixing status, hydraulic residence time, watershed size and morphometry (e.g., maximum and mean depth, surface area, volume, etc.) will be taken into account. In addition, other factors deemed important or relevant in a given situation in the MPCA's best professional judgment may be considered as a part of the review and listing process.

4. *Development of Total Phosphorus Guidelines– Causal Factor*

Total phosphorus is nearly always the primary causal factor in the eutrophication of Minnesota lakes. Several reference lakes were selected in each ecoregion and monitored over two to three summers (Heiskary and Wilson 1988). The reference lakes selected are not the most pristine lakes to be found in a particular ecoregion, rather they are lakes minimally impacted by man's activities, but **representative** of the types of lakes found in that ecoregion. Data from the reference lakes along with a large body of user perception information derived from the Citizens Lake Monitoring Program (CLMP), an extensive review of the literature, and a review by an expert panel, led to the development of total phosphorus (TP) guidelines for the protection of lake uses within each ecoregion (Table 10). As explained in the previous Section, lakes and lake-basin characteristics vary among ecoregions – from the small, deep lakes of the NLF to the large, shallow lakes of the WCBP and NGP. Results from 20 years of lake-observer surveys indicate that the perception of what constitutes high transparency or severe algal blooms also varies by ecoregion. In general, lake users in northern Minnesota are less tolerant of reduced transparency and blooms than are those in southern Minnesota (Heiskary and Wilson 1989).

Table 10. Total Phosphorus Guidelines for Minnesota Lakes (modified from Heiskary and Wilson 1988).

Ecoregion	**Use and Level of Support**	**TP Guideline**
Northern Lakes and Forests	Cold water fishery, Full support	< 15 µg/liter
Northern Lakes and Forests	Primary-contact recreation and aesthetics, Full support	< 30 µg/liter
North Central Hardwood Forests	Primary-contact recreation and aesthetics, Full support	< 40 µg/liter
Western Corn Belt Plains and Northern Glaciated Pains	Primary-contact recreation and aesthetics, Full support, goal Partial support	 < 40 µg/liter < 90 µg/liter

The uses addressed in Table 10 include cold water fisheries, primary contact recreation (swimming) and aesthetics. Since their establishment in 1988, the TP guidelines have served as a basis for prioritizing and selecting nonpoint source projects, setting water quality goals (see Minn. R. ch. 7076, Clean Water Partnership Grants), and evaluating support of swimmable use for 305(b) assessments; they are the foundation for the TP impairment thresholds shown in Table 11. More information on the development of these guidelines may be found in Heiskary and Wilson (1988 and 1989) and Heiskary and Walker (1988). A wide range of data and information were used to develop the TP guidelines as summarized below. The approach is consistent with current EPA guidance on nutrient criteria development (EPA 2000a). Ecoregion-based TP guidelines were developed from an extensive Minnesota lake data set that included:

- Comparisons of 305(b) assessment and reference lake databases,
- User perception information derived from CLMP participants cross-tabulated with Secchi disk,
- Interrelationships between TP, chlorophyll-a and Secchi disk measurements (see below),
- Review of the literature on the relationship between summer-mean chlorophyll-a and algal bloom nuisance frequency, and
- Consideration of ecoregion-based lake morphometric and watershed limitations.

5. *Total Phosphorus Guidelines and Use Support Categories for Lakes*

Based mainly on the total phosphorus (TP) guidelines shown in Table 10 plus our experience in lake assessments, we use the following categories and working definitions of swimmable use support for lakes for 305(b) assessments.

- **Full-support** - few algal blooms and adequately high transparency exist throughout summer to support swimming.
- **Partial support (impaired)** - algal blooms and low transparency may limit swimming for a significant portion of the summer.
- **Non-support (impaired)** - severe and frequent algal blooms and low transparency will limit swimming for most of the summer.

Lakes that **fully support** a cold water fishery (trout lakes) have the lowest TP guideline (< 15 μg/L), because these lakes must be maintained in a nutrient poor (oligotrophic) condition, and they are typically very sensitive to additional TP loading (Table 10). Trout lakes must be oligotrophic or near oligotrophic, to maintain adequate dissolved oxygen levels in the deeper, cold (hypolimnetic) waters throughout the summer stratification. If oxygen is depleted in the hypolimnion, as typically occurs in more nutrient rich lakes, cold water fish are forced into the unacceptably warm epilimnetic waters to find oxygen. Trout populations can not be sustained under these conditions.

The NLF and NCHF ecoregion TP guidelines of 30 μg/L and 40 μg/L, respectively, serve as the upper thresholds for **full support** of swimmable use in the 305(b) report and the preliminary assessment for the 303(d) list. Those concentrations correspond to Carlson's trophic state index (TSI) values of 53 and 57, respectively. See Section IX.A.6. for a description of Carlson's trophic state index (TSI).

Total phosphorus concentrations above full support guideline levels would result in greater frequencies of nuisance algal blooms and increased frequencies of "impaired swimming." The upper threshold for **partial-support** of swimmable use are 35 and 45 μg/L TP, respectively for the NLF and NCHF ecoregions (56 and 59 Carlson TSI units, respectively; Table 11). Total phosphorus concentrations above these levels are associated with **non-support** of swimmable use in the NLF and NCHF ecoregions.

As TP concentrations increase from about 30 µg/L to 60 µg/L in NLF and NCHF lakes, summer mean chlorophyll-a concentrations increase from about 10 µg/L to 30 µg/L (Figures 2a and 3), and Secchi transparency decreases from about 1.7 m to 0.8 m (Figures 2b and 3). Over this range, the frequency of nuisance algal blooms (greater than 20 µg/L of chlorophyll-a) increases from about five percent of the summer to about 70 percent of the summer (Figure 4). The increased frequency of nuisance algal blooms and reduced Secchi transparency results in a high percentage of the summer (26-50 percent) perceived as "impaired swimming" (Heiskary and Wilson 1989). At TP concentrations above 60 µg/L, severe nuisance algal blooms (greater than 30 µg/L of chlorophyll-a) may occur over 40 percent of the summer. This results in about half of the summer season being impaired for swimming, and greater than 25 percent of the summer being unacceptable for any swimming.

Lakes in the WCBP and NGP ecoregions would need a TP less than 40 µg/L to support summing throughout the full summer season, similar to lakes in the NCHF ecoregion (Table 10). However, less than 10 percent of the assessed lakes in these two ecoregions have TP concentrations of 40 µg/L or less (MPCA 2000c), and less than 20 percent have TP concentrations below 70 µg/L. The MPCA feels that a threshold of 70 µg/L is a more reasonable goal for the majority of the lakes in these two ecoregions for the protection of swimming use, and an appropriate threshold to use for purposes of 303(d) listing. Thus, the upper TP threshold for **full-support** is 70 µg/L for the WCBP and NGP ecoregions, which corresponds to a Carlson's TSI of 66. In general, these lakes should be protected from further eutrophication.

At a TP concentration of 70 µg/L, summer-mean chlorophyll-a concentrations average 30-35 µg/L and Secchi transparency is about 0.7 meter. Severe nuisance algal blooms (greater than 30 µg/L of chlorophyll-a for these regions) would occur for approximately 40 to 50 percent of the summer (Figure 4). Lakes with TP in the 70 to 90 µg/L range may **Partial-support** swimmable use; these lakes will be individually reviewed to determine whether or not they are considered impaired. Lakes in the WCBP and NGP with TP concentrations greater than 90 µg/L (Carlson's TSI = 69) are considered **not supporting** of swimmable use. At TP concentrations greater than 90 µg/L, Secchi transparency typically averages 0.5 meter or less and **severe** nuisance algal blooms may occur 75 percent of the summer or more, and **very severe** nuisance blooms over 20 percent (Figure 5).

6. *Eutrophication Thresholds for Chlorophyll-a and Secchi Disk – Response Factors*

The MPCA has developed eutrophication thresholds for the response factors, chlorophyll-a and Secchi disk measurements, in addition to the TP guidelines (causal factor) discussed above.

Chlorophyll-a is a pigment in green plants including algae. The concentration of chlorophyll-a is a measurement of the abundance of algae, and it is a very useful indicator of the trophic status of a lake. Secchi disk measurements are provided largely through the efforts of hundreds of citizen volunteers that monitor lakes across the state as part of the CLMP. In 2004, the Citizen's Lake

Monitoring Program (CLMP) had about 980 volunteers actively taking Secchi disk readings throughout the state. The Secchi disk is a very simple but very effective tool for measuring the clarity of lake water. The Secchi disk is a round black and white or all white disk attached in the center to a calibrated rope that is lowered into the water from a boat to take the reading. In general, the depth at which it can no longer be seen by the observer through the water column is the Secchi disk depth. The greater the Secchi disk depth, the clearer the water, which usually means fewer algae and less nutrients (Figure 2b). Very clear, oligotrophic lakes will have Secchi disk readings that consistently exceed 20 feet; eutrophic lakes will have Secchi disk reading of about 3 feet or less These two measurements, chlorophyll-a and Secchi disk, are routinely used to characterize lake trophic status (EPA 2000a).

The MPCA uses the ecoregion-based TP guidelines in conjunction with Carlson's Trophic State Index (TSI) (Carlson 1977) as a means to classify lakes relative to support of swimmable use in 305(b) assessments. Carlson's TSI is a numeric index of lake trophic status on a scale of 1 to 100. The TSI was developed by Robert Carlson while a graduate student in limnology at the University of Minnesota. The greater the index number the more nutrient enrichment is indicated in the waterbody (Figure 3). Separate indices are calculated from measurements of TP, chlorophyll-a or Secchi disk depth using the following formulas:

TSI for total phosphorus = 14.42 (ln (total phosphorus in μg/L)) + 4.15
TSI for chlorophyll-a = 9.81 (ln (chlorophyll-a in μg/L)) + 30.6
TSI for Secchi disk = 60 – 14.41 (ln (Secchi disk depth in meters))

Where ln = natural log

By using Carlson's TSI we are able to estimate use support based on chlorophyll-a and Secchi transparency in addition to TP. The solid relationships between TP and chlorophyll-a and chlorophyll-a and Secchi transparency are well established based on data from ecoregion reference lakes in Minnesota (Figures 2a and 2b), and other sources.

Chlorophyll-a and Secchi "response" thresholds corresponding to the TP thresholds (Table 11) were derived based on best professional judgment. For the NLF and NCHF lakes, Carlson's TSI values for chlorophyll-a and Secchi that correspond to the phosphorus values were used. Over a range in TP from about 10 – 50 µg/L Carlson's TSI predicted chlorophyll-a and Secchi are relatively similar to the MPCA regression equations (derived from the ecoregion reference lakes). For the WCBP and NGP lakes, MPCA phosphorus, chlorophyll-a and Secchi regression equations were used to define the response thresholds. These equations were deemed to provide a better estimate of chlorophyll-a and Secchi for these more eutrophic lakes, based on our experience. User perception responses, as documented in Heiskary and Wilson (1989) and Smeltzer and Heiskary (1990), were considered as well when selecting thresholds for all ecoregions.

Ecoregion-based TP guidelines (causal) will be the initial impairment threshold determinant. Data for response factors, in addition to summer mean chlorophyll-a, and Secchi disk, include the documentation of excess alga in the form of algae blooms, excessive turbidity, and reports by users of the resource that recreational or aesthetic uses are impaired.

As mentioned in the discussion of ecoregions (in Section IX.A.3.), it is important to reiterate that each lake will be assessed for potential 303(d) listing on a case by case basis. All lake data will be analyzed in the context of the ecoregion in which the lake is located, as well as the lake's morphometry, mixing status, hydraulic residence time, watershed size and any other factors deemed important or relevant in a given situation.

7. *Data Requirements and Determination of Impaired Condition*

a) <u>Minimum Data Requirements</u>

Data quality for lake assessments

The data for lake assessments is drawn from STORET; as such we believe certain "data quality" filters are already in place and are not addressed here. Rather, the quality of data for lake assessments was based on the relative amounts of information available for the assessment. In the case of our assessments for swimmable use (primary contact) we use total phosphorus, chlorophyll-a, and Secchi transparency to make the assessments. This typically implies two or more summers of monitoring on the lake. For 305(b) we prefer data for all three indicators but will make assessments on only Secchi disk data if that is all that is available. Our three categories are as follows:

- good - lake has 12 or more paired TP, chlorophyll-a, and Secchi measurements collected within the most recent ten years;
- fair - lake has <12 but > 1 TP measurement upon which to assess the lake (note that in most instances where TP is collected chlorophyll-a and Secchi are collected as well);
- poor - lake has only Secchi data available for the lake - or - the only data for the lake is greater than 10 years old ("old" data has often been termed "evaluated" in previous 305(b) assessments.

All assessments will be based on data collected over the most recent 10-year period. Data collected by parties outside the MPCA may be used as long as it meets acceptable QA/QC requirements. Any data used should have QA/QC information readily available and meet the requirements for entry into STORET. Data from all sources should be entered into STORET so that a permanent record is established and data may be merged or considered in light of other data available for that lake. The minimum data requirements for a lake to be assessed for the 305(b) report and the 303(d) list are different.

The 305(b) assessment starts by reviewing all lake data for Minnesota lakes in STORET (for the most recent 10 years) that have at least one TP, chlorophyll-a or Secchi disk measurement. This assessment is based on TP if data are available and, if not, Secchi is used based on corresponding

Carlson's TSI values (Figure 3). Lake morphometric data, including surface area and maximum depth for most lakes (typically drawn from Bulletin 25 and/or bathymetric maps), are available from STORET as well. The 305(b) assessment is used to determine candidates for 303(d) listing.

At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. In the 2002 and 2004 assessments only lakes that had 12 total phosphorus (TP), chlorophyll-a, and Secchi measurements collected during the most recent ten-year period were assessed. In the course of those assessments there was some sense that lakes were excluded from the assessment that met the "spirit" of the guidance, e.g., may have had 11 TP, 12 chlorophyll-a, and 12 Secchi for instance.

For the 2006 listing process all lakes that had at least 10 TP measurements were included in the assessment. This resulted in a larger pool of lakes to assess and minimized the chance of excluding lakes from the assessment that have most, if not all, the data needed to make an accurate TMDL listing assessment. No changes were made in the threshold values and lakes to be listed needed to exceed the causative variable – TP and one of the two response variables – chlorophyll-a or Secchi. If there were 12 or more observations for 2 of 3 variables and the values were well above the thresholds the lake was placed on the draft 303(d) list.

In instances where it is exceedingly obvious that the lake is above thresholds one or two additional samples will do little to improve the accuracy of the assessment. For example, in some cases the lake is so far above the TP threshold that if one or two additional samples were taken and the values were at the detection limit (2 µg/L for TP) the lake would still be above the threshold value. All available data are closely reviewed for trends and other relevant information before the lake is proposed for listing and a justification is included in a memorandum that summarizes the lakes that are proposed for listing.

b) Lake Impairment Determinations

The flow chart or decision tree in Figure 6 can be used to guide the assessment process. The first step in the assessment process is to determine whether the waterbody is a lake, which means it:

- Is listed in MDNR Bulletin 25
- Is not listed as a wetland in the MDNR Public Waters Inventory, and
- Is 10 acres or larger, and
- Has a hydraulic residence time of at least 14 days (in Section V.A.).

Some waterbodies listed as wetlands are being treated as lakes if, for example, they are being managed for fishing by being stocked or if they have a beach area – these may be assessed as a lake.

Table 11. Trophic Status Thresholds for Determination of Use Support for Lakes. (Carlson's TSI Noted for Each Threshold.)

Ecoregion (TSI)	**TP ppb**	**Chl-a ppb**	**Secchi m**	**TP Range ppb**	**TP ppb**	**Chl-a ppb**	**Secchi m**
305(b) →	**Full Support**			**Partial Support to Potential Non-Support**			
303(d) →	**Not Listed**			**Review**	**Listed**		
NLF	< 30	<10	≥ 1.6	30 – 35	> 35	> 12	< 1.4
(TSI)	(< 53)	(< 53)	(< 53)	(53-56)	(> 56)	(> 55)	(> 55)
NCHF	< 40	< 15	≥ 1.2	40 - 45	> 45	> 18	< 1.1
(TSI)	(< 57)	(< 57)	(< 57)	(57 – 59)	(> 59)	(> 59)	(> 59)
WCBP & NGP	< 70	< 24	≥ 1.0	70 - 90	> 90	> 32	< 0.7
(TSI)	(< 66)	(< 61)	(< 61)	(66 – 69)	(> 69)	(> 65)	(> 65)

TSI = Carlson's Trophic State Index
Chl-a = Chlorophyll-a, includes both pheophytin-corrected and non-pheophytin-corrected values.
ppb = parts per billion or μg/L
m = meters

Table 11 lists the TP thresholds and corresponding chlorophyll-a and Secchi disk thresholds for listing lakes on the 303(d) list. Case examples in Appendix D show how data for a given lake are taken through the decision tree. Best professional judgment will play an important role in determining impairment. Since TP is the most significant causal factor for lake impairments, the MPCA will use the ecoregion-based TP guidelines as a backdrop for defining use support thresholds.

c) <u>Lakes Needing Further Review</u>

Data that places lakes in the "Review" column in Table 11 indicate a condition between support and non-support of the swimmable use, and further scrutiny is required to determine whether they should or should not be considered impaired and placed on the 303(d) list. These lakes had been referred to as **"partially supporting"** the swimmable use in the 305(b) assessments. Lakes falling in this "Review" category could include (see Table 11):

- Lakes with TP values at or slightly above the "Review" guideline thresholds, and may or may not be exhibiting excess chlorophyll-a or reduced Secchi readings; or
- Lakes with TP values below the TP "Review" thresholds but exhibit elevated chlorophyll-a or reduced Secchi readings; or
- Lakes with TP above the "Listed" thresholds, but with chlorophyll-a values below, and Secchi readings above, "Listed" threshold values.

Review of these lakes would likely consider the following information:

- An analysis of annual data summaries, including summer-mean values, the number of values, and standard errors, for TP, chlorophyll-a and Secchi disk; available for the lake from STORET and/or other quality assured sources that may be provided by collaborators. The statistics provide a basis for determining presence of outlier values (which could require more detailed follow-up) and basic trend analysis;
- Interrelationships between TP, chlorophyll-a and Secchi disk for the summarized and overall data set for the 10-year period;
- Where trends in trophic status indicated, a greater emphasis will be placed on the most recent two or three years of data to determine impairment status;
- User perception information; and
- Other pertinent information such as reports that may aid in determining whether the lake is impaired.

A weight of evidence approach is used for these assessments, as interpreted by a professional judgment team consisting of MPCA staff as well as others familiar with the resource (e.g., lake association, local government unit or watershed district). For example, a lake may exhibit acceptable TP, chlorophyll-a and Secchi disk measurements based on recent data (e.g. last two or three years). These recent data should supersede the long-term mean (based on the 10-year time frame) used in the initial assessment, and would typically result in the lake not being listed.

Lakes in the “Review” category that are recommended for 303(d) listing may require further monitoring and assessment, and will likely be good candidates for some level of rehabilitation – since they are either near or above the ecoregion-based guidelines. Lakes in this category might be good candidates for the Lake Assessment and/or the Clean Water Partnership Programs, and local interest groups should be encouraged to participate in these or other similar programs.

d) Reservoirs and Other Special Situations.

Sampling design and assessments for swimmable use for reservoirs may be different from those used for lakes. Since reservoirs typically exhibit distinct zones, often referred to as inflow segment, transitional segment, and near-dam segment, calculation of “whole reservoir” mean TP may not be an appropriate basis for assessing swimmable use. Rather, the MPCA may want to evaluate the status of the reservoir based on a specific segment – most likely the near-dam segment. Also, water residence time may vary substantially as a function of river flow (e.g., Lake Pepin, Heiskary and Walker 1995) and may influence algal response to available nutrients. In addition, reservoirs often have very large watersheds that may drain portions of one or more ecoregion. Hence the ecoregion guidelines, based on where the reservoir is located, may not be an appropriate basis for evaluating use support.

Lakes with distinct bays, such as Lake Minnetonka, may present a similar situation. The bays may need to be assessed on an individual basis (our current method for storing data for “bayed lakes” readily allows for this). In some instances a single bay may exceed the listing thresholds while other bays in the lake do not. In this case it should be determined whether the entire lake should be listed (e.g., there is distinct interaction between the bays) or simply the individual bay. This will likely require knowledge of flow-through patterns in the lake and assistance from local cooperators to make an appropriate determination.

e) Determination of waterbody type.

As a part of this assessment we need to determine whether the waterbody in question is considered a lake or a wetland – which is not always clear cut; however we note in guidance that we will not be listing wetlands with this methodology. Our previous basis for differentiating between lakes and wetlands is the Protected Waters Inventory (PWI) which uses a code of "LW" for wetlands and "L" or "LP" for lakes.

However, in the process of conducting individual review of shallow lakes in the 2006 assessment it was evident that some lakes that while listed as "LW" appear to be characterized as lakes by local management organizations (e.g. WMOs), are actively managed as lakes by MDNR Fisheries (as evidenced through lake survey data and fish stocking documented on their web site), and/or there is a weight of evidence that suggests the public perceives the waterbody as a lake based on presence of public access, boating and fishing usage. Thus, these factors need be taken into account. As such when there is question on whether the waterbody is best classified as a lake or as a wetland, for the purpose of 303(d) assessment we recommend review of MDNR web-based information, consultation with local resource managers and visits to some lakes in question to help determine what the most appropriate characterization might be.

Notes from these reviews are assembled in a memorandum that summarizes the lake assessment process for the specific (e.g. 2006 list). In these assessments we will note those waterbodies that appear to be classed as wetlands by the PWI and share related information from these other sources. Where this "weight of evidence" suggests that the waterbody is a lake we will include it on the draft list. In contrast, if the lake is listed as "LW" and there is no readily available information to suggest otherwise we will exclude it from the final draft list; however this will be documented in the memorandum so there is some record of this decision. Even with this additional level of scrutiny we may find that a "lake" on the list is more accurately characterized as a wetland and we will allow this to be addressed during the public comment period.

f) Additional assessment factors: evidence of toxic blue-green algae.

The bases for assessing lakes for impairment due to eutrophication are the narrative water quality standards and assessment factors in Minn. R. pt. 7050.0150. The most relevant part, Minn. R. pt. 7050.0150, subp.5 is quoted below: Subp. 5. *Impairment of water due to excess algae or plant growth*. In evaluating whether the narrative standards in subpart 3, which prohibits any material increase in undesirable slime growths or aquatic plants are being met, the commissioner will use all readily available and reliable data and information for the following factors of use impairment, including "D. any other scientifically objective credible, and supportable factor."

As such, we have proposed listing of lakes with evidence of toxic blue-green algae blooms as a basis for listing a lake as evidence of impairment of uses. It has been clearly established that blue-green algae prosper in nutrient-rich environments and are the primary form of algae that causes most problems with aquatic recreation. While we cannot readily predict whether a given bloom will be toxic, there are some factors that should be taken into account in lake assessments for nutrient-impairment. These factors can include:

- actual testing of waters (algal bloom material) for toxins including: Microcystin, Saxitoxin, Anatoxin and any other toxins shown to be associated with blue-green algae blooms. Test results must clearly demonstrate elevated levels of these toxins relative to some objective standard or guideline; and
- documented animal death, fish kills or other related event that may be traceable to blue-green algal toxins. An example was the case of dog deaths on Fish Lake in Kanabec County and Lake Benton in Lincoln County in 2005. In each instance the dog had contact with water where severe blue-green algae were evident. Death was very rapid and in at least one instance an autopsy was conducted and results were consistent with toxins associated with blue-green algae. Supporting data on TP and chlorophyll-a are commonly available as well that help to establish the trophic status of the lake.

In the case of either of the above any available data for the lake will be considered and if TP and one of the response variables are above listing thresholds the lake will be included on the draft 303(d) list.

8. *Summary*

A methodology has been developed for assessing the trophic status of culturally-eutrophied lakes in Minnesota. This methodology uses ecoregion-based total phosphorus, chlorophyll-a and Secchi disk impairment thresholds, and other relevant eutrophication guidelines. The assessments will use all the available and reliable lake data and will consider the morphometry, mixing status and other relevant factors that effect trophic status in individual lakes. The thresholds in this Guidance may change in the future as eutrophication guidelines for Minnesota's lakes are promulgated in Minn. R. ch. 7050.

The assessments of swimmable use support are used for Minnesota's 305 (b) report and the 303(d) list of impaired waters. Several features differentiate assessments for the 305(b) report from assessments for 303(d) listing. The 303(d) assessments require:

- Minimum data requirements of 12 TP, 12 chlorophyll-a and 12 Secchi measurements [with case-by-case exceptions;
- The reliance on data collected in the most recent 10 years (referred to as "monitored" in the 305(b) and Lake Water Quality Assessment reports);
- Use of data for both causal and response variables; and
- Opportunity for more detailed site-specific data review prior to making an impairment decision for 303(d) listing.

Figure 1. Map of Minnesota's Ecoregions

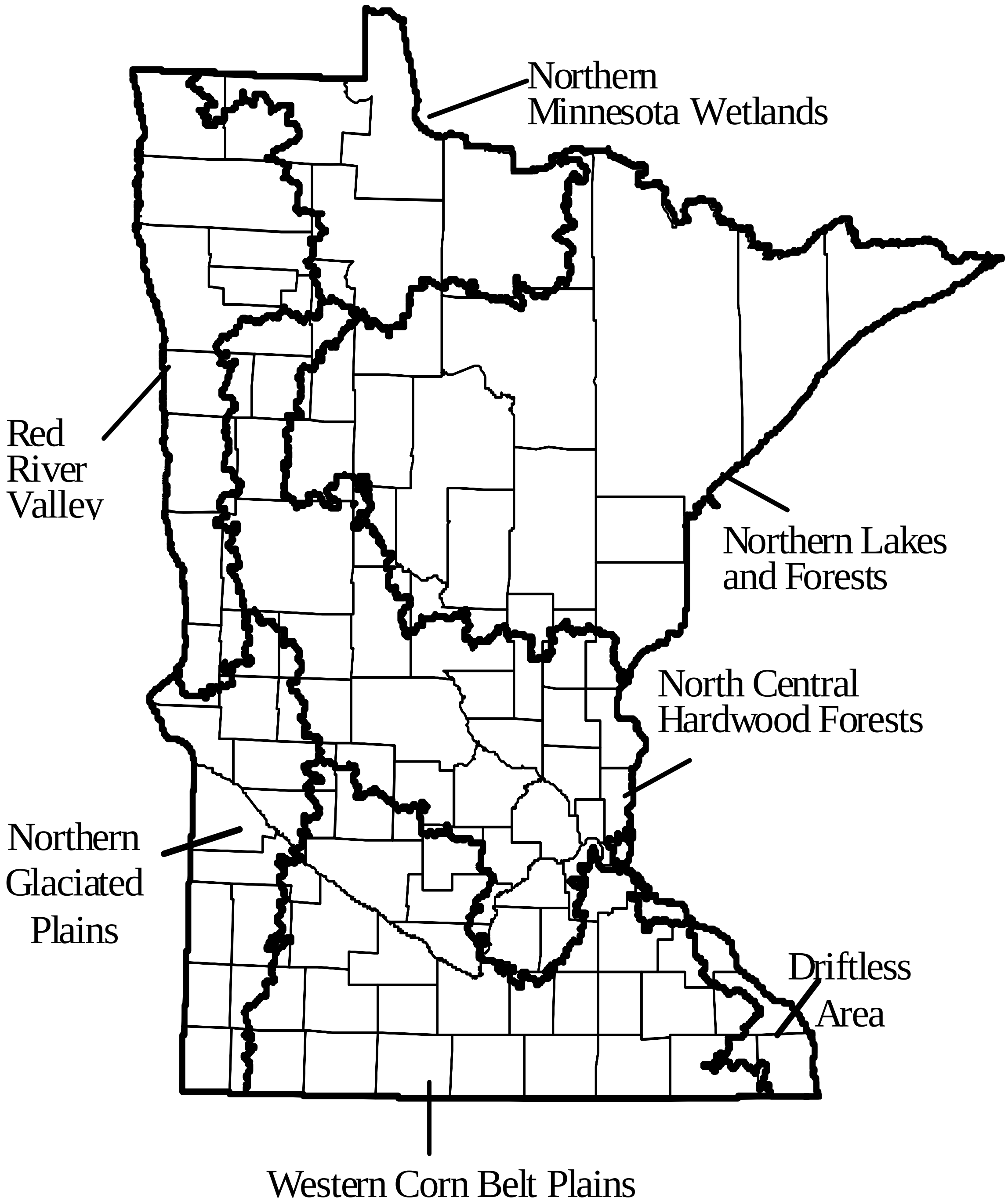


Figure 2a. Total Phosphorus and Chlorophyll-a Scatterplots For Ecoregion Reference Lakes (in ppb).

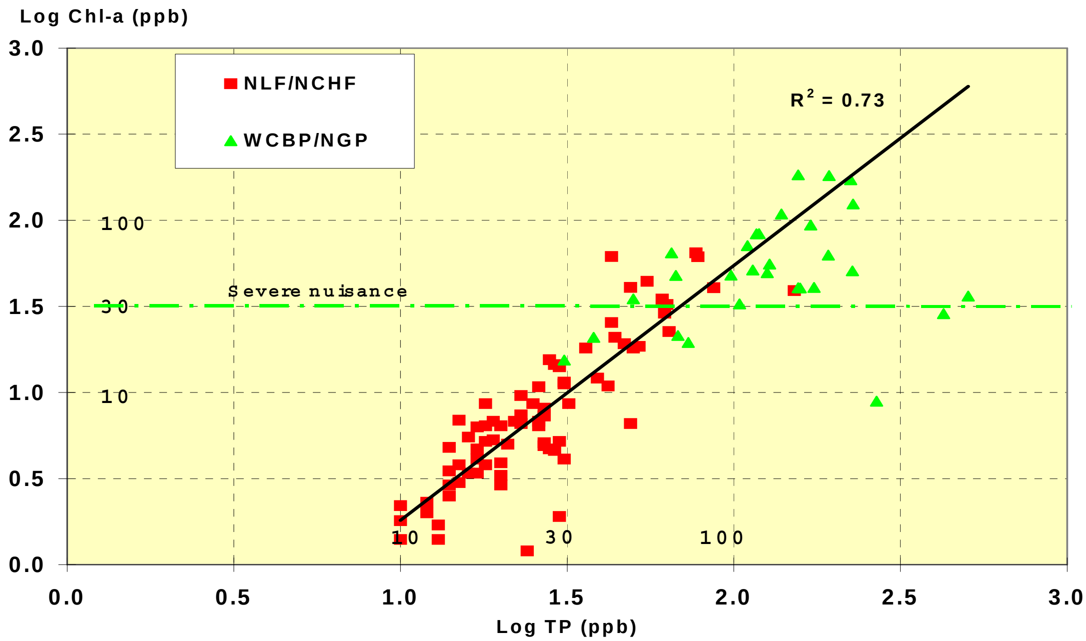


Figure 2b. Chlorophyll-a and Secchi Transparency Scatterplots for Ecoregion Reference Lakes.

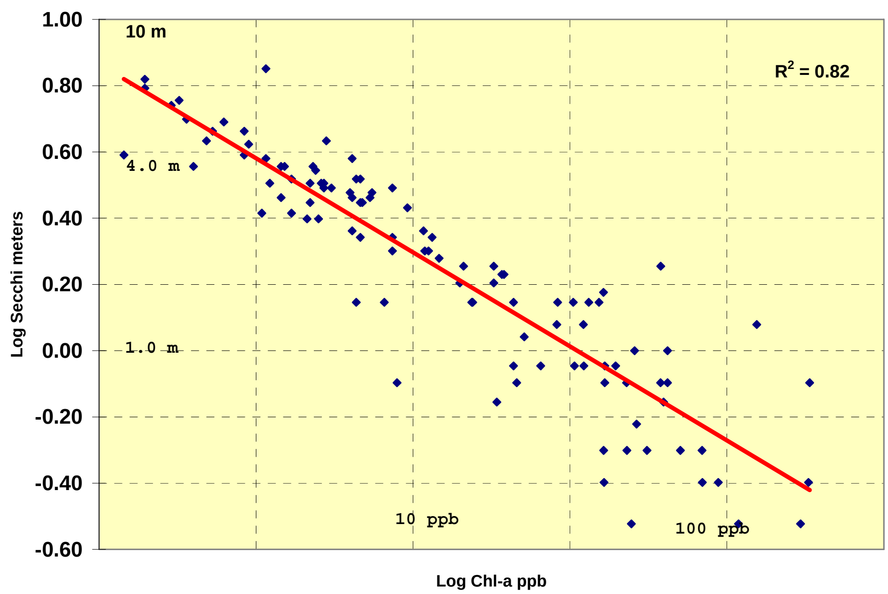
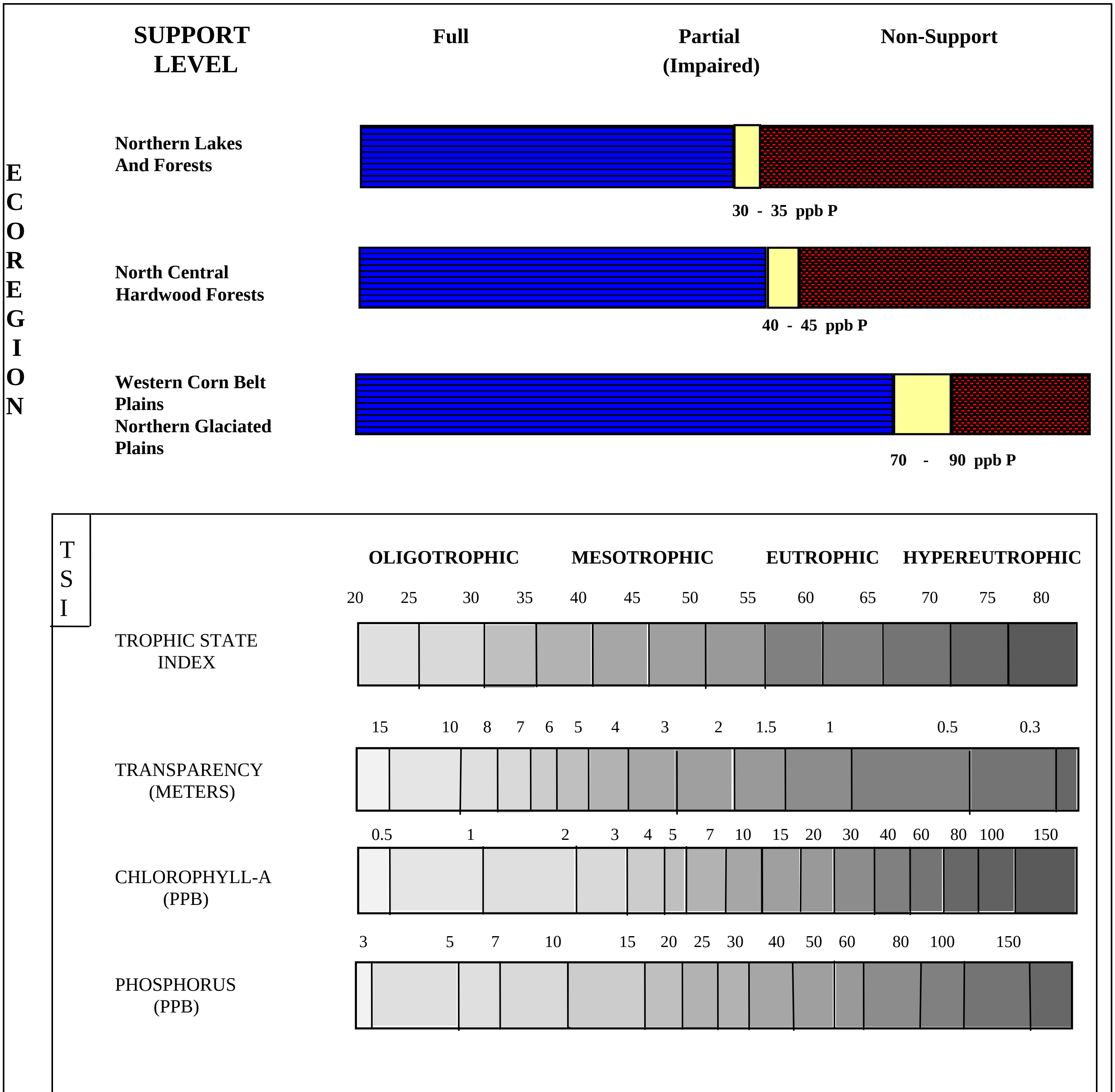


Figure 3. MPCA's Swimmable Use Support Classification for Lake Assessments Relative to Carlson's Trophic State Index by Ecoregion.



Carlson's TSI box from: Moore, L. and Thorton, K. [Ed.] 1988. Lake and Reservoir Restoration Guidance Manual. U.S. Environmental Protection Agency. EPA 440/5-88-00.

Figure 4. Chlorophyll-a Interval Frequency as a Function of Summer-mean Chlorophyll-a and Summer-mean Total Phosphorus.

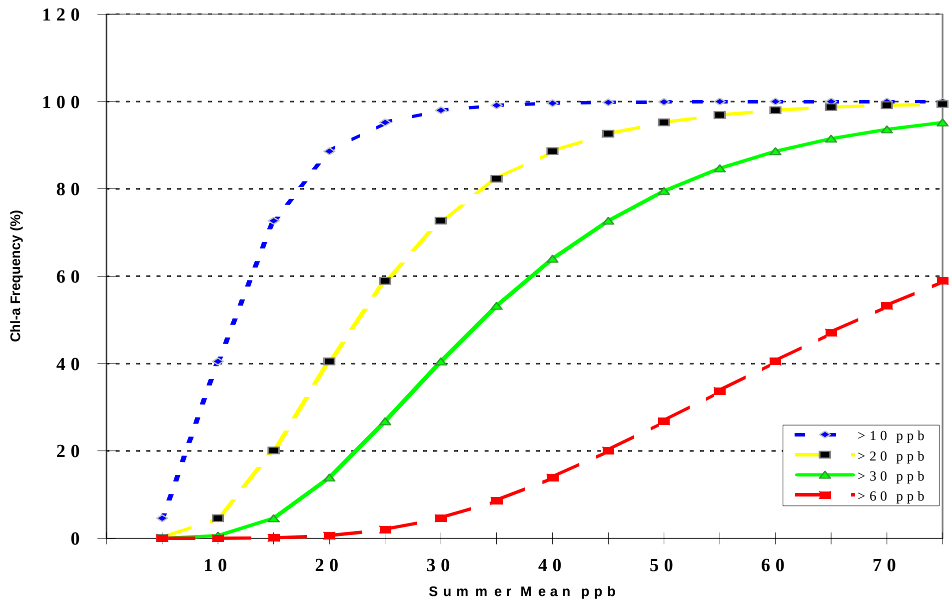


Figure 5. Chlorophyll-a Interval Frequency Versus Total Phosphorus.

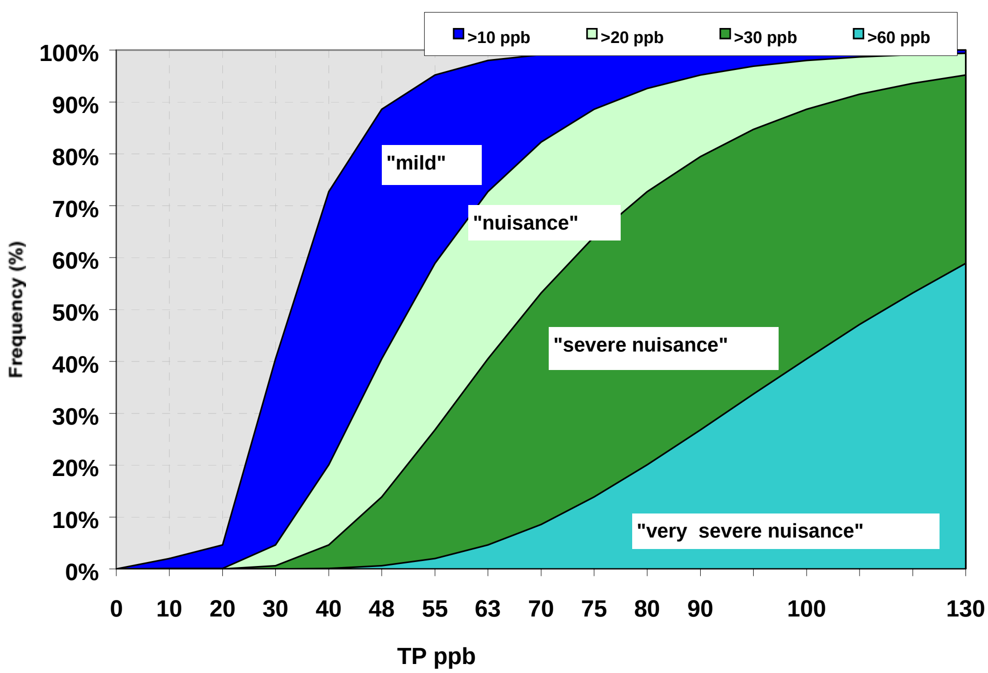


Figure 6. Impairment Determination Decision Tree For Lakes Impacted By Excess Nutrients

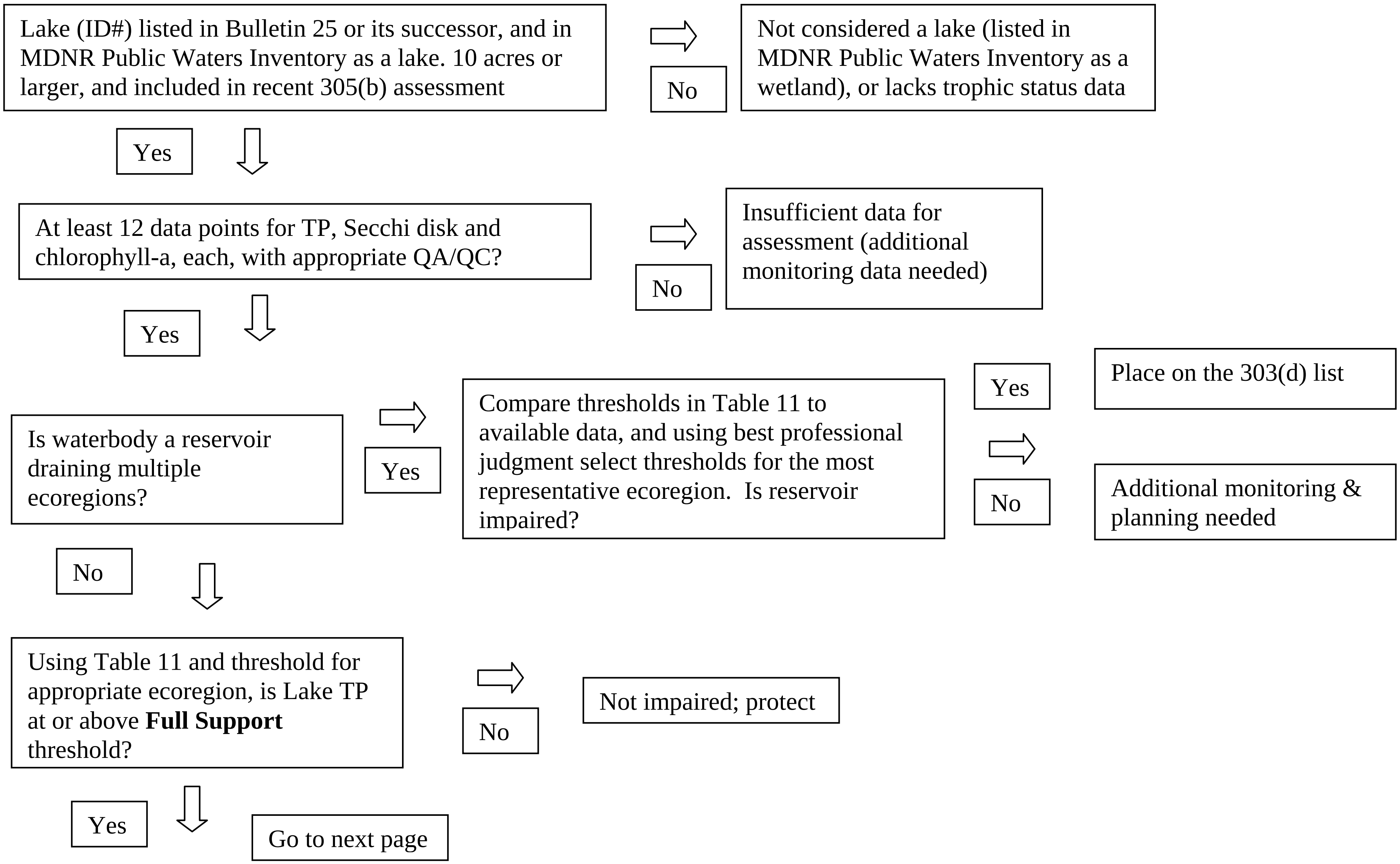
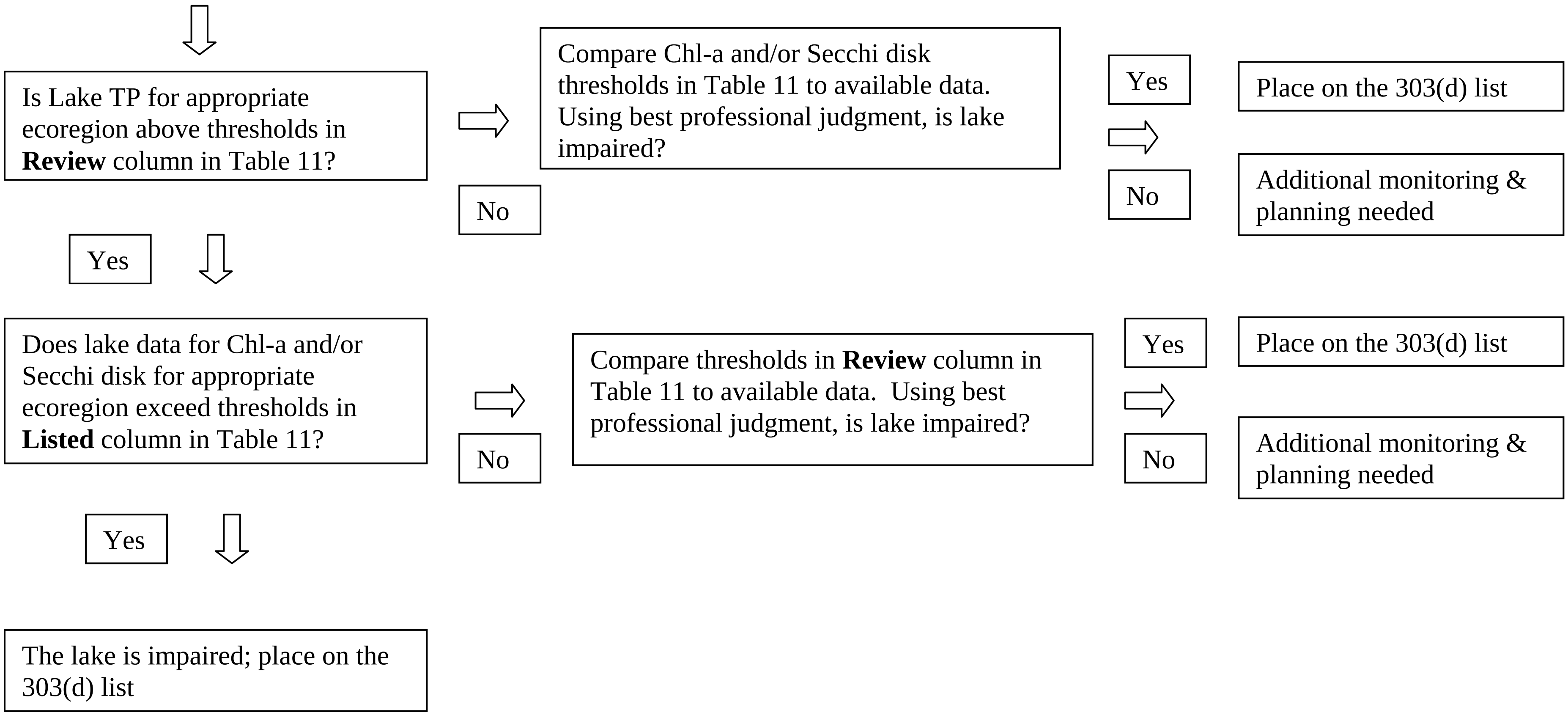


Figure 6. Impairment Determination Decision Tree for Lakes Impacted by Excess Nutrients, Continued



B. IMPAIRMENT OF THE BIOLOGICAL COMMUNITY

1. *Introduction*

The presence of a healthy, diverse and reproducing aquatic community, including invertebrates and plants as well as fish, in a waterbody is a good indication that pollutant concentrations are below levels that would measurably stress the community. The health of the aquatic community can be measured using standardized sampling and assessment tools. Ideally, if the community is found to be healthy, it would indicate as well that pollutant levels are below water quality standards. However, in some situations one or more water quality standard may be exceeded and the biological community still shows no impairment. This may be due to properties in the water that tend to mitigate the toxic effects of a pollutant that the water quality standard does not account for.

The opposite situation can occur as well, i.e., chemical analyses show no impairment and bio-monitoring does. Nevertheless, biological monitoring (bio-monitoring) is a direct means to assess aquatic life use support. The aquatic community tends to "integrate" the effects of pollutants over time because excessive pollutant concentrations on one day may be manifested by some or all members of the community for weeks, months or longer. In contrast, a water sample taken for chemical analysis only indicates the conditions at that moment. For this reason, biological, chemical and physical data will be carefully assessed together by professionals using a weight of evidence approach when determining impairment (see Section V.E.3, page 26).

The MPCA is using water quality assessment indices of biotic integrity (defined below) based on fish and invertebrate communities in rivers and streams, and invertebrate and plant communities in wetlands. Sampling fish communities in lakes is done by the Department of Natural Resources as part of their responsibility to manage a sport fishery and is outside the scope of the MPCA bio-monitoring program.

2. *Basis for Assessment of Biological Community – Narrative Standards*

The basis for assessing the biological community for impairment is the narrative water quality standards and assessment factors in Minn. R. pt. 7050.0150. The most relevant part, Minn. R. pt. 7050.0150, subp. 6 is quoted below:

> *Subp. 6.* ***Impairment of biological community and aquatic habitat.*** *In evaluating whether the narrative standards in subpart 3, which prohibit serious impairment of the normal fisheries and lower aquatic biota upon which they are dependent and the use thereof, material alteration of the species composition, material degradation of stream beds, and the prevention or hindrance of the propagation and migration of fish and other biota normally present, are being met, the commissioner will consider all readily available and reliable data and information for the following factors of use impairment:*
>
> *A. An index of biological integrity calculated from measurements of attributes of the resident fish community, including measurements of:*

(1) species diversity and composition;
(2) feeding and reproduction characteristics; and
(3) fish abundance and condition.

B. An index of biological integrity calculated from measurements of attributes of the resident aquatic invertebrate community, including measurements of:

(1) species diversity and composition;
(2) feeding characteristics; and
(3) species abundance and condition.

C. An index of biological integrity calculated from measurements of attributes of the resident aquatic plant community, including measurements of:

(1) species diversity and composition, including algae; and
(2) species abundance and condition.

D. A quantitative or qualitative assessment of habitat quality, determined by an assessment of:

(1) stream morphological features that provide spawning, nursery, and refuge areas for fish and invertebrates;
(2) bottom substrate size and variety;
(3) variations in water depth;
(4) sinuosity of the stream course;
(5) physical or hydrological alterations of the stream bed including excessive sedimentation;
(6) types of land use in the watershed; and
(7) other scientifically accepted and valid factors of habitat quality.

E. Any other scientifically objective, credible, and supportable factors.

A finding of an impaired condition must be supported by data for the factors listed in at least one of items A to C. The biological quality of any given surface water body will be assessed by comparison to the biological conditions determined for a set of reference water bodies which best represents the most natural condition for that surface water body type within a geographic region.

Additional language supporting the use of narrative water quality standards in wetlands is found in Minn. R. Ch. 7050.0222, subp. 6, which defines the protection of class 2D waters (wetlands) as follow:

> *"The quality of Class 2D wetlands such as to permit the propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats. Wetlands also add to the biological diversity of the landscape. These waters shall be suitable for boating and other forms of aquatic recreation for which the wetland may be usable. This class of surface water is not protected as a source of drinking water. …"*

The aquatic life use support assessment methodology described in this Guidance fully supports this narrative standard and protects the biological integrity of rivers, streams, and wetlands by:

- Measuring attainment directly through sampling of the aquatic biota
- Controlling biological and sampling variability through regionalization, classification and strict adherence to sampling protocol
- Establishing impairment thresholds based on data collected from reference (minimally impaired) waters of the same class, and
- Incorporating a confidence limit (based on the repeatability of the IBI) to account for variability within the aquatic community due to natural spatial and temporal differences and sampling or method errors.

3. *Index of Biological Integrity and Reference Conditions*

a) <u>Introduction</u>

The MPCA uses an index of biological integrity (IBI) as an initial biological impairment determinant for rivers and streams. The IBI is one of the most common and widely accepted analytical tools used to measure the integrity of aquatic communities. The IBI relies on multiple attributes of the aquatic community, called “metrics”, to evaluate a complex biological system. Each metric is based upon a structural (e.g., species composition) or functional (e.g., feeding habits) aspect of the aquatic community that changes in a predictable way in response to human disturbance.

The IBI incorporates professional judgment in a systematic and sound manner but sets quantitative criteria that enable determination of a continuum between very poor and excellent biotic conditions. Since the metrics are differentially sensitive to various perturbations (e.g. siltation, toxic chemicals, etc.) as well as various degrees or levels of change within the range of integrity, conditions at a site can be determined with considerable accuracy. Table 12 shows an example of the fish community metrics used to evaluate small streams in the St. Croix River basin (Niemela and Feist 2000).

For the IBI to be effective in detecting disturbances due to human influence it is necessary to identify and partition the factors that contribute to natural variability (Fausch et al. 1984). On a regional scale, differences in climate, topography, geology and other geophysical characteristics of an area influence aquatic communities. On a reach or wetland level scale, factors such as stream or wetland size and temperature may influence aquatic communities. For this reason it is necessary to classify waterbodies into distinct groups (e.g. small warm water streams, depressional wetlands) and develop different IBIs for separate regions of Minnesota and for different waterbody types. It is not necessary, nor is it possible, to eliminate all of the variability within the IBI due to natural occurring factors. Instead, the variability must be quantified and decisions concerning resource integrity must take into account the natural variability that is not captured through the classification process.

Table 12. Scoring Criteria for Nine Metrics Used to Calculate IBI Scores for Fish Communities in Small Streams, 20 to 54 Mi^2 Drainage Areas.*

Metric For Fish Communities**	**Numeric Score Assigned to Condition:**				
	10	**7**	**5**	**2**	**0**
Species Richness and Composition Metrics					
Total number of species	15 or more	12-14	9-11	6-8	0-5
Number of intolerant species	4 or more	3	2	1	0
Number of minnow species***	6 or more	5	3-4	2	0-1
Percent tolerant species	0-40	41-55	56-70	71-85	86-100
Percent dominant two species	0-44	45-58	59-72	73-86	87-100
Trophic Composition and Reproductive Metrics					
Number of benthic insectivore species	4	3	2	1	0
Percent simple lithophils	49-100	37-48	24-36	13-24	0-12
Abundance and Condition Metrics					
Number of fish per 100 meters***	11 or more				0-10
Percent DELT anomalies	0-1		2-3		< 3

*The sum of the 9 metrics for headwater streams must be multiplied by 1.11 to obtain the final IBI score (0 to 100 point scale).
**Definitions:
Benthic insectivore means fish that feed on insects living in or on the bottom substrate.
Lithophil means fish that prefer large substrates as a place to live and reproduce.
DELT means Deformities, Eroded fins, Lesions or Tumors.
***Number of minnow species and number of fish per 100 meters metrics do not include tolerant species.

b) Sampling Methods and Reference Conditions

The stream fish community is sampled using widely accepted procedures. For the fish community assessments all wadable streams are sampled following procedures outlined in Lyons (1992). Fish community sampling in unwadeable streams follows USGS guidance (Meador, et al. 1993).

The stream invertebrate community is sampled using a multi-habitat method similar to that used by the Florida Department of Environmental Protection (Barbour et. al., 1996). Invertebrates are not currently sampled in unwadable streams.

In depressional wetlands the invertebrate community is sampled using activity traps and a standardized dipnet method in the nearshore emergent zone. Emergent vegetation is sampled in the nearshore zone using standard plant community releve sampling methods. (Gernes and Helgen 1999).

The MPCA uses a regional reference site approach to develop and calibrate the IBI for specific regions of Minnesota (Hughes 1995, EPA 1996). The selected reference sites represent a specific region of Minnesota within a specified waterbody class. Properly defined reference conditions provide a benchmark for comparison to measure the degree of water quality degradation. The term "reference" denotes sites that are least impacted by human influence. Reference sites are not necessarily pristine, and in fact rarely are. Many reference sites reflect at least a small degree of impairment resulting from centuries of settlement and land use. The following land use characteristics are used to help guide the reference site selection process. In the process of locating reference sites an attempt is made to meet as many of the following criteria in the sampling site as possible.

Streams:

- Land within the watershed is primarily in a natural state (forest, wetlands, meadow).
- Stream morphology (i.e., riffles, runs, pool sequence) in the stream reach and upstream watershed is in a natural condition (e.g., the stream has not been channelized or dredged).
- Continuous riparian area within the upstream watershed and along the reach (e.g., land use is consistent laterally, soils and vegetation are undisturbed).
- Stream fish community has not been altered through stocking of forage or game fish species or chemically treated to remove rough fish.
- No point source discharges, ditches or drainage canals within the watershed and sampling site.
- Stream morphological characteristics in stream reach representative of upstream and downstream reaches.
- No stream habitat "improvements" within the stream reach (i.e., wing dams, rip rap, etc.)
- Reach has not been snagged (e.g., removal of woody debris to promote drainage)
- No dams or diversions upstream or downstream, or if present not within two replications of major morphological units (i.e., riffles, runs, pool sequence).
- No bridges upstream of the reach, or if present within the watershed not within two meander cycles or two replications of major morphological units.

Wetlands:

- No history of drainage, filling, or excavation activities within the natural extent of the wetland
- Well buffered by natural vegetation around the perimeter of the wetland
- No direct discharges from municipalities or industries

- No indication of recent silvicultural activities within the drainage area.
- No agricultural runoff, and no direct runoff from deicing compounds from streets or highways
- No history of aquaculture, including fish rearing or stocking.
- No known history of or ongoing active pesticide (e.g, mosquitoes), herbicide, or algacide treatments within the wetland or watershed.

In addition to reference sites, the sites selected for development of an IBI must span a gradient or range of disturbance from minimal to severe (Karr and Chu 1999). Land use information is used during the site selection process to identify the potential impairment level of each site. Human disturbance within the watershed of each site is quantified by examining geographical information within the watershed concerning land use, riparian vegetation, point source discharges, feedlots, and ditching. Habitat information collected at each stream site is used to examine in-stream disturbance factors.

c) Impairment Threshold Defined by Narrative Description of Fish Community

Karr et al. (1986) provides a narrative description (e.g., excellent, good, etc.) of the fish community along the IBI scoring range (Table 13). The narratives describe the general attributes of the fish community in moderately sized (3 to 10 meter wide) warm water streams. The scoring range for each class and the narrative descriptions that describe each class are appropriate for similar type streams in Minnesota but do not necessarily apply to other stream classes (i.e., cold water streams, headwater streams).

With the inception of the bio-monitoring program in the 1980s, the first watersheds to be assessed were the Minnesota River Basin (Bailey et al. 1992) and the Red River basin (Niemela et al. 1998). The IBI scores developed for these first two basins are based on the scoring system employed by Karr (1981). In Karr's (1981) system, the IBI scores range from 12 to 60 (shown in Table 13). IBI scores showing an "excellent", "good" or "fair" fish community are considered indicative of support of the aquatic life use. The narrative guidelines from Karr et al. (1986) shown in Table 13 have been superseded by IBI thresholds based on reference site conditions (described below). The MPCA will continue to use the Karr threshold levels to make use support determinations for these watersheds until they can be revisited.

d) Reference Site-based IBI Thresholds

The MPCA bio-monitoring and assessment methods have evolved and matured as the program has gained experience and acquired more data from a range of watersheds and ecoregions in Minnesota. Beginning in the St. Croix River basin in 2000, the MPCA began developing IBI scores for stream fish and invertebrate communities based on a zero to 100 point scoring system. The rationale for switching to the 100 point system was that it was more understandable to people not familiar with the IBI. The IBIs developed for invertebrate and plant communities of wetlands in the North Central Hardwood Forest Ecoregion in 1999 originally used a 10 to 50

point scoring system. This scoring system has been applied to all wetland sampled through 2001.
Subsequently, the metric scoring procedure has been modified such that wetland IBIs are now also based on a zero to 100 point scoring system.

Table 13. Guidelines for Interpreting Overall Fish Community IBI Scores Using the 60 Point System, from Karr et al. 1986.

Overall IBI Score: 60 Point System	**Biological Integrity Rating**	**Fish Community Attributes**
60-51	Excellent	Comparable to the best situation with minimal human disturbance; all regionally expected species for habitat and stream size, including the most intolerant forms, are present with a full array of age and size classes; balanced trophic structure
50-41	Good	Species richness somewhat below expectations, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundance, or size/age distributions; trophic structure show signs of imbalance
40-31	Fair	Signs of additional deterioration include decreased species richness, loss of intolerant forms, reduction in simple lithophils, increased abundance of tolerant species, and/or highly skewed trophic structure (e.g., increasing number of omnivore species and less specialized feeding species); older age classes of top carnivores rare or absent
30-21	Poor	Relatively few species; dominated by tolerant forms, habitat generalists, and omnivores; few or no top carnivores or simple lithophilic spawners; growth rates and condition factors sometimes depressed; hybrids sometimes common
20-12	Very poor	Very few species present, mostly tolerant forms, hybrids, or exotics; few large or older fish; DELT fish sometimes common
No Score	Very poor	Thorough sampling finds few fish or no fish; impossible to calculate an IBI

DELT means fish with deformities, eroded fins, lesions, or tumors

In the new method impairment thresholds are based on the **range of IBI scores measured at the reference sites** within each stream class. The reference site data are used to define impairment thresholds that are more appropriate for each class of waterbody being considered. For example, in cool water streams in the St. Croix River basin the bottom of the range of IBI scores for very small (0-20 mi^2 drainage area), small (20-55 mi^2 drainage area), and moderate sized streams (55-270 mi^2 drainage area) are 46, 68, and 69 respectively (Figure 7). The lowest IBI score in the range of all IBI scores measured at reference sites is an appropriate threshold limit for biogeographically similar areas of the state because reference streams or wetlands within similar regions are likely to exhibit similar departures from pre-settlement conditions. This departure, or lack there of, in reference sites shows what can be expected in a least impacted condition for a given area.

As in the example above, the rivers and stream of the St. Croix River basin are relatively unimpacted by human activities. However, for other regions in Minnesota, the threshold IBI may need to be adjusted upward (i.e., an IBI score within the range of all reference site IBI scores) to take into consideration the degree that the reference sites within the region have already been impaired. For example, Ohio EPA uses the lower 25th percentile from the range of IBI scores measured at reference sites as an appropriate threshold level given the amount of disturbance that has taken place at their reference sites (Ohio EPA 1988). Use of the 25th percentile of the IBI range, or other percentile value, may be appropriate for some Minnesota watersheds. The MPCA will make these threshold determinations as additional watersheds are monitored and data from several watersheds can be compared. Professional judgment teams will be part of this process.

An error term is calculated around the selected reference site-based threshold IBI (Figure 8). The error term delineates a range in IBI scores that fall within the 95 percent confidence limits. The error term is generated from replicate samples. The confidence limits account for variability due to natural temporal changes as well as method error. Figures 8a and 8b show the same IBI impairment thresholds shown in Figure 7 for the St. Croix basin streams, but with the 95 percent confidence limits around the thresholds, in the context of land use and habitat ratings. As the MPCA reference site data base expands to include sites from different time periods, the confidence limits may be reduced or eliminated altogether.

4. *Data Requirements and Determination of Impaired Condition*

Biological data are used to assess stream reaches for impaired biological conditions for both the 305(b) report and the 303(d) list. The period of record is the most recent decade of data and information. Biological assessments can be based on a single biological monitoring event on a given reach.

Table 14 shows the IBI thresholds for the use support categories for the 60-point scale, the 100-point scale, and the reference site methods. Sites that have IBI scores above the threshold level of impairment are considered to be **fully supporting** of aquatic life. Sites that have IBI scores below the threshold level of impairment are considered **non-supporting** of aquatic life.

As stated, the narrative guidelines from Karr et al. (1986) shown in Table 13 were used as threshold levels to indicate impairment of streams in the Red and Minnesota River basins. Sites that scored in the “poor” or “very poor” range are listed as **non-supporting** for purposes of 305b reporting and 303(d) listing. This conservative impairment threshold was used in the earlier stages of IBI development before enough data had been collected at reference sites to switch to a more refined method. Sites with IBI scores that fall within the “poor” or “very poor” narrative classes have significantly **impaired** aquatic communities. The MPCA will continue to use this threshold level to make use support determinations of streams for these watersheds until they can be revisited.

As described above, 95 percent confidence limits have been applied to reference site-based IBI impairment thresholds (Figure 8). Sites with IBI scores above the 95 percent confidence limit are very likely to be un-impaired and those with IBI scores below the 95 percent confidence limit are very likely to be impaired. Sites with IBI scores within the confidence limits will be further evaluated by professional judgment teams. A **partial support** status may be assigned to a stream segment or wetland if multiple samples taken at sites within the segment or wetland provide discrepant information (i.e. some sites are considered supporting and others are non-supporting). Those reaches or wetlands that are non-supporting or partially supporting of their aquatic life uses are identified as candidates for the 303(d) list.

Following the initial assessment based on the IBI scores, a final determination of impairment for 303(d) listing is based on an assessment of all available information. This information includes habitat quality, available water chemistry data, the biological condition of nearby upstream and downstream segments or nearby or adjacent wetlands, local land use information, and other watershed data. The MPCA will present this information to the appropriate professional judgment group for the basin in which the reach is located to help make final determinations on use support for 303(d) listing.

5. *Listing of impaired wetlands*

The Agency is planning to list impaired wetlands in the 2008 listing cycle, but believes that it needs to communicate with and receive input from key stakeholders first. The Agency also needs to better understand how wetland biological TMDL pollution reduction plans can be achieved through the use of US EPA’s Stressor Identification Guidance Manual. A very detailed Wetland Listing Timeline is included as Appendix E. This coordinated effort will involve several Divisions of the Agency; in addition numerous key external coordination groups will be utilized – the Clean Water Legacy work groups and the Interagency Wetland working group.

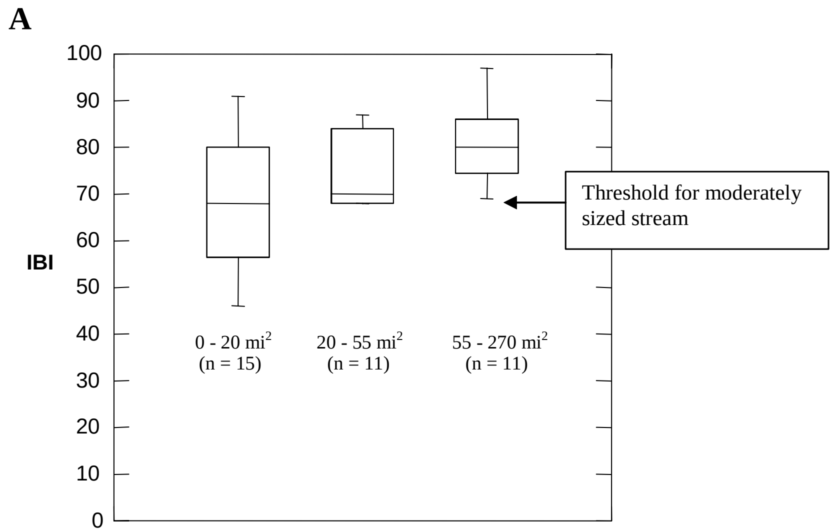
The Wetland Listing Timelines consist of developing a Communication/Education Plan, developing pilot study wetland TMDL plans for both agricultural and urban settings, developing TMDL restoration scenarios based on the pilot study wetland TMDLs, and, finally, developing the draft list of impaired wetlands based on the Guidance Manual and the lessons learned from the pilot studies.

Table 14. Summary of Data Requirements and IBI Thresholds for Assessment of biological Communities.

Impairment Assessment For	**Period of Record**	**Minimum No. of Data Points**	**Use Support or Listing Category Based on IBI Score**		
IBI Thresholds for streams defined by narrative description of the fish community→ (Old method, Red and Minnesota Rivers)			**Excellent, Good or Fair**	**Multiple sites in a stream segment give discrepant results**	**Poor or Very Poor**
IBI Thresholds for streams and wetlands defined by the reference condition → (New method; e.g., St. Croix River)			**IBI ≥ impairment threshold***		**IBI < impairment threshold***
305(b) Report	Most recent 10 years	na	Fully Supporting	Partially Supporting	Not Supporting
303(d) List (TMDL)	Most recent 10 years	na	Not Listed	Listed**	Listed

* impairment threshold is based on IBI scores from regional reference sites. Threshold levels are dependent on region, stream size and stream or wetland classification
(see text).
** Following review by professional judgment team.
na = Not applicable

Figure 7. Box Plots of IBI Scores for Reference Streams, Showing Use Support and Impairment Thresholds at Lower End of IBI Range, for Three Stream Size Classes in the St. Croix River Basin for A) fish and B) inverts. Box plots Show the Median (50th Percentile), Upper Quartile (75th Percentile), Lower Quartile (25th Percentile), Maximum and Minimum. (Text box points to impairment threshold for moderately sized stream as an example.)



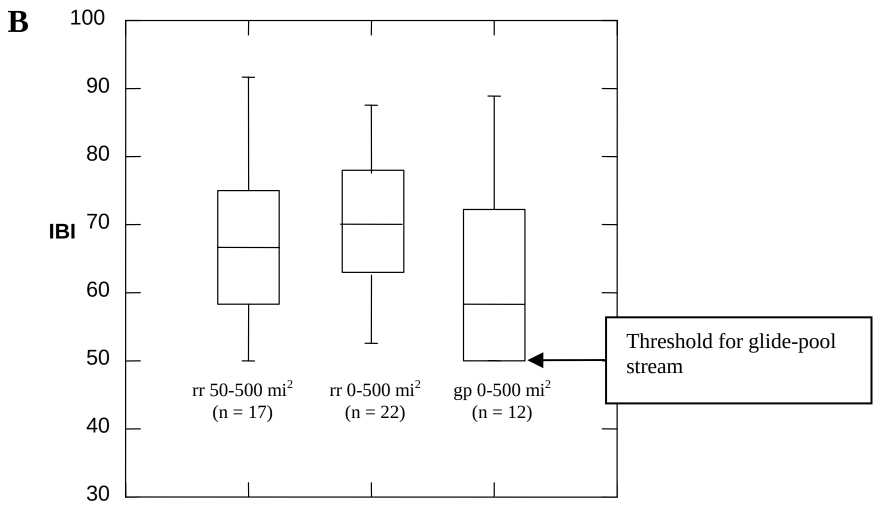


Figure 8a. Impairment Thresholds for: A. Very Small (0-20 mi^2), B. Small (20-55 mi^2), and C. Moderate (55-270 mi^2) Streams in the St. Croix River Basin. Open Ovals Represent IBI Scores for Individual Sampling Sites. Horizontal Dotted Line is IBI Impairment Threshold for Each Size Class. Shaded Area Represents 95% Confidence Limit around Impairment Thresholds.

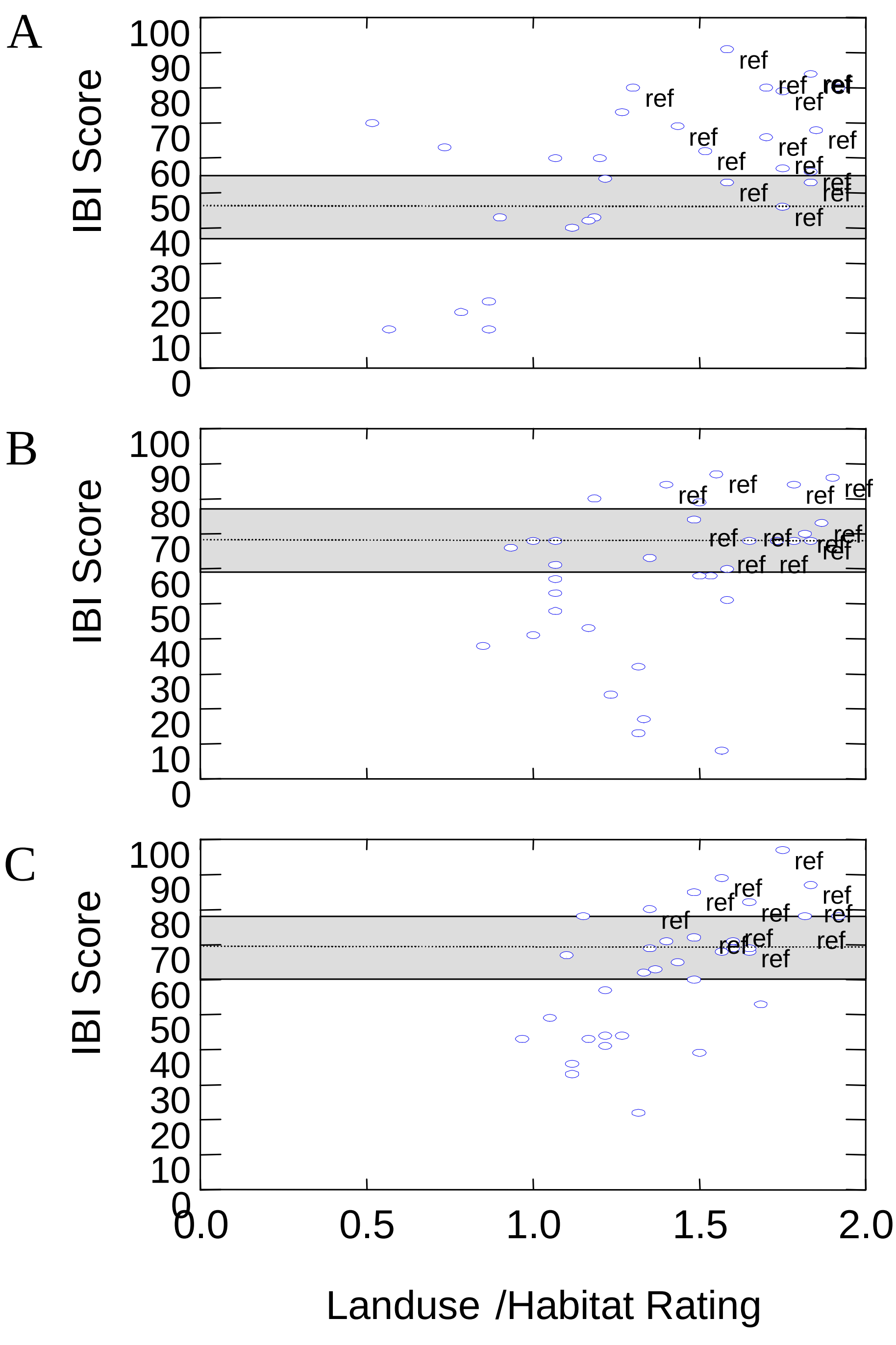
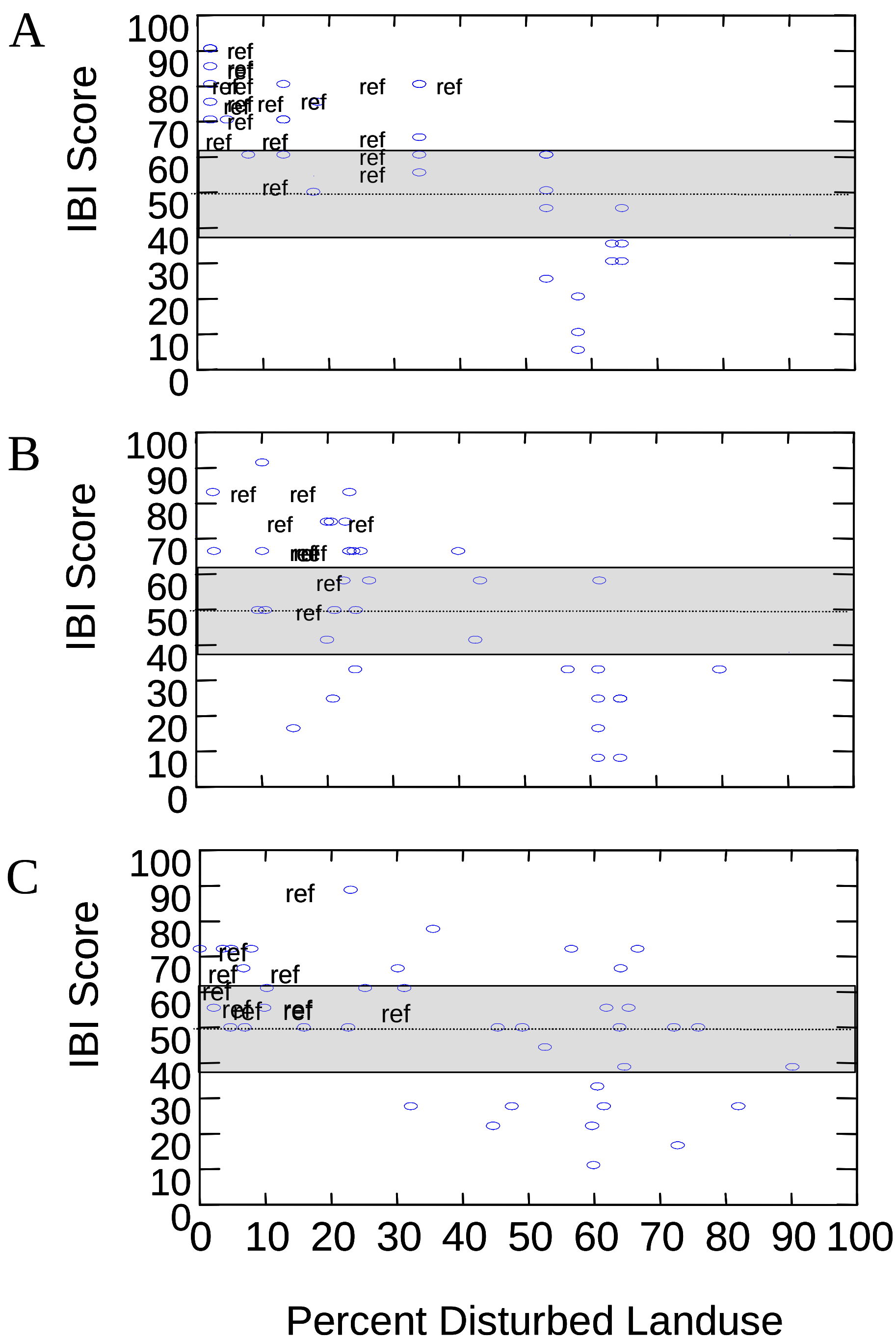


Figure 8b. Impairment Thresholds for: A. Small riffle-run (0-50 mi^2), B. Large riffle-run (50-500 mi^2), and C. Glide-pool (0-500 mi^2) Streams in the St. Croix River Basin. Open Ovals Represent IBI Scores for Individual Sampling Sites. Horizontal Dotted Line is IBI Impairment Threshold for Each Size Class. Shaded Area Represents 95% Confidence Limit around Impairment Thresholds.



C. CONTAMINANTS

1. *Introduction and Fish Consumption Advice*

In the context of water quality standards, support of the aquatic life beneficial use means that the concentrations of toxicants in water must be low enough that:

- The aquatic community is healthy, diverse and successfully reproducing, and
- The fish and other aquatic organisms are safe for people and wildlife to eat.

In the context of the 305(b) report and 303(d) list assessments, however, the acceptability of fish for human consumption is considered a beneficial use **separate from** aquatic life use support. This is because the two uses are assessed independently; i.e., a waterbody may be impaired for one but not the other. In other words, toxicants may be at levels that have no ill effects on aquatic life (fully supporting), but due to bioaccumulation, the fish are not safe to eat (impaired). Also, very different data and protocols are used in the assessments. Impairment due to fish contaminants has been discussed in a narrative section of recent 305(b) reports (1996 – 2002) to provide information to the public. Individual waterbodies impaired due to fish contaminants were included in the 2002 303(d) list.

This Section deals with the assessment of fish for human consumption based on fish contaminant data. The data used in the MPCA assessments is the same data used by the Minnesota Department of Health (MDH) to issue the Fish Consumption Advisories.

To ensure the continued good health of people that eat fish in Minnesota, the MDH issues guidelines for how often certain fish can be safely eaten. This is called the Minnesota Fish Consumption Advisory (MFCA) (MDH 2001; in Section XI.B.1 for the MFCA Web site). The MDH, with the help of extensive EPA toxicity and risk assessments for mercury and PCBs, establishes the concentrations of contaminants in fish that trigger the various levels of advice – from “unlimited consumption” to “do not eat”. The MFCA is strictly advisory, the goal being to help people that eat fish make intelligent decisions on which fish to eat and which to avoid. There is nothing mandatory or regulatory about the advice itself. In contrast, the 303(d) list is a list of waterbodies that do not meet legally enforceable water quality standards, and for which a remedial plan may be required. While mindful of these differences in purpose and function of the MFCA and the 303(d) list, the MPCA also feels it is very important to maintain as much consistency as possible between the protocols MDH uses to assess data for the MFCA and the protocols MPCA uses to assess data for determination of impairment.

Consistency is important to facilitate public understanding and acceptance of both assessment processes as well as for scientific reasons. Thus, the MPCA will use the same data analysis procedures and the same fish tissue concentrations that trigger a certain level of consumption advice for the assessment of potentially impaired waters due to fish contaminants. Finally, it is important to emphasize that **one can not assume, because a particular waterbody does not appear on the 303(d) list, the fish in that waterbody are safe for unlimited consumption**.

Most likely it means the fish from that waterbody have not been tested. Only those waterbodies from which the fish have been tested and found to exceed the impairment thresholds will be put on the 303(d) list. The MFCA should be consulted for general advice on fish consumption and health risks (MDH 2001).

The fish contaminant program is a multi-agency program: the MPCA, the Department of Natural Resources, the Department of Agriculture, as well as the Minnesota Department of Health have a role. Minnesota has been collecting fish for mercury and polychlorinated biphenyls (PCB) tissue analysis since the late 1970s. Over the years other bioaccumulative pollutants, such as DDT, dioxins and toxaphene have been analyzed in fish tissue samples, but only at very limited locations where potential problems were suspected. Of the bioaccumulative pollutants that have been monitored in fish, mercury and PCBs are the primary contaminants found at levels of concern to human consumers of fish.

The MFCA and the MPCA fish contaminant assessments deal just with these two pollutants. Fish from some waterbodies may contain both mercury and PCBs. The consumption advice, and the determination of an impaired condition consider both pollutants. The majority of consumption advisories on lakes are due to mercury contamination. Fish from urban lakes seem more likely to have PCB-based consumption advice than fish from non-urban lakes. About 40 percent of the river advisories reflect both mercury and PCB contamination; the rest are due mainly to mercury. Fish contaminant data are also used by the MPCA to determine where site-specific studies are needed, to help identify sources of pollutants, and to look for trends in fish tissue levels.

Contaminants in fish can be a threat to wildlife consumers of fish and other aquatic organisms as well as humans. However, at the time this Guidance was prepared, the MPCA does not have a program to analyze whole fish samples for the purpose of assessing risks to wildlife.

2. *Basis for Assessment of Fish Contaminants – Narrative Standards*

The basis for assessing the contaminants in fish tissue is the narrative water quality standards and assessment factors in Minn. R. pt. 7050.0150, subp. 6 which is quoted below:

> *Subp. 7.* ***Impairment of waters relating to fish for human consumption.*** *In evaluating whether the narrative standards in subpart 3, which prevent harmful pesticide or other residues in aquatic flora or fauna, are being met, the commissioner will use the residue levels in fish muscle tissue established by the Minnesota Department of Health to identify surface waters supporting fish for which the Minnesota Department of Health recommends a reduced frequency of fish consumption for the protection of public health. A water body will be considered impaired when the recommended consumption frequency is less than one meal per week, such as one meal per month, for any member of the population. That is, a water body will not be considered impaired if the recommended consumption*

frequency is one meal per week, or any less restrictive recommendation such as two meals per week, for all members of the population. The impaired condition must be supported with measured data on the contaminant levels in the indigenous fish.

3. *MDH Thresholds for Consumption Advice*

The determination of fish consumption advice and water quality standards for mercury and PCBs can be boiled down to two elements, **toxicity** and **exposure**. Toxicity refers to the harmful effects of the substance on humans at various doses, and exposure refers to the sources of the toxicant to humans. Exposure is discussed in the next Section. To define toxicity both MDH and MPCA rely on the extensive EPA assessments of the toxicity of mercury and PCBs to humans. The end result of these toxicity assessments for mercury (a non-carcinogen) is the "reference dose", and the end result for PCBs (a carcinogen) is a "cancer potency slope". Reference dose, expressed in units of daily dose, is an estimate of the daily exposure to human populations, included sensitive sub-populations, that is likely to be without appreciable risk of deleterious effects over a lifetime.

Cancer potency slope is the upper 95^{th} percentile confidence limit of the slope from a linear non-threshold model of incremental cancer risk, expressed in days times kilogram body weight per milligram of toxicant.

Accordingly, the MDH fish consumption advice and the MPCA impairment determinations are based on the same EPA-derived reference dose and potency slope. A good summary of the toxicity assessment and derivation of the reference dose for mercury is included in the new EPA mercury criterion discussed below (EPA 2001a).

The MDH has established concentrations of mercury and total PCBs in fish tissue that corresponds to meal frequency recommendations. These concentrations are derived using health-based estimates of exposure to mercury and PCBs, through fish consumption that are likely to be without appreciable risk of harmful effects on humans (assuming the advice is followed). The mercury advice of interest to 303(d) listing targets the most sensitive individuals in the population including, but not limited to, children, pregnant women and their fetuses. It is not necessarily protective of hypersensitive individuals. The advice is derived using the best peer-reviewed science available.

The fish tissue mercury and PCB concentrations and corresponding MDH advice categories are shown in Table 15. It is coincidental that the one meal-per-week threshold is 0.2 ppm for both mercury and PCBs. Mercury concentrations in Table 15 are for consumption by the more sensitive sub-population of young children and women of child-bearing age. The concentrations for PCBs apply to all humans.

Table 15. Fish Tissue Concentrations (in ppm) for Levels of Consumption Advice Established by MDH for Mercury and Total PCBs.

Mercury	**Mercury Concentration in Fish, ppm**			
	< 0.05	0.05 - 0.2	0.2 - 1.0	> 1.0
Consumption Advice* →	Unlimited	1 meal/week	1 meal/month	Do not eat

Total PCBs	**Total PCBs Concentration in Fish, ppm**				
	< 0.05	0.05 - 0.2	0.2 - 1.0	1.0 - 1.9	> 1.9
Consumption Advice →	Unlimited	1 meal/week	1 meal/month	1 meal/2 months	Do not eat

*Consumption advice for young children and women of child-bearing age.
Shaded cells indicate consumption advice that corresponds to non-support and an impaired condition.

4. *Selection of Single Fish Meal-Per-Week Impairment Threshold*

The consumption of fish is an important route of exposure of mercury and PCBs to humans. Exposure varies with how often people eat fish and with the levels of PCBs and or mercury in the fish they eat. While the MPCA readily accepts the assessments of mercury and PCB toxicity to humans by the experts within EPA (and MDH), we have departed from EPA policy with regard to assumptions about fish consumption (exposure). This is based on the prevalence and importance of sport fishing in Minnesota. The EPA assumes people eat 17.5 grams per day for purposes of calculating their human health-based aquatic life criteria (EPA 2000b). This generic assumption applies to everybody in the U.S.

Minnesota human health-based water quality standards are calculated assuming people eat **30 grams of fish per day**. Thirty grams per day is the 80^{th} percentile fish consumption rate of sport-caught fish for the angling population based on surveys available in 1989. EPA assumes people eat 17.5 grams per day (EPA 2000b); prior to 2000, EPA assumed 6.5 g/d. EPA assumed 15 g/d (a median value for anglers) for the promulgation of the Great Lakes Initiative in 1995. The MPCA arrived at a value of 30 grams per day in 1989 based on several surveys of the fish eating habits of upper Midwest anglers (not the population as a whole) (MPCA 2000e). Thirty grams per day equals about a **half-pound meal per week** (0.463 pounds/week).

The single fish meal-per-week consumption rate (or 30 g/d) is the basis for all Minnesota human health-based water quality standards in both Minn. R. chs. 7050 and 7052. Therefore, for purposes of assessing support of the “fish consumption” use, that use is judged to be supported if it is safe to eat one fish meal per week (over a life time), consistent with the assumption inherent in the numeric water quality standards. In other words, advice to limit consumption to “no more than one meal-per-week” (or any advise that allows more consumption) is not considered an exceedance of the mercury or PCB water quality standards, and waterbodies with such advice will not be listed as impaired. Advice to limit consumption to less than one meal per week, such as one meal per month, for any member of the population, is an indication of impairment (see Tables 15 and 16).

The surveys from which the 30 g/d value was derived indicate that less than 20 percent of anglers and less than 95 percent of the whole population in the upper Midwest eat more sport-caught fish than one meal-per-week averaged over a lifetime. A more recent survey of fish consumption habits of people living in Minnesota and North Dakota suggests that 30 g/d may be more protective than these earlier surveys indicate (EERC 2001). The 95th percentile consumption rates of sport-caught fish for all Minnesotans with fishing licenses reported in the EERC survey is 30.4 g/d (32.1 g/d in a lognormal distribution).

If reliable data are available to show that localized populations in Minnesota consistently eat more (or less) than 30 g/d, Minn. R. pt. 7050.0222, subp. 8 allows the MPCA to recalculate an existing standard using the local fish consumption data. The resulting site-specific standard may be more stringent or more lenient than the standard based on 30 g/d.

5. *Mercury*

A brief discussion of mercury and a listing of Minnesota's mercury water quality standards can be found in Section VII.B.2. Relevant to the assessment of mercury in fish is the issuance by EPA of a revised human health-based water quality criterion for methylmercury (EPA 2001a). This new criterion is unique among all EPA (Clean Water Act section 304(a)) criteria in that the medium for the acceptable mercury concentration is **fish tissue** rather than water. A fish tissue criterion for mercury is logical because it is fish that are the main source of methylmercury exposure to both humans and wildlife. Also, a tissue-based criterion eliminates the need for a bioaccumulation factor in the criterion calculation which can be a significant source of uncertainty. The new EPA criterion is 0.3 mg/kg (ppm) methylmercury in fish muscle tissue. Since nearly 100 percent of the mercury in fish muscle is methyl mercury, the criterion can be assumed to be a total mercury criterion.

In the determination of the 0.3 ppm criterion, EPA assumes people eat 17.5 grams of fish per day, as mentioned above. If the EPA criterion is re-calculated assuming people eat 30 g/day, the criterion becomes 0.17 ppm. This EPA criterion and the MFCA are both based on the same EPA-derived reference dose of 0.1 μg/kg/day. The difference between the MDH value of 0.2 ppm from Table 15 and the re-calculated EPA criterion of 0.17 ppm, both of which assume a single half pound meal of fish per week, has to do with how the consumption of **marine** fish is taken into account. The MFCA is advice about eating fish from any source, sport-caught, store-bought, marine or freshwater. The EPA aquatic life criteria (applicable in Minnesota) apply only to freshwater habitats. But, in the calculation of freshwater criteria, EPA assumes people eat a certain amount of marine fish in addition to the 17.5 g/d of freshwater fish. As a result, the freshwater criterion is lowered to allow for this "outside" source of mercury (this is standard procedure in EPA criteria and MPCA standard calculations). Thus, the re-calculated mercury criterion ends up at 0.17 rather than 0.2 ppm. Considering the points listed below, the MPCA believes that the use of 0.2, rather than 0.17 ppm as the basis for impairment decisions is appropriate.

- EPA rounded the reference dose of 0.1 μg/kg/day to one significant figure; thus, 0.17 and 0.2 ppm could be considered essentially the same number,
- The use by MPCA of the more protective fish consumption amount (30 g/d),
- The use of safety factors in the criterion calculation (again, standard procedure),
- Uncertainties inherent in criteria development, and
- The importance of maintaining consistency in the MPCA/MDH approaches.

6. *Polychlorinated Biphenyls*

Since the manufacture and sale of polychlorinated biphenyls (PCB) were banned in 1976, measured concentrations in fish tissue have decreased by 90 percent in some fish species in the Mississippi River and by 75 percent in Lake Superior lake trout. It is anticipated that, with time, natural volatilization and sedimentation processes in lakes and streams will further reduce fish exposure to PCBs in the environment at most locations. The total PCB concentrations in Lake Superior water dropped from about 2.4 ng/L in 1980 to 0.18 ng/L in 1992, mostly due to volatilization (Jeremiason et al. 1994). The fish tissue concentration thresholds for PCB consumption advice are shown in Table 15 (also in Section VII.B.2.).

7. *Data Requirements and Determination of Impaired Condition*

The one exception to the overall practice of using the latest 10 years of data for the 305(b) and 303(d) assessments is for the analysis of mercury fish tissue data. The complete mercury fish tissue data record will be used; that is, at present, there is no age limit for mercury fish tissue data. The reason for this departure from the 10-year period of record in this case is rather simple. A state-wide trend analysis of mercury fish tissue concentrations measured over the last 10 – 15 years indicates a very slight average rate of decline – about one percent per year (MPCA 2002). This is not a large enough downward trend to justify using only the latest 10 years of data. Also, there have been no significant changes in sampling or analytical procedures associated with the fish tissue data that would invalidate the older data. It would not be justifiable to remove a waterbody from the 303(d) list simply because the mercury fish tissue data for that waterbody were collected more than 10 years ago. Only the most recent 10 years of data are used in the assessment of fish tissue data for PCBs. As noted previously, significant downward trends in PCB concentrations have been documented. Thus, older data is not likely to be a valid indicator of current conditions.

The MDNR coordinates the fish tissue sampling program with input from the MPCA and MDH on where to collect fish. Each year some waterbodies are sampled for the first time and some waterbodies are re-sampled. Sample locations are determined by:

- Where MDNR personnel will be conducting population surveys,
- Waterways where fishing pressure is relatively high,

- Where previous collections are becoming outdated, or
- Where information is needed for special studies or trend analysis.

The edible portion, which is a skin-on fillet, is prepared in the MPCA fish processing lab. Currently, fish samples are analyzed by the Department of Agriculture analytical lab. Since fish bioaccumulate these pollutants, concentrations below method detection limits are not usually an issue. When they do occur, one half of the method detection limit (less-than value) is used in the assessments. The data for each lake or river reach are separated by species and by individual size classes: 5-15, 15-20, 20-25, 25-30 and 30 + inches. **Data collected in the five-year period that includes the most recent sampling is averaged**. That is, the assessment program identifies the most recent data point, then searches back five years for additional data from the same waterbody, same species, same size class, and averages them. The entire mercury data base will be searched, but only the most recent 10 years for PCB data. Waterbodies will be considered impaired if the arithmetic average concentration for any fish species in any size class exceeds 0.2 ppm for either mercury or PCBs. Only waterbodies with measured data in excess of this threshold will be listed (Table 16).

Fish can be very mobile and difficult to attribute to a discrete portion of a lake or river reach. For the 305(b) and the 303(d) assessments, all fish tissue information from a lake are aggregated unless there is evidence to show that fish from certain parts of a lake are isolated and may be exposed to different levels of contamination. For rivers, fish are collected with nets or electrofishing gear in a range of river miles generally not more than five miles apart. Sampled sections of a river are associated with river reaches in the USGS hydrologic unit code system. However, fish tissue data from one or more sampling station may be considered representative of more than just the reach from which they were collected. Adjacent river reaches may be listed as well as the reach from which the fish were collected based on general information about the home range of the species, location of upstream or downstream fish barriers such as falls and dams, and significant river tributaries.

Table 16. Summary of Data Requirements and Fish Contaminant Thresholds for Assessment of Fish for Human Consumption.

Impairment Assessment For	**Period of Record***	**Minimum No. of Data Points***	**Fish Contaminant Levels for Mercury and PCBs. Fish Consumption Advice**	
Fish Contaminant Levels → Advice to Eat a Fish Meal →			**≤ 0.2 ppm. Once a week, or more frequent**	**> 0.2 ppm. Less frequent than once a week**
305(b) Report	Hg: no limit. PCBs: 10 yrs.	one	Information	Information
303(d) List (TMDL)	Hg: no limit. PCBs: 10 yrs.	one	Not Listed	Listed

*Available data averaged by waterbody by species by size class over a five-year period that includes most recent data.

X. Removal of Waterbodies From 303(d) List of Impaired Waters

There are three basic ways in which waterbodies are removed from the 303(d) impaired waters list:

- If new and reliable data or information indicates that the waterbody is no longer impaired and is meeting water quality standards. Such a waterbody would be de-listed before a TMDL plan was developed.
- If a TMDL assessment and preliminary plan for reducing the sources of pollution so that water quality standards will be met is completed and approved by EPA.
- If the sources of impairment are determined to be essentially entirely non-anthropogenic in origin.

A. WATERBODY NO LONGER IMPAIRED

1. *Numeric Standards*

In general, waterbodies will be assessed and listing or de-listing decisions will be made using the methods described in this Guidance. In practice, there will usually be more data available for the “de-listing” assessment than was available for the “listing” assessment, because an early step in the TMDL process is additional monitoring. New and old data will be considered together in the re-assessments, unless tangible improvements of sufficient dimension to change impairment status have taken place in the reach, in which case only new data will be used in the de-listing assessment. Improvements could include implementation of best management practices to reduce nonpoint sources, improvements in wastewater treatment, or some combination of nonpoint and point source reductions. If the new data show the waterbody to be un-impaired, either because the original, smaller data set provided a false indication of impairment, or because conditions have in fact improved, the MPCA will petition the EPA to de-list the waterbody. It is possible, however, that even with the improvements, the new data may still show impairment. In this case the waterbody is not de-listed.

All de-listing decisions are subject to review by the appropriate professional judgment teams (see Section V.E.). Information about watershed improvements should be brought to the professional judgment team for consideration. The MPCA will make a final determination on whether the reach can be considered no longer impaired, and should be submitted to EPA for de-listing.

As stated, generally the same standards, guidelines and thresholds are used to remove a waterbody from an impaired waters list that were used to place it on the list. The same period of record relative to the de-listing review date, minimum data requirements, and impairment thresholds for the various categories of pollutants apply (see Tables 4, 5, 6, 8, 9, 11, 14 and 16 and the appropriate Sections of the Guidance for details).

It is essential that data used in the de-listing assessment be collected under appropriate conditions. For dissolved oxygen and for pollutants with toxicity- and human health-based water quality standards, data should be from observations taken during critical conditions, i.e. those conditions most likely to result in exceedances of the standard. For example, if a waterbody was listed as impaired due to low dissolved oxygen, the measurements used to support de-listing would likely need to be collected in the early morning (generally no later than two hours after sunrise, so as to reflect the daily minimum) during periods of very low flow. For other pollutants, data should be from observations that provide an accurate representation of the overall period of time under consideration and are not biased by, for example, being collected only during a certain season or under certain flow conditions.

The following is a summary of the specific data and assessment requirements needed to consider removing a waterbody from the 303(d) list, impaired due to exceedances of numeric standards.

<u>Turbidity</u>, must have:

- At least 20 observations (new and old data) in the most recent 10 years, of which at least 10 observations (new and old data) are in the most recent 5 years, or
- At least 20 observations (new data) in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status, and
- In either case, there must be fewer than 10% of samples exceeding the water quality standard.

<u>Dissolved Oxygen</u>, must have:

- At least 10 observations (new and old data) in the most recent 10 years, of which at least 5 observations (new and old data) are in the most recent 5 years, or
- At least 10 observations (new data) in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status, and
- In either case, there must be fewer than 10% of samples exceeding the water quality standard.

<u>Un-ionized Ammonia and Chloride</u>, must have:

- At least 5 observations (new and old data) for any 3-year interval in the most recent 10 years, or
- At least 5 observations (new data) for any 3-year interval in the most recent 5 years, and evidence of action in the watershed of sufficient dimension to change impairment status, and
- In either case, no more than one exceedance of the chronic water quality standard in any 3-year interval (chronic standard is a 4-day average).

<u>Mercury, water column data</u>, must have:

- At least 5 observations for any 3-year interval in the most recent 10 years, and
- No more than one exceedance of the chronic water quality standard in any 3-year interval (chronic standard is a 30-day average).

Fecal coliform bacteria, must have for step one:

- At least 10 observations in the most recent 10 years.

Fecal coliform bacteria, must have for step two:

- At least 5 observations per applicable month (April - October) – data are combined for each month over most recent 10 years, unless there are a sufficient number of observations to aggregate data by month over consecutive two year time periods or to calculate individual monthly or 30 day geometric means or
- At least 5 observations per applicable month (April - October) – data are combined for each month over most recent years since corrective actions were taken in the watershed of sufficient dimension to change impairment status, unless there are a sufficient number of observations to aggregate data by month over consecutive two year time periods or to calculate individual monthly or 30 day geometric means and
- In either case, no exceedance of the monthly mean standard (200 organisms per liter) by the geometric mean in any of those months for 10 year aggregated data or less than 10% of months exceed the standard for two year aggregated or individual monthly or 30 day geometric means and
- In either case, fewer than 10% of sample observations exceed "maximum" standard (400 or 2000 organisms per liter).

2. *Narrative Standards*

Lakes, to be considered for de-listing, must exhibit an improving trend in total phosphorus and either chlorophyll-a concentrations or improved Secchi disk measurements, based on the most recent two or three years (summers) of data; and summer-mean values must be below the "Non-Support" thresholds (Table 11). Associated with data showing the improving trend will often be evidence of management actions that account for the improvement. A lake could also be de-listed if it is shown that "outlier" data contributed to exceedances of the non-support thresholds. Lakes in the "Review" category (Table 11) will automatically be subjected to trend analysis and a review of the most recent data.

Streams with impaired aquatic communities can be de-listed if additional bio-monitoring indicates that the community is no longer impaired when compared to the threshold indices of biotic integrity (IBI). Streams listed as impaired using the earlier narrative IBIs (Karr et al. 1986, Table 13) can be de-listed using the same narrative IBIs if watershed-specific, reference site-based, IBIs have not been determined for that reach. Otherwise, streams will be de-listed using the reference site-based threshold IBIs (in Section IX.B.).

Lakes and rivers listed as impaired due to fish tissue contaminants will be de-listed when additional sampling and analysis show that the fish tissue concentrations, by species and size class, are below 0.2 mg/kg (ppm) for both mercury and PCBs (in Section IX.C.5.).

B. EPA APPROVED TMDL PLAN

The second major way waters are de-listed is through the completion of the TMDL process. Under the current federal TMDL regulation, the TMDL process must progress through the step where an EPA-approved plan is in place that indicates in general how the river reach or lake is to be brought back into compliance with water quality standards. That is, under current EPA regulations, the waterbody does not need to be brought back to an un-impaired condition to be de-listed. Irrespective of this EPA regulation, the MPCA is committed, with the help of local entities, to improving the water quality in all impaired waters so beneficial uses are restored, where restoration is possible.

C. WATERBODY IMPAIRED DUE TO NATURAL CAUSES/CONDITIONS

A third pathway for removing a waterbody from the impaired waters list is to determine that there are essentially no anthropogenic sources contributing to the impairment. Thus, the sources of the impairment are all natural. According to US EPA's Consolidated Assessment and Listing Methodology, these waters are impaired but no TMDL pollution reduction study plan is required.

XI. Sources of Information and MPCA Contacts

The readers of this document are encouraged to access the sources of information listed in this Section. Included are e-mail addresses and phone numbers of MPCA staff that work in areas relevant to the protocols and procedures in this Guidance. They are listed alphabetically by subject area. Also provided are some pertinent Web sites, listed by agency.

A. MPCA STAFF

1. 303(d) list, general questions and comments. Howard Markus at howard.markus@pca.state.mn.us or 651.296.7295.
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B. WEB SITES

The MPCA and other agencies maintain a number of Web sites that provide information on aspects covered in this Guidance; some of the more pertinent sites are listed below.

1. *MPCA Web Sites*

The MPCA home page is at http://www.pca.state.mn.us . From this site the reader can link to all the MPCA Web sites listed below and many more.

- Water quality standards, general information: http://www.pca.state.mn.us/water/standards/index.html
- 305(b) Report:
  Rivers: http://www.pca.state.mn.us/water/basins/305briver.html
  Lakes: http://www.pca.state.mn.us/water/basins/305blake.html
- Lake protection, including Citizen Lake Monitoring Program and lake water quality: http://www.pca.state.mn.us/water/lake.html
- MPCA Quality Management Plan. Provides guidance on monitoring and data management, approved by the EPA: http://www.pca.state.mn.us/programs/pubs/qa-qmp.pdf
- Phosphorus strategy: http://www.pca.state.mn.us/water/phosphorus.html
- Quality assurance and quality control requirements for water quality sampling and data assessment for lakes and streams: http://www.pca.state.mn.us/programs/qa_p.html
- This Guidance: http://www.pca.state.mn.us/water/tmdl/index.html#publications
- TMDLs and the 303(d) list: http://www.pca.state.mn.us/water/tmdl/index.html
- Water quality standards and water quality rules; select Minn. R. ch. 7050, Minn. R. ch. 7052 or other rule from list: http://www.pca.state.mn.us/water/standards/index.html
- Watersheds and basin management: http://www.pca.state.mn.us/water/basins/index.html
- *Data Access Website* with environmental data on surface waters statewide: http://www.pca.state.mn.us/data/eda

2. ***Minnesota Department of Health Web Sites, Fish Consumption Advice***

- Fish consumption advice, general: http://www.health.state.mn.us/divs/eh/fish/
- List of individual lakes with fish consumption advice, 1997: http://www.health.state.mn.us/divs/eh/fish/eating/lakespecpop.pdf

3. ***EPA Web Sites***

The EPA main office in Washington D.C. maintains many relevant Web sites; their home page for water related topics is: http://www.epa.gov/ow/ . The EPA Region 5 office in Chicago has their own relevant Web sites; their home page for water is: http://www.epa.gov/r5water/ . Minnesota is in EPA Region 5.

- EPA Region 5, TMDLs: http://www.epa.gov/region5/water/wshednps/topic_tmdls.htm
- EPA Region 5, water quality monitoring and assessment: http://www.epa.gov/r5water/
- EPA Headquarters Web site for TMDLs in general: http://www.epa.gov/owow/tmdl/

XII. Summary of Data Requirements and Methods for Use Support and Impairment Determinations

Tables 17 and 18 summarize the fundamental data and information requirements for 305(b) and 303(d) use support and impairment determinations for all categories of pollutants. Exceedance thresholds listed for non-bioaccumulative and bioaccumulative toxics are for the **chronic** standards. This summary should not be considered a definitive description of the assessment methods for the various pollutant categories. For the complete description of data and information requirements, as well as the assessment protocols and supportive discussion, the reader must consult the appropriate Section of the Guidance. Data for the most recent 10-year period is used in the assessments for all pollutant categories, except for the contamination of fish tissue with mercury (all data can be used). The pollutant categories treated in the Guidance are:

1. Pollutants with toxicity-based standards
2. Pollutants with human health-based standards
3. Conventional pollutants and water quality characteristics
4. Fecal coliform bacteria
5. Eutrophication of lakes (effects of excess nutrients)
6. Impairment of the biological community (fish)
7. Fish tissue contaminants

Table 17. Summary of Data Needed for Water Quality Assessments for 305(b) Report and 303(d) List for Use Support and Impairment Determinations, for Pollutants with Numeric Standards.

Pollutant Category **305(b) Report, or 303(d) List**	**Minimum Number of Values*, and Data Treatment**	**Exceedance Thresholds:** • **Number or Percent Exceedances of Chronic Standards** **Use Support or Listing Category**		
Pollutants with Toxicity-based Standards	Number of Exceedances →	≤ 1	na	≥ 2
305(b)	5 values in 3 years	Fully supporting	na	Not supporting
303(d)	5 values in 3 years	Not listed	na	Listed
Pollutants with Human Health-based Standards	Number of Exceedances →	≤ 1	na	≥ 2
305(b)	5 values in 3 years	Not assessed for 305(b)	na	Not assessed for 305(b)
303(d)	5 values in 3 years	Not listed	na	Listed
Conventional Pollutants and Water Quality Characteristics	Percent Exceedance →	< 10 %	10 – 25 %	> 25 %
305(b)	10 values in 10 years	Fully supporting	Partially supporting	Not supporting
303(d)	10 values in 10 years	Not listed	Listed	Listed
Fecal Coliform, Step 1 200 orgs./100 ml	Percent Exceedance →	< 10 %	≥ 10 %	na
305(b)	10 values in 10 years	Fully supporting	Step 2	na
303(d)	10 values in 10 years	Not listed	Step 2	na
Fecal Coliform, Step 2 200 orgs./100 ml	Number of months with Exceedances → (geometric mean)	No months	1 or 2 months	> 2 months
305(b)	Geometric mean of 5 values over 10 years for each month	Full supporting	Partially supporting	Not supporting
303(d)	Geometric mean of 5 values over 10 years for each month	Not listed	Listed	Listed
Fecal Coliform, Step 2 2000 orgs./100 ml	Percent Exceedance →	< 10 %	10 – 25 %	> 25 %
305(b)	10 values in 10 years	Full supporting	Partially supporting	Not supporting
303(d)	10 values in 10 years	Not listed	Listed	Listed

* Values are individual or single data points. Exceedance thresholds are of individual values unless noted otherwise.
na = not applicable. There is no "partially supporting" or "review" category for toxics and fish tissue contaminants, no "not supporting" or "listed" category for step 1 of fecal coliform assessments, and no specific minimum data requirements for biological and fish tissue contaminant assessments.

Table 18. Summary of Data Needed for Water Quality Assessments for 305(b) Report and 303(d) List for Use Support and Impairment Determinations, for Pollutants with Narrative Standards.

Pollutant Category **305 (b) Report, or 303(d) List**	**Minimum Number of Values*, and Data Treatment**	**Exceedance Thresholds:** • **Eutrophication Guideline values** • **IBI Scores** • **Contaminant Levels in Fish Tissue** **Use Support or Listing Category**		
Eutrophication (lakes) Northern Lakes and Forests Ecoregion	Total phosphorus →	< 30 µg/L	30 – 35 µg/L	> 35 µg/L
	Chlorophyll-a →	< 10 µg/L	10 – 12 µg/L	> 12 µg/L
	Secchi disk →	≥ 1.6 meters	1.6 – 1.4 meters	< 1.4 meters
305(b)	1 total phosphorus, chlorophyll-a or Secchi disk	Full supporting	Partially supporting	Potentially Not supporting to Not supporting
303(d)	12 total phosphorus, 12 chlorophyll-a and 12 Secchi disk	Not listed	Review, to determine to list or not list	Listed
Eutrophication (lakes) North Central Hardwood Forests Ecoregion	Total phosphorus →	< 40 µg/L	40 – 45 µg/L	> 45 µg/L
	Chlorophyll-a →	< 15 µg/L	15 – 18 µg/L	> 18 µg/L
	Secchi disk →	≥ 1.2 meters	1.2 – 1.1 meters	< 1.1 meters
305(b)	1 total phosphorus, chlorophyll-a or Secchi disk	Full supporting	Partially supporting	Potentially Not supporting to Not supporting
303(d)	12 total phosphorus, 12 chlorophyll-a and 12 Secchi disk	Not listed	Review, to determine to list or not list	Listed
Eutrophication (lakes) Northern Glaciated Plains and Western Corn Belt Plains Ecoregions	Total phosphorus →	< 70 µg/L	70 – 90 µg/L	> 90 µg/L
	Chlorophyll-a →	< 24 µg/L	24 – 32 µg/L	> 32 µg/L
	Secchi disk →	≥ 1.0 meters	1.0 – 0.7 meters	< 0.7 meters
305(b)	1 total phosphorus, chlorophyll-a or Secchi disk	Full supporting	Partially supporting	Potentially Not supporting to Not supporting
303(d)	12 total phosphorus, 12 chlorophyll-a and 12 Secchi disk	Not listed	Review, to determine to list or not list	Listed

* Values are individual or single data points. Exceedance thresholds are of individual values unless noted otherwise.
** Assessment of mercury fish tissue data not limited to most recent 10 years.
na = not applicable. There is no “partially supporting” or “review” category for toxics and fish tissue contaminants, no “not supporting” or “listed” category for step 1 of fecal coliform assessments, and no specific minimum data requirements for biological and fish tissue contaminant assessments.

Table 18. continued

Pollutant Category **305 (b) Report, or 303(d) List**	**Minimum Number of Values*, and Data Treatment**	**Exceedance Thresholds:** • **IBI Scores** • **Contaminant Levels in Fish Tissue** **Use Support or Listing Category**		
Biological Community (fish)	IBI score → (old method)	Excellent, good or fair	na	Poor or very poor
	IBI score → (new method)	IBI ≥ basin-specific threshold IBI	Discrepant results within stream segment	IBI < basin-specific threshold IBI
305(b)	See Section IX.B.	Fully supporting	Partially supporting	Not supporting
303(d)	See Section IX.B.	Not listed	Listed	Listed
Fish Tissue Contaminants**	Tissue concentration →	≤ 0.2 ppm Hg or PCBs	na	> 0.2 ppm Hg or PCBs
305(b)	Waterbodies with fish consumption advice	Information	na	Information
303(d)	mean concentration, by lake by species by size, over most recent 5-year period having data	Not listed	na	Listed

* Values are individual or single data points. Exceedance thresholds are of individual values unless noted otherwise.
** Assessment of mercury fish tissue data not limited to most recent 10 years.
na = not applicable. There is no “partially supporting” or “review” category for toxics and fish tissue contaminants, no “not supporting” or “listed” category for step 1 of fecal coliform assessments, and no specific minimum data requirements for biological and fish tissue contaminant assessments.

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APPENDIX A.

List of Class 2 Numeric Water Quality Standards for Toxicants

Minnesota Class 2 numeric water quality standards for toxic substances are listed in Tables A-1 through A-7. For the complete list of Class 2 water quality standards, and standards for the other use classes, the reader should consult Minn. R. chs. 7050 and 7052. All the Class 2 standards in Minn. R. ch. 7052, which are applicable only to the Lake Superior basin, are repeated here; but the reader is advised to consult both rules for definitive lists of all standards.

The standards are organized in the tables as follows:

Minn. R. ch.7050

- Table A-1, toxicity-based chronic and maximum standards
- Table A-2, human health-based chronic standards and bioaccumulation factors (BAF)
- Table A-3, toxicity- or human health-based chronic standards and BAFs
- Table A-4, toxicity-based chronic and maximum standards that vary with hardness or pH

Minn. R. ch.7052 (Lake Superior basin)

- Table A-5, toxicity-based chronic and maximum standards
- Table A-6, human health- and wildlife-based chronic standards and BAFs
- Table A-7, toxicity-based chronic and maximum standards that vary with hardness or pH

Table A-1. Chronic and Maximum Toxicity-based Water Quality Standards for Minnesota Class 2 Waters, From Minn. Rules Part 7050.0222. See Notes Below.

#	Toxicant	Units	Chronic Standard For Subclass			Maximum Std. For Subclass		Total to Dissolved Factor	
			2A	2Bd	2B/C/D	2A	2Bd/B/C &D	Chronic Stds.	Max. Stds.
1	Aluminum, t	µg/L	87	125	125	748	1072	1.0	1.0
2	Ammonia, un-ionized	µg/L	16	40	40	none	none	na	na
3	Anthracene	µg/L	0.035	0.035	0.035	0.32	0.32	na	na
4	*Cadmium, t	µg/L	1.0	1.1	1.1	3.9	33	0.909	0.946
5	Chloride	mg/L	230	230	230	860	860	na	na
6	Chlorine	µg/L	11	11	11	19	19	na	na
7	Chlorpyrifos	µg/L	0.041	0.041	0.041	0.083	0.083	na	na
8	*Chromium III, t	µg/L	207	207	207	436	436	0.860	0.316
9	Chromium VI, t	µg/L	11	11	11	16	16	0.962	0.982
10	*Copper, t	µg/L	9.8	9.8	9.8	18	18	0.960	0.960
11	Cyanide, free	µg/L	5.2	5.2	5.2	22	22	na	na
12	Di-n-octyl phthalate	µg/L	30	30	30	825	825	na	na
13	Ethylbenzene	µg/L	68	68	68	1859	1859	na	na
14	Fluoranthene	µg/L	1.9	1.9	1.9	3.5	3.5	na	na
15	*Lead, t	µg/L	3.2	3.2	3.2	82	82	0.791	0.791
16	Naphthalene	µg/L	81	81	81	409	409	na	na
17	Parathion	µg/L	0.013	0.013	0.013	0.07	0.07	na	na
18	Phenanthrene	µg/L	3.6	3.6	3.6	32	32	na	na
19	Phenol	µg/L	123	123	123	2214	2214	na	na
20	Selenium, t	µg/L	5.0	5.0	5.0	20	20	1.0	1.0
21	*Silver, t	µg/L	0.12	1.0	1.0	2.0	2.0	0.85	0.85
22	Toluene	µg/L	253	253	253	1352	1352	na	na
23	1,1,1-Trichloroethane	µg/L	329	329	329	6988	6988	na	na
24	Xylene (m, p & o)	µg/L	166	166	166			na	na
25	*Zinc, t	µg/L	106	106	106	117	117	0.986	0.978

Standards for trace metals are listed as total metal (t), but are converted to dissolved metal for implementation using “total to dissolved factors” (total metal standard times factor = dissolved metal standard).

*Chronic and maximum standards vary with ambient total hardness (as $CaCO_3$); values shown are for a hardness of 100 mg/L. Hardness dependant formulas are shown in Table A-4.

na = Not applicable

Table A-2. Chronic Human Health-based Water Quality Standards for Class 2 Minnesota Waters, From Minn. Rules Part 7050.0222; and Bioaccumulative Factors Used to Determine Standards. See Notes Below.

#	Toxicant	Units	Chronic Standard For Subclass			Bioaccumulation Factor For Subclass*		Type
			2A	2Bd	2B/C/D	2A	2Bd/B/C/D	
1	Acenaphthene	μg/L	20	20	20	387	387	org.
2	Acrylonitrile	μg/L	0.38	0.38	0.89	48	48	C
3	Arsenic	μg/L	2.0	2.0	53	2.3	2.3	S
4	Bromoform	μg/L	33	41	466	24	6	C
5	Carbon tetrachloride	μg/L	1.9	1.9	5.9	30	30	C
6	Chlordane	pg/L	73	290	290	244,644	61,161	C
7	Chlorobenzene	μg/L	20	20	20	45	12	org.
8	DDT	pg/L	110	1700	1700	625,614	39,518	C
9	1,2-Dichloroethane	μg/L	3.5	3.8	190	5	1	C
10	Dieldrin	pg/L	6.5	26	26	222,918	55,730	C
11	Di-2-ethylhexyl phthalate	μg/L	1.9	1.9	2.1	791	791	C
12	Endosulfan	μg/L	0.0076	0.029	0.031	3006	751	S
13	Endrin	μg/L	0.0039	0.016	0.016	35,760	8940	S
14	Heptachlor	pg/L	100	390	390	53,525	13,381	C
15	Heptachlor epoxide	pg/L	12	480	480	21,288	5322	C
16	Hexachlorobenzene	pg/L	61	240	240	239,478	59,870	C
17	Lindane	μg/L	0.0087	0.032	0.036	1962	491	C
18	Mercury	μg/L	0.0069	0.0069	0.0069	42,653	42,653	S
19	Methylene chloride	μg/L	45	46	1940	2	1	C
20	PCBs, t	pg/L	14	29	29	224,507	104,060	C
21	1,1,2,2-Tetrachloroethane	μg/L	1.1	1.5	13	38	9	C
22	Tetrachloroethylene	μg/L	3.8	3.8	428	49	49	C
23	Toxaphene	pg/L	310	1300	1300	65,858	16,464	C
24	Thallium	μg/L	0.28	0.28	0.56	66	66	S
25	1,1,2-Trichloroethylene	μg/L	25	25	120	17	17	C
26	2,4,6-Trichlorophenol	μg/L	2.0	2.0	2.0	229	57	org.
27	Vinyl chloride	μg/L	0.17	0.18	9.2	4	1	C

Type = Type of human toxicant; C = chemical is considered a carcinogen; S = chemical is considered a systemic toxicant; org. = organoleptic, i.e., chemical imparts a disagreeable taste or odor to fish flesh.

* Bioaccumulation factors shown calculated assuming 6.0 % lipid for fish in Class 2A waters, and 1.5 % lipid for fish in Class 2B/C/D waters. Toxicants with bioaccumulation factors greater than 5000 for any Class 2 water are considered highly bioaccumulative.

Table A-3. Chronic and Maximum Water Quality Standards for Minnesota Class 2 Waters, for which the Lowest and Applicable Chronic Standard is Either Human Health-based or Toxicity-based, Depending on the Subclass of Class 2 Waters. From Minn. Rules Part 7050.0222. All Concentrations in μg/L. See Notes Below.

#	**Toxicant**	Chronic Standard Basis **For Subclass**			**Max. Std.**	**Bioaccumulation Factor**		**Type**
		2A	2Bd	2B/C/D	All Class 2	Class 2A	Class 2Bd/B/C/D	
1	Alachlor	3.8_H	4.2_H	59_T	800	10	2.5	C
2	Antimony	5.5_H	5.5_H	31_T	90	1	1	S
3	Atrazine #	3.4_H	3.4_H	10_T	323	2	2	C
4	Benzene	9.7_H	11_H	114_T	4487	16	4	C
5	Chloroform	53_H	53_H	155_T	1392	6	6	C
6	Cobalt #	2.8_H	2.8_H	5.0_T	436	1	1	S
7	*Nickel, t	158_T	158_T	158_T	1418	1	1	S
8	**Pentachlorophenol #	0.93_H	1.9_H	5.5_H	9.1	142	35	C

Chronic Standard $_{Basis}$: Subscript $_H$ = human health-based; subscript $_T$ = toxicity-based.
Type = Type of human toxicant; C = chemical is considered a carcinogen; S = chemical is considered a systemic toxicant.

*Nickel:

1. Toxicity-based standards, listed as total metal (t), are converted to dissolved metal for implementation using a "total to dissolved factor" of 0.997 (chronic) and 0.998 (maximum) (total metal standard times factor = dissolved metal standard).
2. Chronic and maximum toxicity-based standards vary with ambient total hardness (as $CaCO_3$); values shown are for a hardness of 100 mg/L. Hardness dependant formulas are shown in Table A-4.
3. Class 2A and Class 2Bd chronic standards are not to exceed human health-based standard of 297 μg/L as total nickel. The Class 2B/C/D chronic standards are always toxicity-based and have no human health-based "cap".

** Pentachlorophenol:

1. Toxicity-based standards vary with ambient pH; maximum standard shown is for a pH value of 7.0. PH dependant formulas are shown in Table A-4.
2. Class 2A and 2Bd chronic standards are always human health-based regardless of pH.
3. Class 2B/C/D chronic standards are not to exceed human health-based standard of 5.5 ug/L.

Note the following:

1. The aquatic-toxicity standard for atrazine of 10 μg/L is applicable as a criterion value to Class 2A and 2Bd waters for protection of aquatic life.
2. The aquatic-toxicity standard for cobalt of 5 μg/L is applicable as a criterion value to Class 2A and 2Bd waters for protection of aquatic life.
3. Like the human health-based standard, the aquatic-toxicity criterion for pentachlorophenol is pH dependent. These values are similar, for example in a Class 2B waters at a pH of 7 the human health-based standard is 5.5 μg/L and the toxicity-based criterion is 5.7 μg/L. The toxicity-based criterion value is applicable for all Class 2 waters to protect aquatic life.

Table A-4. Chronic and Maximum Water Quality Standards for Minnesota Class 2 Waters that Vary with Ambient Total Hardness (as $CaCO_3$), or pH. See Notes Below.

#	Toxicant	Class 2 Subclass	Chronic Standard Where: see notes	Maximum Standard Where: see notes
1	Cadmium, t	2A	Exp.(0.7852(ln TH)-3.490)	Exp.(1.128(ln TH)-3.828)
	Cadmium, t	2Bd/B/C &D	Exp.(0.7852(ln TH)-3.490)	Exp.(1.128(ln TH)-1.685)
2	Chromium III, t	All	Exp.(0.819(ln TH+1.561)	Exp.(0.819(ln TH)+3.688)
3	Copper, t	All	Exp.(0.620(ln TH)-0.570)	Exp.(0.9422(ln TH)-1.464)
4	Lead, t	All	Exp.(1.273(ln TH)-4.705)	Exp.(1.273(ln TH)-1.460)
5	*Nickel, t	All	Exp.(0.846(ln TH)+1.1645)	Exp.(0.846(ln TH)+3.3612)
6	Silver, t	All	na	Exp.(1.720(ln TH)-7.2156)
7	Zinc, t	All	Exp.(0.8473(ln TH)+0.7615)	Exp.(0.8473(ln TH)+0.8604)
8	**Pentachlorophenol	2A/2Bd	na	Exp.(1.005(pH)-4.830)
	**Pentachlorophenol	2/B/C/D	Exp.(1.005(pH)-5.290)	Exp.(1.005(pH)-4.830)

Where: Exp. = the natural antilogarithm of the expression in parentheses
ln = natural logarithm
TH = Total hardness as $CaCO_3$ in mg/L
pH = pH in standard units
Results in μg/L

*Nickel: Class 2A and Class 2Bd chronic standards are not to exceed human health-based standard of 297 μg/L as total nickel. The Class 2B/C/D chronic standards are always toxicity-based and have no human health-based “cap”.

**Pentachlorophenol: Class 2B/C/D chronic standards are not to exceed human health-based standard of 5.5 ug/L.

Table A-5. Chronic and Maximum Toxicity-based Water Quality Standards for Minnesota Class 2 Waters in the Lake Superior Basin, From Minn. Rules Part 7052.0100. All concentrations in μg/L. See Notes Below.

#	**Toxicant**	**Chronic Standard For Subclass**				**Max. Std.**	**Total to Dissolved Factor**	
		Lake Superior	2A except L. Sup.	2Bd	2B/C/D	All subclass	Chronic Stds.	Max. Stds.
1	*Cadmium, t	2.5	2.5	2.5	2.5	4.5	0.85	0.85
2	Chlorobenzene	10	10	10	10	860	na	na
3	*Chromium III, t	86	86	86	86	1803	0.86	0.316
4	Chromium VI, t	11	11	11	11	16	0.962	0.982
5	*Copper, t	9.3	9.3	9.3	9.3	14	0.96	0.960
6	Cyanide, free	5.2	5.2	5.2	5.2	22	na	na
7	2,4-Dimethylphenol	21	21	21	30	825	na	na
8	*Nickel	52	52	52	52	469	0.997	0.998
9	Parathion	0.013	0.013	0.013	0.013	0.65	na	na
10	Selenium, t	5.0	5.0	5.0	5.0	20	0.922	0.922
11	Toluene	253	253	253	253	1352	na	na
12	*Zinc, t	120	120	120	120	120	0.986	0.978

Standards for trace metals are listed as total metal (t), but are converted to dissolved metal for implementation using "total to dissolved factors" in Minn. R. pt. 7052.0360 (total metal standard times factor = dissolved metal standard).
*Chronic and maximum standards vary with ambient total hardness (as $CaCO_3$); values shown are for a hardness of 100 mg/L. Hardness dependant formulas are shown in Table A-7.
na = Not applicable

Table A-6. Chronic Human Health-based and Wildlife-based Water Quality Standards for Minnesota Class 2 Waters in the Lake Superior Basin, From Minn. Rules Part 7052.0100; Showing Bioaccumulative Factors. See Notes Below.

#	Toxicant	Units	**Chronic Standard For Subclass**				**Bioaccumulation Factor 1 % Lipid****		**Type**
			Lake Sup.	2A	2Bd	2B/C/D	Trophic Level 3	Trophic Level 4	
1	Arsenic	μg/L	2.0	2.0	2.0	53	2.3	2.3	S
2	Benzene	μg/L	10	11	12	237*	1.4	1.4	C
3	Chlordane	pg/L	40	56	225	225	79,430	61,660	C
4	DDT	pg/L	11	11	11	11	346,700	602,600	W
5	Dieldrin	pg/L	1.2	1.6	6.5	6.5	41,800	193,000	C
6	2,4-Dinitrophenol	μg/L	53	53	55	1982*	0.4	0.4	S
7	Endrin	μg/L	0.0039	0.0039	0.016	0.016	na	5960	S
8	Hexachlorobenzene	pg/L	74	105	418	419	26,300	25,120	C
9	Hexachloroethane	μg/L	1.0	1.5	5.0	6.2	204	172	C
10	Lindane	μg/L	0.08	0.11	0.43	0.46	1059	8511	S
11	Mercury	μg/L	0.0013	0.0013	0.0013	0.0013	27,900**	140,000**	W
12	Methylene chloride	μg/L	46	46	47	1994*	0.2	0.2	C
13	PCBs, t	pg/L	4.5	6.3	25	25	552,800	1,166,000	C
14	Pentachlorophenol	μg/L	0.93	0.93	1.9	13	na	6	C
15	2,3,7,8-TCDD	pg/L	0.0014	0.0020	0.0031	0.0031	93,600	90,000	C/W
16	Toxaphene	pg/L	11	15	62	62	275,100	215,800	C
17	Trichloroethylene	μg/L	22	24	29	330	3.4	3.4	C

Type = Type of toxicant, or basis for the applicable chronic standard; C = chemical is considered a human carcinogen; S = chemical is considered a human systemic toxicant; W = Wildlife-based standard; C/W = Lake Superior and Class 2A standards are human health-based (cancer), Class 2Bd/B/C/D standards are wildlife-based, for 2,3,7,8-TCDD.
*Toxicity-based standard is applicable standard because it is lower than human health-based standard shown.
**Bioaccumulation Factors (BAF):

1. BAFs for organic chemicals shown at 1% lipid; These BAFs are multiplied by 8.5, 6.0 and 1.5% lipid (for both trophic levels 3 and 4) to determine Lake Superior, Class 2A and Class 2Bd/B/C/D standards, respectively.
2. BAFs for mercury are not lipid-based
3. Toxicants with bioaccumulation factors greater than 1000 for any Class 2 water are considered Bioaccumulative Chemicals of Concern in the Lake Superior basin.

Table A-7. Chronic and Maximum Water Quality Standards for Minnesota Class 2 Waters in the Lake Superior Basin that Vary with Ambient Total Hardness (as $CaCO_3$), or pH. From Minn. Rules Part 7052.0100. See Notes Below.

#	Toxicant	Class 2 Subclass	Chronic Standard Where: see notes	Maximum Standard Where: see notes
1	Cadmium, t	All	Exp.(0.7852(ln TH)-2.715)	Exp.(1.128(ln TH)-3.6867)
2	Chromium III, t	All	Exp.(0.819(ln TH+0.6848)	Exp.(0.819(ln TH)+3.7256)
3	Copper, t	All	Exp.(0.8545(ln TH)-1.702)	Exp.(0.9422(ln TH)-1.700)
4	Nickel, t	All	Exp.(0.846(ln TH)+0.0584)	Exp.(0.846(ln TH)+2.255)
5	Zinc, t	All	Exp.(0.8473(ln TH)+0.884)	Exp.(0.8473(ln TH)+0.884)
6	*Pentachlorophenol	2A/2Bd	na	Exp.(1.005(pH)-4.869)
	*Pentachlorophenol	2/B/C/D	Exp.(1.005(pH)-5.134)	Exp.(1.005(pH)-4.869)

Where: Exp. = the natural antilogarithm of the expression in parentheses
ln = natural logarithm
TH = Total hardness as $CaCO_3$ in mg/L
pH = pH in standard units
Results in µg/L

*Pentachlorophenol: Class 2B/C/D chronic standards are not to exceed human health-based standard of 5.5 µg/L.
na = Not applicable

APPENDIX B.

Method Detection Limits for Toxicants

Limits of detection (method detection limits) and limits of quantification for the Wisconsin State Laboratory of Hygiene, for certain trace metals and bioaccumulative organochlorine chemicals, are shown in Table B-1. The MPCA has contracted with this lab, which meets QA/QC requirements, for the analysis of some water samples collected using clean techniques. Their analytical capabilities are shown as an example.

Two "detection limits" are listed, the limit of detection (LOD) and limit of quantification (LOQ). The limit of detection is the ultimate capability of the analytical method to detect or measure the substance in water. The limit of quantification is the ability of the method to measure the substance in water with a specified level of confidence that the amount reported is accurate. To gain the confidence provided by the LOQ, results must be reported at a level greater than the LOD. The MPCA uses the LOQs to define "less-than values".

Table B-1. Limits of Detection and Limits of Quantification for the Wisconsin State Laboratory of Hygiene.

Substance	**LOD**	**LOQ**	**Units**	**Sample Size Needed**
Trace Metals				
Arsenic	0.1	na	ug/L	250 milliliter
Cadmium	0.01	0.03	ug/L	250 milliliter
Copper	0.01	0.04	ug/L	250 milliliter
Lead	0.005	0.015	ug/L	250 milliliter
Nickel	0.09	0.3	ug/L	250 milliliter
Zinc	0.04	na	ug/L	250 milliliter
Mercury	0.1	0.3	ng/L	500 milliliter
Chlorinated Organics				
Lindane (gamma-BHC)	0.025	0.082	ng/L	160 Liter
alpha-Chlordane	0.011	0.037	ng/L	160 Liter
gamma-Chlordane	0.010	0.033	ng/L	160 Liter
p,p'DDT	0.025	0.082	ng/L	160 Liter
p,p'DDD	0.025	0.082	ng/L	160 Liter
p,p'DDE	0.015	0.050	ng/L	160 Liter
Toxaphene	5	16	ng/L	160 Liter
Hexachlorobenzene	0.0030	0.010	ng/L	160 Liter

na = not available

APPENDIX C.

Professional Judgment Group Transparency Form for Assessed Streams – Four Examples

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AUID: 07010103-501 **Assessment Cycle:** 2006

Aquatic Life Assessment:	**Swimming Assessment:**	**Review For Delisting:** No
FS	NA	**More Monitoring:** Yes

Comments:
Main Comments: Need more monitoring for turbidity and DO.
Aq Rec Result: NA
Aq Rec Comments: Assess Quality:

AUID: 07010103-502 **Assessment Cycle:** 2006

Aquatic Life Assessment:	**Swimming Assessment:**	**Review For Delisting:** Yes
NS	FS	**More Monitoring:** No

Comments:
Main Comments: Additional turbidity Sonde data has been collected, summarized, but still needs to be entered into STORET.

Consider delisting for turbidity.
Aq Rec Result: FS

Impairment ID: 413 **Impairment Name:** Turbidity

AUID: 07010203-505 **Assessment Cycle:** 2006

Aquatic Life Assessment: NA **Swimming Assessment:** NA **Review For Delisting:** No **More Monitoring:** No

Comments:

Main Comments: No assessment for turbidity because the CSMP data set is relatively small, single year, and not corroborated.
PJG follow-up for DO:
Assessment Data summary showed DO PS 4/18 (22%)
Data time range 2000-2004
Stations: S003-007 & S002-952 (these are actually at the same location CSAH 15 southwest of Zimmerman)
Recommend not listing for DO impairment at this time and doing additional monitoring because the dataset is small and the AUID is very long. Also may want to evaluate whether the AUID needs to be split.
Total of 18 observations, exceedences on four dates
06-20-01 3.33 mg/L
07-02-02 1.25 mg/L
09-17-02 2.73 mg/L
06-14-04 3.75 mg/L
Note that this AUID is 72 miles long and this station is at the downstream end of the AUID.
Aq Rec Result: NA
Aq Rec Comments: Assess Quality:

AUID: 07010203-507 **Assessment Cycle:** 2006

Aquatic Life Assessment: FS **Swimming Assessment:** NA **Review For Delisting:** No **More Monitoring:** No

Comments:

Main Comments: Follow up on transparency tube corroboration is included below. The corroboration is from Sherburne County SWCD.
Agree with the FS for TTube assessment.
"Sherburne SWCD collected TSS data for one site in this reach. Number of samples: 14. Average TSS = 8 mg/L. The HBI for one macroinvertebrate sampling was determined for 2 sites. Values were 5.24 and 4.67 (Sherburne and Benton SWCD data).

APPENDIX D.

Case Examples of Lake Impairment Determinations.

The following are examples of Minnesota lake data that have been taken through the "decision tree" shown in Figure 6 in the body of this Guidance. These case-specific examples illustrate the impairment determination process.

1. Case Example: Lake which lacks trophic status data or does not have DNR ID number

a. Rice Lake (1-0067) Aitkin County

Rice Lake is a 4,422 acre lake near McGregor in Aitkin County. No trophic status data was available for lake and was not included in our 305(b) assessment. Subsequently the lake was not evaluated.

2. Case Examples: Lake with insufficient or old data

a. Island Lake (58-0062) Pine County

Island Lake is a 546 acre lake with a maximum depth of 35 feet. It is a highly developed and highly used lake in this part of Pine County. A LAP study was done on the lake in the early 1990's. The lake exhibited mean TP of 44 µg/L, chlorophyll-a of 19 µg/L, and Secchi of 2.1 m. The TP and chlorophyll-a values are well above thresholds for the NLF ecoregion, however the data is based on only eight observations. Subsequently the lake was not listed.

3. Case Example: Lake which does not exceed causal and response thresholds

4. Case Examples: Lake near TP threshold (Review category)

a. Cedar Lake (27-0039) Hennepin County

Cedar Lake is 170 acre lake with a maximum depth of 51 feet. It is a part of the "Minneapolis Chain of Lakes." In the 305(b) assessment it had a mean TP of 44 µg/L, chlorophyll-a of 12 µg/L and Secchi of 2.8 m. Since its TP is near the threshold value of 40 µg/L it is subject to review for the TMDL list.

A review of long-term data indicates a Secchi of 2.5 m based on _ years of data. Recent trophic status data from monitoring done as a part of the Chain of Lakes CWP project reveal a mean TP of 33 µg/L, chlorophyll-a of 9.2 µg/L and Secchi of 2.8 m in 1996 (Derby et al. 1997). Further improvement in trophic status of the lake has occurred since that time as a result of extensive CWP and Minneapolis Parks project (Lee, 2001, personal communication). Based on the currently low TP and trend toward improving trophic status Cedar Lake should not be listed.

4. Case Example: Lake in review category with elevated TP but response variables below thresholds.

a. **Clearwater Lake (86-0252) Wright County**

Clearwater Lake is a large (3,182 acre) and highly used lake in Wright County. It was the focus of Clean Lakes Phase I and II efforts in the 1970's and 1980's. BMP's and wetland restorations were implemented as a part of the CLP. A review of data reveals recent improvements in trophic status with Secchi averaging 2.3 m over the past 10 years and a significant improvement overall based on 24 years of data. Recent TP and chlorophyll-a over this period averaged 37 and 11 µg/L, respectively. Further review suggested 1995 data may contain outliers based on a mean TP of 157 µg/L, high standard error, and a mean chlorophyll-a of 12.8 µg/L. Subsequently the lake was not listed.

b. Leven Lake (61-0066) Pope County

Leven Lake is located in northern Pope County directly north of Villard Lake. Leven Lake is fed by a stream that enters the northeastern part of the lake and its watershed extends into Douglas County. It has a total surface area of 283 acres and a maximum depth of 10 meters.

Based on the 305(b) assessment it has a TP of 61 µg/L, chlorophyll-a of 16 µg/L and a Secchi of 1.6 m. The TP is well above the threshold, however chlorophyll-a is low and Secchi is high relative to the TP value. Based on Pope County water plan monitoring from 1994 – 1997 TP exceeded 40 µg/L in all four years and was over 100 µg/L in 1994. Chlorophyll-a data were available for only two years. Monitoring by MPCA in 2000 revealed a summer-mean TP of 136 µg/L, chlorophyll-a of 21 µg/L, and Secchi of 1.8 m. Algae samples, collected as a part of that effort were dominated by blue-green algae which often float near the surface and may allow for deeper transparency than would be expected based on TP or chlorophyll-a measurements.

Based on the elevated TP measured in Pope County and MPCA monitoring and high chlorophyll-a and dominance by blue-green algae noted in 2000 we would recommend listing Leven Lake. However, a review is appropriate and local resource managers should be asked to comment on locally collected data and offer any other insights they may have on the lake.

6. Case Example: Impaired lake with sufficient data

a. Long Lake (62-0067) Ramsey County

Long Lake is a 184-acre lake with a maximum depth of 27 feet and mean depth of 14 feet. It is located near the city of New Brighton in Ramsey County and is located in a region of the state referred to as the North Central Hardwoods Forest (NCHF) ecoregion. Based on its morphometric characteristics it is near the median for lakes in the North Central Hardwood

Forests ecoregion (based on sample sizes of about 700-800 assessed lakes). Long Lake - Rush Lake Regional Park is a 200-acre park on the east side of Long Lake that includes a staffed swimming beach. The park also includes a public boat launch on the south end of the lake.

A Clean Lakes Project was implemented from 1978 – 1987. The project was funded by the U.S. Environmental Protection Agency (EPA), the state of Minnesota through the Legislative Commission on Minnesota Resources and the Rice Creek Watershed District. This project was directed at improving the water quality of Long Lake. Specifically the project was to reduce sediment loading and delta formation in the lake and improve water clarity. As reported in the final project report implementation activities have been successful at reducing sediment loads to the lake such that delta formation has not recurred. However, water clarity remains unchanged and nuisance algal blooms persist. This points to the need for additional actions to improve lake water quality.

Lake water quality assessment data for Long Lake, as summarized in our most recent assessment (MPCA 2000) are summarized in Table E-1. These data were summarized as part of our 305(b) reporting efforts and published on our Web site. These particular data represent summer-mean (June through September) surface water measurements collected between 1989 and 1998. These samples have been collected by a variety of agencies (organizations) and persons during this period of time. In the raw data table the "site" identification code describes the agency, organization or program responsible for collection of the data. For example sites with a "100" prefix were collected by MPCA staff, while the "200" code is used for Citizen Lake Monitoring Program participants. Our discussion will follow the order in the proposed methodology.

Table E-1. Long Lake Water Quality Assessment Data

Total phosphorus	# of obs	Chlorophyll-a	# of obs	Secchi	# of obs.	TSI-TP	TSI-Chl-a	TSI-Secchi
µg/L		µg/L		m				
105	**40**	**43**	**40**	**1.0**	**108**	**72**	**68**	**60**

1. Data considerations: The minimum data set for TMDL assessment purposes is defined as 12 or more TP measurements, 12 or more Secchi measurements, and 12 or more chlorophyll-a measurements for the assessment period. All assessments should be based on current data that is defined as data collected between 1989 and 1998 for this assessment. Long Lake surpasses all four data considerations.

2. Initial lake impairment determinations: Minnesota's ecoregion-based TP guidelines provide the initial basis for determining the impairment status of the lake. These guidelines were developed based upon a combination of information that considered: a) phosphorus impacts on lake condition (as measured by chlorophyll-a, algal bloom frequency, transparency, and hypolimnetic oxygen depletion); b) impacts on lake user (aesthetics, recreation, fisheries, water supply, etc.); and c) attainability (as related to watershed characteristics, regional phosphorus export values, lake morphometry, etc.). Background information on the development of the guidelines is well-documented in peer-reviewed literature as noted in the

proposed listing methodology. And similar methods are currently being used in EPA guidance documents for nutrient criteria development (EPA 2000) and in protocol for developing nutrient TMDLs (EPA 1999a and 1999b).

a) The TP guideline for full support of swimmable use in the NCHF ecoregion has been set at 40 µg/L as a summer-mean. NCHF lakes with TP < 40 µg/L will typically exhibit a low frequency of algal blooms and adequately high transparency to support swimmable use throughout the summer. A level of TP between 40 µg/L and 50 µg/L has been used as a basis for describing “partial support” of swimmable use. Lakes with TP concentrations in this range will exhibit periodic algal blooms and reduced transparency that may interfere with swimmable use. Lakes with TP concentrations above 50µg/L are classified as “not-supporting.” Long Lake at 105 µg/L exceeds both these thresholds.
b) In addition to exceeding this assessment threshold we believe “response” thresholds should be considered as well prior to listing a lake. One method is a comparison of the chlorophyll-a and Secchi data to the TP data by means of Carlson’s TSI as noted in the methodology. In this case the corresponding TSI values for TP, chlorophyll-a and Secchi are as follows: 71, 68, 60. All three of these measures indicate “eutrophic to hypereutrophic” conditions for Long Lake. Correspondence of the three values is relatively good considering the high mean TP for the lake. A mean chlorophyll-a concentration of 43 µg/L would rank near the 25th percentile (75 percent have lower concentration) based on 559 NCHF assessed lakes and a mean Secchi of 1.0 meters would rank between the 10th- 25th percentile based on 853 NCHF lakes. Also, at a mean chlorophyll-a concentration of 43 µg/L “nuisance” blooms (chlorophyll-a > 20 µg/L) would occur about 80-90 percent of the summer and “severe nuisance” blooms (chlorophyll-a > 30 µg/L) would occur about 60-65 percent of the summer. These levels of algae combined with low transparency would typically be associated with swimming impaired conditions for lakes in the NCHF.

Based on all of the above the lake is impaired and should be listed.

b. Case Example: Impaired lake with sufficient data – bayed lake

7. Case Example: Reservoir with sufficient data.

a. Lake Byllesby (19-0006) Dakota County

Lake Byllesby is located on the Cannon River, downstream from the confluence of the Straight River and the outlet of Cannon Lake. Its watershed is quite large with the Cannon Lake portion draining primarily from the NCHF ecoregion and the Straight River portion from the WCBP. It has two county parks (Dakota and Goodhue), swimming beaches and multiple boat accesses.

A LAP study was conducted on the lake in 1996. Data from that study revealed a lakewide mean TP of 258 µg/L, chlorophyll-a of 63 µg/L and Secchi of 0.75 m. Chlorophyll-a in the near-dam segment (where the beaches are located) peaked at 207 µg/L. Blue-green algae were dominant from June through September. The data from this study and historical data are well above the thresholds for the NCHF or WCBP ecoregions that comprise the lake's watershed. As a result Lake Byllesby should be listed.

Literature Cited

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Appendix E.

Wetland Listing Timelines

Action Item	Jul-Dec 2005	Jan-Jun 2006	July-Dec 2006	Jan-Jun 2007	Jul-Dec 2007	Jan-Apr 2008
Communication/Education Plan						
Notify Clean Water Legacy Stakeholders	CO		CO			CO
Brief Interagency Wetland breakfast group	RG					
Brief wetland staff at Interagency Wetland Group	EAO/RG					
Brief Interagency Wetland breakfast group	RG					
Meet with stakeholders		EAO/RG				
Discuss at TMDL Local Governmental Unit Training Sessions			RG			
Develop fact sheet		EAO/RG				
Regularly update EPA via conference calls		RG/CO	RG/CO	RG/CO	RG/CO	RG/CO
Develop Theoretical TMDL Study Plans						
Benchmark with other states	RG					
Plan wetland Stressor ID with EPA		EAO/RG				
Conduct stressor ID		EAO/RG				
Finalize stressor ID reports		EAO/RG				
Draft 1 Agricultural and 1 Urban wetland TMDL			RG			
Develop priority & schedule criteria				RG		
Review with stakeholders				RG		
Develop TMDL Restoration Scenarios						
Bench mark with other states			RG			
Develop local and watershed wetland goals				RG		
Develop draft plans				RG		
Determine costs and fund sources					RG	
Review with stakeholders					RG	
TMDL Listing						
Review existing listing guidance			EAO			
Draft list of impaired wetlands			EAO			

Assess wetland data using assessment guidance	EAO		
Finalize list		EAO	
Develop schedules		RG	
Meet with local stakeholders		EAO/RG	
Public Meetings		EAO/RG	
List wetlands			EAO

KEY:
CO - Commissioner's Office
EAO - Environmental Analysis & Outcomes
RG - Regional Division