Methodology for Iowa's 2006 Water Quality Assessment, Listing, and Reporting Pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act

Prepared by:

Iowa Department of Natural Resources:
Environmental Services Division
Geological Survey & Land Quality Bureau
Watershed Monitoring & Assessment Section

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Introduction

Iowa's 2006 assessment and listing methodology attempts to incorporate recommendations in U.S. EPA's guidance for the 2006 assessment, listing, and reporting requirements pursuant to Sections 303(d) and 305(b) of the federal Clean Water Act (U.S. EPA 2005). This EPA guidance establishes the formats for an "integrated report" (IR) that satisfies the listing requirements of Section 303(d) and the reporting requirements of Sections 305(b) and 314 of the Clean Water Act (CWA). This EPA guidance replaces all previous guidance pertaining to Sections 305(b) and 303(d) except EPA's Consolidated Assessment and Listing Methodology (CALM) (U.S. EPA 2002). Due to the lack of details regarding the mechanics of water quality assessment in more recent EPA guidance, IDNR continues to use assessment methods recommended in previous EPA guidance (U.S. EPA 1997). Iowa's 2006 methodology meets the requirements of CWA, Section 303(d)(1)(a) and 40 CFR Section 130.24 and incorporates requirements of Iowa's credible data law (Attachment 1). The changes in methodology between the 2004 and 2006 listing cycles are summarized in Table 1 and are explained throughout this document.

Overview of the assessment and listing process:

The process of assessing water quality and adding waterbodies to the state list of "impaired" waters involves three interrelated program areas of the federal Clean Water Act (CWA): (1) establishment of state water quality standards that identify beneficial uses for the state's waterbodies and that identify criteria to determine whether each use is being achieved, (2) development of water quality assessments by comparing water quality information to water quality standards to determine whether or not beneficial uses are being achieved, and (3) addition of the appropriate waters assessed as "not fully supporting" beneficial uses (i.e., "impaired") to the state's Section 303(d) list. The state's 303(d) list is thus a public accounting of all assessed waterbodies determined to be impaired where a TMDL needs to be developed. A waterbody placed on the 303(d) list has been assessed as not fully meeting water quality standards including designated uses (e.g., for primary contact recreation, aquatic life, and/or as a source of drinking water for a public water supply). The failure to fully meet state standards can results from the following: violations of numeric criteria, narrative criteria, anti-degradation requirements as defined in U.S. EPA's regulations regarding water quality standards (40 CFR 131), and/or a determination that a specific designated use cannot be achieved. The violations of water quality standards might be due to an individual pollutant, multiple pollutants, or an unknown cause of impairment. As provided for in U.S. EPA's (2005) guidance, other waterbodies may be assessed as impaired but not included on the 303(d) list. These waters will be included in Category 4 of the Integrated Report (water is impaired, but a TMDL is not needed) (Table 1). IR Category 4 includes impaired waterbodies where (1) a TMDL has been completed but water quality standards have not yet been attained; (2) other required control measures are expected to result in attainment of water quality standards in a reasonable period of time; and (3) the impairment or threat is not caused by a "pollutant" as defined by U.S. EPA.

The Iowa Water Quality Standards:

According to U.S. EPA, a water quality standard is composed of three components: (1) a description of beneficial use, (2) criteria to protect this use, and (3) an anti-degradation policy that ensures protection of water quality where water quality exceeds levels necessary to protect fish and wildlife propagation and recreation in and on the water. Thus, the basis for a state's 305(b) assessments and Section 303(d) lists of impaired waters is ultimately the state's water quality standards. The version of the *Iowa Water Quality Standards* with the effective date of July 16, 2003 was used as the basis for water quality assessments prepared for this (2006) assessment and listing cycle. This version of the *Standards* was the most recent EPA-approved version available during the period of time covered by the 2006 assessment and listing cycle (2002 through 2004). This version of the standards is available upon request from Iowa DNR's Watershed Monitoring & Assessment Section.

The Total Maximum Daily Load (TMDL):

The Watershed Monitoring & Assessment Section of the Iowa DNR's Geological Survey and Land Quality Bureau conducts water quality assessments as required by Clean Water Act Section 305(b). Based on these assessments, section staff identify waterbodies in the state of Iowa that may require a total maximum daily load (TMDL) allocation to address the causes and sources of pollutants contributing to impairment of a designated use or other applicable beneficial use (IR Category 5 waters). In general terms, a TMDL defines the level of water quality needed to support a water quality standard, including the designated uses, water quality criteria, and the anti-degradation policy that comprise the standard. Conceptually, a TMDL is the maximum pollutant load from point sources and nonpoint sources, plus a load allocated to a "margin of safety," that a waterbody can receive and continue to meet water quality standards. The margin of safety accounts for the lack of understanding of the relationship between pollutant loads and water quality. The methodology used by IDNR staff to identify impaired waterbodies for the 2006 reporting/listing cycle in Iowa is described in this document.

<u>Deadlines:</u>

According to current EPA regulations, the Section 303(d) list of impaired waterbodies must be submitted to EPA by April 1 of every even numbered year. Thus, this methodology was designed to meet the deadline for submission of the list to be submitted to U.S. EPA in April 2006.

<u>The "integrated report":</u>

Based on previous guidance from U.S. EPA (e.g., U.S. EPA 1997), most states, including Iowa DNR, have historically produced separate Section 305(b) reports and Section 303(d) lists. Section 305(b) reports have attempted to characterize water quality statewide and thus identified not only designated use impairments but also water quality concerns that are worthy of note and further investigation but do not constitute Section 303(d)-type water quality impairments. The 303(d) lists, on the other hand, have represented the subset of waterbodies assessed for the Section 305(b) report with known and reasonably verifiable impairments of a designated use or general use, as defined in the *Iowa Water Quality Standards,* that are appropriate for Section 303(d) listing. Based on development of new guidance by U.S. EPA (2003), however, an "integrated report" was prepared for the 2004 cycle that incorporated elements of both the Section 305(b) report and Section 303(d) list. Based on updated guidance from U.S. EPA (2005), IDNR again used the integrated report format for the 2006 Section 305(b) reporting and Section 303(d) listing cycle.

In their guidance for the 2004 and 2006 integrated assessment, reporting, and listing cycles, U.S. EPA (2003, 2005) recommended that reporting requirements of Sections 305(b) and 303(d) be "integrated" into a report that contains five assessment categories and associated subcategories:

- Category 1: All designated uses are met.

- Category 2: Some of the designated uses are met but there is insufficient data to determine if remaining designated uses are met.

- Category 3: Insufficient data exist to determine whether any designated uses are met.

- Category 4: Water is impaired or threatened but a TMDL is not needed because one of the following occur:

    4a. A TMDL has been completed;
    4b: Other required control measures are expected to result in attainment of water quality standards in a reasonable period of time;

4c: The impairment or threat is not caused by a "pollutant."

- Category 5: Water is impaired or threatened and a TMDL is needed [IR Category 5 is the state's Section 303(d) list].

The five categories of EPA's integrated reporting and listing format used for Iowa's 2006 integrated report are further explained below and are summarized in Table 2. These same categories were also used for Iowa's 2004 integrated report. In the descriptions below, the text in italics is taken directly from U.S. EPA's (2005) guidance for integrated reporting. The notes that follow these excerpts contain IDNR's interpretations and modifications of this guidance.

> **Category 1 waterbodies:** *Waters belong in Category 1 if they are attaining all designated uses and no use is threatened. Segments should be listed in this category if there are data and information that are consistent with the State's methodology and this guidance, and support a determination that all WQSs* [water quality standards] *are attained and no designated use is threatened.*
>
> **Category 2 waterbodies:** *Waters should be placed in Category 2 if there are data and information that meet the requirements of the State's assessment and listing methodology that support a determination that some, but not all, designated uses are attained and none are threatened. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize a water consistent with the State's listing methodology.*
>
> > Iowa DNR has made the following modifications to IR Category 2: the renaming of EPA's Category 2 as Category 2a and the addition of Category 2b.
> >
> > > <u>Category 2a: Some uses supported; insufficient information to determine whether other uses are supported.</u> This wording is consistent with U.S. EPA's definition of IR Category 2.
> > >
> > > <u>Category 2b: At least one use assessed as fully supported with at least one other use "evaluated" as impaired.</u> An "evaluated" assessment of impairment lacks sufficient confidence to take forward to either Category 5 (Section 303(d) list) or Category 4 (impaired but TMDL not required). This subcategory allows tracking of the "impaired / evaluated" waterbodies (e.g., a biological

assessment of impairment based on data generated by a non-IDNR sampling protocol). Waters placed into subcategory 2b will be added to Iowa's list of "waters in need of further investigation."

Category 3 waterbodies: *Waters belong in Category 3 if there are insufficient or no data and information to determine, consistent with the State's listing methodology, if any designated use is attained. To assess the attainment status of these waters, States should schedule monitoring on a priority basis to obtain data and should also make efforts obtain information necessary to move these waters into Categories 1, 2, 4, and 5.*

Iowa DNR has made the following modifications to IR Category 3: the renaming of EPA Category 3 to Category 3a and the addition of Category 3b.

<u>Category 3a. Insufficient data exist to determine whether any uses are met; no uses are assessed [either "evaluated" or "monitored"].</u> This wording is consistent with U.S. EPA's definition of IR category 3.

<u>Category 3b: Insufficient data exist to determine whether any designated uses are met, but at least one use is assessed as potentially impaired based on an "evaluated" assessment.</u> This category is similar to IDNR's Category 2b, but no other uses are assessed as "fully supported" (i.e., the only use assessed is the one assessed as "impaired/evaluated"). Similar to IDNR subcategory 2b, this subcategory allows tracking of the "impaired / evaluated" waterbodies. Waters placed into subcategory 3b will be added to Iowa's list of "waters in need of further investigation."

Category 4 waterbodies: *Waters belong in Category 4 if one or more designated uses are impaired or threatened but establishment of a TMDL is not required. States may place an impaired or threatened water that does not require a TMDL in one of the following three subcategories:*

- *<u>Category 4a: a TMDL has been completed for the water-pollutant combination.</u> Waters should only be placed in Category 4a when all TMDLs needed to result in attainment of all applicable WQ Standards have been approved or established by EPA. Current regulations do not require TMDLs for all waters.*

- *<u>Category 4b: other required control measures are expected to result in the attainment of WQSs in a reasonable period of time.</u> Some waters may be excluded from Category 5, and placed into Category 4b. In order to meet the requirements to place these waters into Category 4b, the State must demonstrate that "other pollution control requirements (e.g., best management practices) required by local, State or Federal authority" (see 40 CFR 130.7(b)(1)(iii)) are expected to address all water-pollutant combinations and attain all WQ Standards in a reasonable period of time. EPA expects that States will provide adequate documentation that the required control mechanisms will address all major pollutant sources and establish a clear link between the control mechanisms and WQ Standards.*

- *<u>Category 4c: the impairment or threat is not caused by a pollutant.</u> Waters should be listed in Category 4c when an impairment is not caused by a pollutant. "Pollution," as defined by the Clean Water Act, is the "man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water." In some cases, the pollution is caused by the presence of a pollutant and a TMDL is required. In other cases, pollution does not result from a pollutant and a TMDL is not required. An example of a pollutant stressor would be copper; an example of a non-pollutant stressor ("pollution") would be "low flow."*

Iowa DNR has made the following modification to IR Category 4: the addition of Category 4d.

<u>Category 4d. Water is impaired due to a pollutant-caused fish kill and enforcement actions were taken against the party responsible for the kill: a TMDL is neither appropriate nor needed.</u> For purposes of Section 305(b) assessments in Iowa, all waters affected by a fish kill, whether caused by a known pollutant or a suspected pollutant, are assessed as impaired. Those kills where a pollutant cause was identified are placed into either Category 4d (responsible party identified and enforcement action taken: TMDL not required) or Category 5 (no responsible party identified; enforcement action not taken: a pollutant problem may remain and a TMDL is potentially needed).

Category 5 waterbodies: *This category constitutes the Section 303(d) list that EPA will approve or disapprove under the CWA. Waters should be placed in Category 5 when it is determined, in accordance with the State's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to cause an impairment or threat. If that impairment or threat is due to a pollutant, the water should be placed in Category 5 and the pollutant causing the impairment identified.*

Iowa DNR has made the following modifications to IR Category 5: the renaming of EPA's Category 5 to Category 5a and the addition of Category 5b.

<u>Category 5a: Water is impaired or threatened by a pollutant stressor and a TMDL is needed.</u> This wording is consistent with U.S. EPA's definition of IR Category 5.

<u>Category 5b: Impairment is based on results of biological monitoring or a fish kill investigation where specific causes and/or sources of the impairment have not yet been identified.</u> The assessment adequately demonstrates that an impairment exists, but either the cause or the source of the impairment is unknown. The primary use of this subcategory is for biologically-based (biomonitoring) impairments with the cause listed as "unknown" and for fish kill-based impairments where a pollutant cause was identified but no source was found. Additional monitoring / investigation, such as that conducted as part of IDNR's stressor identification procedure, is needed to determine causes or sources before the TMDL can be developed.

According to U.S. EPA's (2005) guidance, the Section 303(d) list is composed of waters included on IR Category 5 of the Integrated Report, and only includes those waters for which a TMDL needs to be developed. This list includes waterbodies impaired by "pollutants" such as nitrate and indicator bacteria. The source of impairment might be from point sources, nonpoint sources, groundwater or atmospheric deposition. Some sources of impairment of Iowa waterbodies originate outside of the state. Historically, Iowa has listed impaired waterbodies regardless of whether the source of pollutant is known and regardless of whether the pollutant source(s) can be legally controlled or acted upon by the state of Iowa. This methodology is consistent with that history.

As specified in Iowa's credible data law, waterbodies where the assessment indicates a potential impairment, but where sufficient and credible data are lacking, will not be included on the state's 303(d) list (IR Category 5). According to this methodology, these waters will be included in IR Category 2 or 3 and placed on the state list of "waters in need of further investigation" as provided for by Iowa's credible data legislation.

Changes in methodology since the 2004 reporting/listing cycle

The changes in IDNR's assessment and listing methodology between the 2004 and current (2006) cycles are summarized in Table 1. The following changes were made.

(1) Threatened waters: Prior to the 2006 assessment/listing cycle, IDNR used the assessment category of "fully supported/threatened" in two ways:

(1) to indicate a waterbody where all uses are fully supported but, due to historical impacts, some minor water quality impacts occur; no adverse water quality trend is present: waterbody not impaired;

(2) to indicate that a use is fully supported but an adverse water quality trend exists that suggests that the use would be assessed as "impaired" by the time of the next biennial assessment: waterbody impaired (this is the EPA definition of "threatened").

The use of the threatened/not impaired category allowed IDNR to differentiate between waterbodies with excellent water quality and/or biotic integrity and those with good water quality/biotic integrity but that show evidence of minor impacts. Based on a recommendation from EPA Region 7 and based on a review of assessment results from other states, IDNR decided to (1) abandon its use of the threatened/not impaired category and (2) adopt the EPA definition of "threatened" that uses are supported but an adverse trend suggests that impairment is likely: waterbody impaired.

(2) Listings based on those of adjacent states: For the 2006 assessment/listing cycle, IDNR will adopt, subject to Iowa's credible data considerations, listings of adjacent states for shared (border) waters where Iowa has a similar use designation and supporting water quality criteria. Prior to the 2006 cycle, IDNR would base listings for border waters only on an analysis of monitoring data from adjacent states.

(3) Change in indicator bacterium from fecal coliforms to *E. coli*: The change of indicator bacteria from fecal coliform bacteria to *E. coli* was required by changes in the *Iowa Water Quality Standards* that became effective in July 2003 (IAC 2003). These updated standards also expanded the length of the recreational season from seven months (April 1-October 31) to nine months (March 15-November 15). This change in indicator bacterium required that IDNR use data for *E. coli* to assess support of primary contact (Class A) uses for the 2006 assessment/listing cycle.

(4) Elimination of the high-flow exemption for indicator bacteria: Historically, IDNR used provisions in the *Iowa Water Quality Standards* to exclude data for indicator bacteria that were collected during runoff-related high-flow conditions. Due to revisions in the *Standards*, IDNR now uses all existing and available monitoring data for indicator bacteria (i.e., *E. coli*) when determining support of primary contact recreation (Class A) uses. The revised *Iowa Water Quality Standards* (IAC 2003) essentially eliminated the provision present in previous versions of the *Standards* that exempted the state standard for indicator bacteria during conditions when surface waters were materially affected by surface runoff. The current *Standards* (IAC 2003) state that the *E. coli* criteria shall apply when the primary contact recreation (Class A) uses can reasonably be expected to occur. Neither the *Standards* nor their supporting (rule-referenced) documents, however, contain guidance on the stream flow conditions that characterize conditions when the Class A uses "can reasonably be expected to occur." Any attempt to implement such an exemption for Iowa's current *Standards* would be problematic. Consequently, all the existing, readily available, and credible monitoring data for *E. coli* will be compared to the appropriate Iowa water quality criteria for the purpose of assessing support of Class A uses.

(5) Use of single-sample maximum value for indicator bacteria to assess support of primary contact recreation uses. Historically, due to the lack of a single sample maximum criterion in the *Iowa Water Quality Standards*, IDNR used the EPA-recommended single-sample maximum value for identifying impairments of Class A (primary contact recreation) uses for rivers and non-beach areas of lakes:

> *if more than 10 percent of the samples exceeded a single-sample maximum value of 400 fecal coliform organisms / 100 ml, the primary contact recreation uses of the waterbody should be assessed as "partially supported"* (U.S. EPA 1997).

The single-sample maximum value, however, was not used for identifying impairments at beach areas of Iowa lakes and reservoirs . Due to the design of IDNR's beach monitoring program, sufficient data existed for beaches to calculate 30-day geometric mean levels of indicator bacteria that could then be compared to Iowa's Class A bacteria (fecal coliform) criterion.

The July 2003 revisions of the *Iowa Water Quality Standards* included the addition of a single-sample maximum value for the newly-adopted indicator bacterium, *E. coli*. Thus, for the 2006 reporting/listing cycle, all Iowa surface waters with data of sufficient quantity and quality will now be assessed based on the Iowa's single-sample maximum criterion for *E. coli*. Stream/river reaches and non-beach areas of lakes (where sampling frequency is monthly) will be assessed as in past reporting cycles: if significantly more than 10% of the combined results over the three recreation seasons exceed the single sample maximum value, the primary contact recreation uses will be assessed as "partially supported." For beach areas (where sampling frequency is weekly), if significantly more than 10 percent of the samples collected during any recreational season exceed the single-sample maximum value, the primary contact recreation uses will be assessed as "partially supporting." Determining whether more than 10 percent of the data values exceed the single-sample maximum criterion will be based on maintaining a greater than 90 confidence level that the 10 percent of actually do exceed this criterion (see Lin et al. 2000). The final assessment of support of the Class A uses will also depend on comparison of geometric mean levels of indicator bacteria to Iowa's geometric mean criterion.

(6) Uniform assessment reaches for the Upper Mississippi River: Due to a 2004 interstate agreement (memorandum of understanding) developed by the Upper Mississippi River Basin Association's *Water Quality Task Force*, Iowa DNR implemented the uniform assessment reaches for the Iowa reach of the Upper Mississippi River that are consistent with assessment reaches used by the adjacent states of Wisconsin and Illinois.

In 1999, the Upper Mississippi River Basin Association (UMRBA) formed a water quality task force composed of water administrators in the five states of the Upper Mississippi River (UMR) basin to, in part, facilitate interstate coordination on Section 305(b) assessments and Section 303(d) listings for the Upper Mississippi River. Relative to this coordination, and for the purpose of improving interstate consistency in assessments and listings, UMRBA prepared and published the report *Upper Mississippi River Water Quality: the states' approaches to Clean Water Act monitoring, assessment, and impairment decisions* (UMRBA-WQTF 2004) that summarizes the various approaches used for Section 305(b) assessments and Section 303(d) listings by each of the five UMR states (this report is available at http://www.umrba.org/reports.htm). Also, as part of this effort, the Task Force recommended that the five UMR states enter into a memorandum of understanding that defined consistent assessment reaches for the entire length of the Upper Mississippi River. Signing of this MOU was completed in September 2004. As a result of adopting the UMRBA's consistent assessment reaches (Table 3), the number of assessment segments along the Iowa reach of the UMR decreased from fourteen to five. As part of the MOU, however, each state retained the flexibility to continue to assess subsegments within the larger UMRBA assessment reaches, and IDNR will continue to use this approach when and where appropriate. For purposes of compliance with the UMRBA MOU, however, IDNR will also provide Section 305(b) assessments and Section 303(d) listings on the expanded scale of the UMRBA uniform assessment reaches.

(7) Revision of the concept of "impaired waters": For purposes of ensuring that Iowa's impaired waters are eligible for funds to improve water quality, the concept of "impaired waters" was defined (expanded) to include not only IR Category 5 (waters requiring a TMDL = the state's Section 303(d) list) but also waters in IR Category 4a, 4b, and 4c (waters assessed as impaired but do not require development of a TMDL). With Iowa's adoption of EPA's Integrated Reporting format for the 2004 reporting/listing cycle, waters assessed as impaired and appropriate for Section 303(d) listing were potentially placed into two IR categories: Category 5 (impaired and TMDL required) and Category 4 (impaired but TMDL not required). According to EPA guidance for the IR format (EPA 2003, 2005), a state's Section 303(d) (i.e., impaired waters) list is comprised only of the waters in IR Category 5. When speaking more generally of the state's impaired waters, however, waters in IR Category 4 may also need to be included. For example, waters in IR Category 4a (impaired but TMDL prepared and approved by U.S. EPA) are technically not included in the states Section 303(d) but remain impaired and remain in need of funds for (1) implementing the approved TMDL and (2) post-implementation monitoring to determine whether state standards are now being met. Likewise, waters in IR Category 4c (impaired by non-pollutant stressors) are impaired and could benefit from water quality improvements focused on the non-pollutant stressors (e.g., improvements in aquatic habitats). If these waters are not considered as part of the state's "impaired waters list," they may not be eligible to receive grant funds (e.g., through Clean Water Act Section 319) for projects designed to improve water quality. Thus, waters from IR Category 4 and IR Category 5 will be considered "impaired" and eligible for water quality improvement funding.

(8) Basis for impairment of fish consumption uses: Impairments of fish consumption uses will be based on existence of advisories based on the new (2006) Iowa Department of Public Health/Iowa DNR risk-based advisory protocol as opposed to existence of advisories based on use of the U.S. Food & Drug Administration's "action levels." The existence of, or potential for, a fish consumption advisory has long been the basis for assessing the support of fish consumption uses in Iowa's rivers and lakes. Prior to 2006, IDNR used action levels published by the U.S Food and Drug Administration to determine whether consumption advisories should be issued for fish caught as part of recreational fishing in Iowa. In 2005, the Iowa Department of Public Health, in cooperation with IDNR, developed a revised protocol that abandoned the U.S. FDA action levels in favor of more protective risk-based trigger levels. This protocol went into effect in January 2006 (see *http://www.iowadnr.gov/fish/news/consump.html* for more information on Iowa's revised fish consumption advisory protocol). This new protocol now serves as the basis for Section 305(b) assessments and identification of Section 303(d) impairments of fish consumption uses.

(9) Sub-segmenting Iowa lakes: Where supported by availability of credible data, Iowa lakes will be sub-segmented to account for (1) water quality differences between deeper water areas (e.g., near the dam) and shallow water areas (e.g., up-lake arms under influence of lake tributaries) and (2) localized impairments that, based on other monitoring data, do not exist in other portions of the lake. While the sub-segmenting of Iowa's stream and river reaches has been a part of the Iowa's Section 305(b) assessment framework since 1988, Iowa's lakes have historically been treated as a single waterbody—regardless of size—for purposes of water quality assessment and impaired waters listing. Typically, lake monitoring in Iowa has been conducted only at the deepest location of the lake. Thus, any water quality assessment developed would be based solely on that data, and the resulting assessment would be applied to the entire lake. Data are now available for a number of lakes from multiple locations in addition to the deepest portion of the lake. This monitoring has shown that gradients exist in water quality conditions from deeper to shallower portions of the lake, such that data from deeper locations may show "full support" of designated uses while data from shallower locations in up-lake areas may suggest impairment of these uses. Thus, depending on the availability of data for multiple locations within a lake, Iowa lakes will be sub-segmented and assessed accordingly for the 2006 assessment and listing cycle. Any Section 303(d) impairments identified for a given lake sub-segments is specific to that sub-segment and does not apply to the remainder of the lake.

(10) Modification in use of the "10-percent rule" for identifying impairments: Historically, IDNR used a raw score approach to determine whether greater than 10 percent of the samples collected exceeded a water quality criterion (e.g., for dissolved oxygen). This approach has always been problematic due to the small numbers of samples typically collected over a two or three-year period as part of ambient monitoring programs. For the 2006 reporting/listing cycle, the determination of whether more than 10 percent of samples exceed a criterion, and thus suggest "impairment" of designated uses, will be based on guidelines used by the state of Nebraska (NDEQ 2006, Liu et al. 2000) that (1) account for problems with estimating percent violations with small sample sizes and (2) maintain a greater than 90 percent confidence that more than 10 percent of the samples actually do exceed the criterion.

The Assessment and Listing Process

Preparation of Iowa's integrated [305(b)/303(d)] report includes the following basic steps:

- Assemble all existing and readily available water quality-related data and information not previously used for 305(b) water quality assessments;
- Identify water quality-related data and information of sufficient quality and quantity for purposes of developing defensible water quality assessments;
- Compare these water quality-related data and information to state water quality standards to determine the degree to which assessed waters meet these standards;
- Identify impairments that are based on water quality-related data and information that meet the state's data quantity and data quality requirements;
- Place waters into one of the five categories specified in U.S. EPA's (2003, 2005) "integrated report" guidance for water quality assessment and listing;
- Prepare the state list of waters in need of further investigation as required by state law;
- Prioritize the waterbodies on the draft Section 303(d) list (Category 5) for TMDL development (high, medium, and low);

- Provide the draft integrated report, including the draft Section 303(d) list (Category 5), to the public for review and comment;
- Revise and finalize the integrated report based on new information and public input;
- Submit the finalized integrated report, including the Section 303(d) list, to U.S. EPA for approval/disapproval;
- Develop a schedule for development of TMDLs for Section 303(d)-listed (IR Category 5) waterbodies.

Sources of existing and readily available water quality-related data and information:
As specified in U.S. EPA's current (1992) TMDL rule (40 CFR 130.7), sources of existing and readily available water quality-related data and information to be considered as part of Section 303(d) listing include, but are not limited to, the following:

- the state's most recent (2004) CWA Section 305(b) assessments;
- CWA Section 319 nonpoint source assessments;
- dilution calculations, trend analyses, or predictive models for determining the physical, chemical, or biological integrity of streams, rivers, lakes, and estuaries;
- water quality-related data and water-related information from local, State, Territorial, or Federal agencies (especially the U.S. Geological Survey's National Water Quality Assessment Program (NAWQA) and National Stream Quality Accounting Network (NASQAN)), Tribal governments, members of the public, and academic institutions.

Historically, the majority of information used by IDNR to develop Iowa's Section 303(d) list of impaired waters has been taken from its Section 305(b) assessments. Data sources used to assess water quality conditions in Iowa for purposes of Section 305(b) assessment include, but are not limited to, the following:

- Physical, chemical, and biological data from ambient fixed station water quality monitoring networks conducted by IDNR and other agencies (e.g., U.S Geological Survey, U.S. Army Corps of Engineers);
- Data from water quality monitoring conducted by adjacent states on border rivers and waters flowing into the state;
- Data from biological monitoring being conducted by IDNR in cooperation with the University of Iowa Hygienic Laboratory (UHL) as part of a current effort to establish

biological criteria for Iowa's ecoregions and subecoregions and as part of the on-going regional Environmental Monitoring and Assessment Program (EMAP) project;

- Data from the IDNR-sponsored statewide lake monitoring project conducted by Iowa State University;
- Data from monitoring of bacterial indicators in rivers and at beaches of publicly-owned lakes;
- Data from programs to monitor fish tissue for toxic contaminants;
- Reports of pollutant-caused fish kills;
- Where readily available, data from public water supplies on the quality of raw and finished water;
- Drinking water-related source water assessments under Section 1453 of the Safe Drinking Water Act;
- Data from special studies of water quality and aquatic communities;
- Best professional judgment of IDNR staff;
- Results of volunteer monitoring (e.g., by IOWATER-trained volunteers);
- Water-related information received from the public.

The cutoff date for the data collection period for Iowa's 2006 Integrated Report is the end of the calendar year 2004. This is a general guideline used by IDNR, and more recent information may be used for some types of water quality information (e.g., fish consumption advisories and reports of pollution-caused fish kills). Large amounts of staff time are needed to summarize monitoring data, compare the summarized results to water quality standards, develop the waterbody-specific assessments of the degree to which designated uses are supported, and to solicit and respond to public comments on the draft Section 303(d) list. Also, water quality data generated by the various agencies are not available immediately following sample collection: a lag time of from a few months up to half a year is associated with obtaining results of water quality monitoring networks. Given these time requirements, and given the other work responsibilities of IDNR staff that prepare Iowa's Integrated Report, the allowance of a 15-month window for report preparation prior to the April deadline is not excessive.

For purposes of developing water quality assessments for the 2006 integrated report, three years of water quality data were typically used for both conventional pollutant parameters (e.g., indicator bacteria) and the less frequently monitored toxic parameters (e.g., toxic metals). This is the second consecutive 305(b)/303(d) cycle for which IDNR has used a three-year data gathering period. Prior to the 2004 cycle, only two years of data were used for Iowa's Section 305(b) reports. For most assessments, the use of three years of data increases the number of samples upon which the decision on use support is based and will help address the problem of year-to-year fluctuations in water quality. More recent data and information are used where appropriate to supplement the current assessment. Older data, up to five years old, are used to supplement data from the current assessment period for water quality parameters with low collection frequency (e.g., toxic metals).

As specified in Iowa's credible data law, and based on the uncertainty inherent in using old data to characterize current water quality conditions, data between five and ten years old are used for Section 305(b) assessments but are not used for purposes of adding waters to Category Five of the Integrated Report (i.e., the Section 303(d) list). Data older than five years are generally believed to be less reflective of current ambient water quality than are more recent data. Of course, nearly all recent water quality data have already been used for Section 305(b) assessments and thus have already been considered for Section 303(d) listings. Also, a listed waterbody will not be removed from the state's Section 303(d) list simply because the data upon which the impairment was based have aged beyond five years.

The sources of water quality data used for water quality assessments and impaired waters listings in Iowa are discussed in more detail below.

- **Physical, chemical, and biological data from ambient fixed station water quality monitoring networks conducted in Iowa by IDNR and other agencies**

  The IDNR, in cooperation with UHL, has conducted routine ambient monitoring of river water quality in Iowa since the early 1980s. Due to resource constraints, the majority of this monitoring prior to 1999 was limited to relatively few (16) locations. Due to an appropriation from the Iowa Legislature, this monitoring program was significantly expanded beginning in October 1999. Iowa rivers are now monitored monthly at 82 sites for 94 physical, chemical, and bacterial parameters through a contract with the UHL which provides both data collection and laboratory services. Sixty-two of these sites are classified as ambient (background) sites. These sites are distributed throughout every major river basin in an effort to provide good geographic coverage of the state. Twenty-three of the sites are associated with 10 major cities, with monitoring stations located both upstream and downstream from each city. In addition to the standard parameters, the upstream/downstream urban sites are being tested for a variety of pharmaceuticals, industrial chemicals, and insecticides. For more information on the IDNR's ambient and city monitoring programs see the following web site: *http://wqm.igsb.uiowa.edu/*.

Long-term ambient water-quality monitoring has also been conducted in Iowa by the following agencies: U.S. Army Corps of Engineers, U.S. Geological Survey (USGS), and utilities such as the Des Moines Water Works, the Cedar Rapids Water Department, and the Rathbun Rural Water Association. The monitoring networks in Iowa conducted by agencies other than IDNR are typically designed to answer questions specific to drinking water sources or to the effects of in-stream structures or large facilities on water quality (e.g., flood control reservoirs or power generating facilities). For example, networks have been established by the U.S. Army Corps of Engineers on the Des Moines, Raccoon, and Iowa rivers to evaluate changes in water quality caused by Saylorville, Red Rock, and Coralville reservoirs, respectively. In general, stations in these networks have remained fixed for nearly four decades, and they have been monitored more frequently than stations in the IDNR/UHL network. Thus, these networks provide a relatively long-term database that can be used to characterize water quality conditions. For information on the monitoring networks on the Des Moines and Raccoon rivers, see the following web site: *http://www.cce.iastate.edu/research/lutz/dmrwqn/dmrwqn.html*.

Currently, USGS conducts routine water quality monitoring at three fixed stations in Iowa: the Mississippi River at Clinton, the Missouri River at Omaha (Council Bluffs), and the Big Sioux River at Akron. All three of these sites are remnants of the USGS National Stream Quality Accounting Network (NASQAN). In late 1994, the USGS began routine monitoring at selected locations in the Skunk, Iowa, Cedar, and Wapsipinicon river basins as part of the National Water Quality Assessment Program (NAWQA) in the Eastern Iowa Basins study unit. This monitoring was conducted through September 1998. The NAWQA program is designed to generate comprehensive and nationally-consistent water quality information that can be used to describe the status and trends of the nation's water resources. NAWQA monitoring in the Eastern Iowa Basins study unit is currently in the low-intensity phase with resumption of routine monitoring scheduled for 2005 (Stephen Kalkhoff, U.S. Geological Survey, Iowa City, personal communication). During the 2002-2004 data gathering period, four stations in the Eastern Iowa Basins NAWQA unit were monitored: Wapsipinicon River near Tripoli (Bremer Co.), Iowa River near Rowan

(Wright Co.), South Fork Iowa River near New Providence (Hardin Co.), and Iowa River near Wapello (Louisa Co.) Data from USGS monitoring in Iowa are available at the following web site: *http://waterdata.usgs.gov/nwis/sw*.

- **Data for Iowa tributaries of the Upper Mississippi River generated by the Long Term Resource Monitoring Program**

  Intensive water quality monitoring of Pool 13 of the Upper Mississippi River and several Iowa tributaries is conducted by Iowa DNR staff at Bellevue, Iowa, as part of the Long-Term Resource Monitoring Program (LTRMP). The LTRMP was authorized under the Water Resources Development Act of 1986 as an element of the U.S. Army Corps of Engineers "Environmental Management Program" (EMP) and is currently being implemented by the U.S. Geological Survey in cooperation with the five Upper Mississippi River basin states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin). State staff at six field stations in the Upper Mississippi River system conduct monitoring of fisheries, macroinvertebrates, vegetation, as well as water quality on specified reaches of the river. Water quality monitoring by the LTRMP began in 1988 and continues. LTRMP stations with chemical data used for water quality assessments in Iowa are summarized in Table 4.

- **Data from water quality monitoring conducted by adjacent states on border rivers and waters flowing into the state**

  States adjacent to Iowa (South Dakota, Minnesota, Wisconsin, Illinois, Missouri, and Nebraska) also have fixed station ambient water quality monitoring programs that generate data useful for purposes of water quality assessments in Iowa. Data from these monitoring networks are available either through the U.S. EPA's national water quality database "STORET" [http://wqm.igsb.uiowa.edu/iastoret/] or through personal contacts with water quality monitoring staff of environmental agencies in these states. These data are used with the guidelines described in this document to assess the degree to which *Iowa Water Quality Standards* are being met. In addition, decisions on assessment and listing for interstate waters are coordinated, to the extent possible, with water quality staff from the adjacent states.

- **Data from biological monitoring being conducted by IDNR in cooperation with UHL as part of a current effort to establish biological criteria for Iowa's ecoregions and subecoregions and as part of the ongoing Regional EMAP project**

Biological criteria or "biocriteria" are narrative or numeric expressions that describe the best attainable biological integrity (reference condition) of aquatic communities inhabiting waters of a given designated aquatic life use. In order to develop biocriteria, knowledge of the variation in the ecological and biological conditions within a state is necessary. Ecoregions, generally defined as regions of relative homogeneity in ecological systems and relationships between organisms and their environments, have been used by several states when developing biocriteria for their water quality standards. Reference sites are located on the least impacted streams within an ecoregion. Monitoring results from regional reference sites can thus serve as benchmarks to which other streams in the region can be compared.

In Iowa, a list of candidate stream reference sites was generated for the state's ten ecoregions and subecoregions in the early 1990s. Sampling of reference sites began in 1994 and continues; the current rate of sampling is 20 sites per year. Stream biological sampling is conducted from July 15 to October 15. In addition to reference site sampling, sampling at "test" sites is conducted to determine how much a stream's biological health is impacted by disturbances such as channelization, livestock grazing, manure spills, wastewater discharges and urban runoff. Currently, approximately 40 test sites are sampled per year. At both reference sites and test sites, standard sampling procedures are used so that data from all sites are comparable. The samples measure how many types of benthic macroinvertebrates and fish are present and the abundance of each type in relation to the whole sample. Benthic macroinvertebrates are collected from several types of habitat including aquatic vegetation, boulders, leaf packs, overhanging vegetation, rocks, root mats and woody debris. Fish are sampled in one pass through the sampling area using electrofishing gear.

These bioassessment sampling protocols have also been used to examine the location and amount of biological impairment in TMDL-targeted watersheds. That is, this "watershed" sampling has been used to identify problem areas that need to be addressed (see IDNR/WRS 2001). More watershed sampling is planned to support development of stream restoration plans, including TMDLs. The data from the sampling of reference sites, test sites, and watershed sites are being used to develop indicators of stream biological integrity that will form the basis for establishment of numeric biocriteria that will be used for Section 305(b) assessments of aquatic life use support.

In 2002, Iowa DNR, in cooperation with the University of Iowa Hygienic Laboratory, began biological sampling as part of a Regional Environmental Monitoring and Assessment Program (REMAP) project designed to randomly select Iowa stream sites over four years to objectively measure biological integrity in flowing streams. This project is based on a random sampling design that will be used to obtain an unbiased sample population from which accurate statements about the status of Iowa's perennial streams can be extrapolated. The survey will sample approximately 60 sites a year and measures several indicators of stream ecosystem health including: fish tissue, sediment, and water contaminant levels; physical habitat quality; and fish and benthic macroinvertebrate populations. This study will determine the current biological health of Iowa streams and help provide a uniform assessment of stream conditions in the Central Plains of the United States.

- **Data from the IDNR-sponsored lake monitoring conducted by Iowa State University**

  Data from statewide surveys of Iowa lakes completed in the early 1980s (110 lakes) and early 1990s (115 lakes) by Iowa State University have served as a basis for past assessments of lake water quality in Iowa. Beginning in 2000, 131 lakes throughout Iowa were monitored annually as part of a IDNR-sponsored five-year project to assess their condition and measure the temporal variability in lake water quality. This monitoring is being conducted by Iowa State University and has continued through 2004. All lakes assessed as part of the 1990/1992 statewide lake survey are being sampled as well as 16 additional lakes. Each lake is sampled three times during the summer season to assess seasonal variability. Samples are taken at the deepest point in each lake basin. Vertical probes are lowered through the water column to determine vertical profiles for temperature, dissolved oxygen, specific conductivity, pH, turbidity, and chlorophyll. An integrated column sampler is used to collect water from the upper mixed zone in thermally stratified lakes and from the entire water column in lakes that lack stratification. The data from these samples are used to develop water quality assessments for the lakes monitored.

- **Data from monitoring of bacterial indicators in rivers and at beaches of publicly-owned lakes**

  Indicator bacteria, such as fecal coliform bacteria and *E. coli*, are commonly monitored by state environmental agencies to indicate the degree to which surface waters support their designated uses for primary contact recreation. High levels of these indicator bacteria suggest that using a river or lake for either primary contact recreation (e.g., swimming or water skiing) or secondary contact recreation (e.g., wading while fishing) presents a health risk due to the potential for waterborne diseases. As part of fixed station monitoring networks in Iowa, several river reaches designated for primary or secondary contact recreation uses are monitored for bacterial indicators on a monthly basis.

  Historically, this type of monitoring had not been conducted at Iowa's lakes. In 1999, however, the IDNR Division of Parks, Recreation and Preserves monitored ten of Iowa's public beaches for indicator bacteria. In 2000, beach monitoring was expanded to thirty-one Iowa beaches and was placed under the direction of IDNR's Watershed Monitoring and Assessment Section. From May through September, these beaches were monitored weekly. All beaches were monitored for three U.S. EPA-recommended bacterial indicators: fecal coliform, enterococci, and *E. coli*. Since 2001, annual monitoring at approximately thirty-five beaches at state-owned lakes as been conducted on a weekly basis during summer recreational seasons.

- **Data from programs to monitor fish tissue for toxic contaminants**

  Annual, routine monitoring for bioaccumulative toxics in Iowa fish tissue is conducted as part of three long-term programs: (1) U.S. EPA Region VII's *Regional Ambient Fish Tissue Monitoring Program*, (2) water quality studies of the Des Moines River near Saylorville and Red Rock reservoirs conducted by Iowa State University under contract with the U.S. Army Corps of Engineers, and (3) water quality studies of the Iowa River near Coralville Reservoir conducted by the University of Iowa also under contract with the U.S. Army Corps of Engineers.

  Since 1980, annual fish collection and analysis activities in Iowa have been conducted by IDNR as part of the U.S. EPA Region VII's *Regional Ambient Fish Tissue (RAFT) Monitoring Program*. Each year in late summer, IDNR fisheries biologists collect fillet samples of both bottom-feeding fish (common carp or channel catfish) and predator fish (usually largemouth bass, crappie, or walleye) from approximately 20 locations on rivers and lakes in Iowa. Selection of sample sites is based on the level of fishing use and date of most recent fish tissue sampling. Currently, samples are analyzed for 19 pesticides, four organic compounds, and four metals. The RAFT program also involves (1) monitoring for trends in levels of toxics in bottom feeding fish (common carp) at ten fixed sites on Iowa's larger rivers as well as (2) follow-up monitoring designed to verify the existence of high contaminant levels and to determine whether the issuance of consumption advisories is justified.

Iowa State University (Department of Civil Engineering, Environmental Engineering Section) conducts annual fish contaminant monitoring for bottom-feeding fish (common carp) at Saylorville and Red Rock reservoirs as part of a U.S. Army Corps of Engineers water quality monitoring program. The University of Iowa has conducted fish contaminant monitoring as part of a similar program at Coralville Reservoir.

Fish contaminant monitoring is also conducted as part of special studies of water quality. For example, the Kansas City District of the U.S. Army Corps of Engineers periodically conducts fish contaminant monitoring at Rathbun Reservoir in southern Iowa. Also, fish contaminant monitoring was conducted over a 13-year period (1988-2000) in Pool 15 of the Upper Mississippi River near Davenport, Iowa, in response to a PCB contamination problem.

- **Reports of pollutant-caused fish kills**

  IDNR routinely receives reports of fish kills that are investigated by IDNR staff from either the Fisheries Bureau or the Compliance & Enforcement Bureau. Information from the reports of these kills, including location, the cause and source of the kill, the size of waterbody affected, and the number of fish killed, is entered into the IDNR Fish Kill Database.

- **Data from public water supplies on the quality of surface water sources and finished water**

  The IDNR Environmental Services Division administers the public drinking water program in Iowa under delegation of authority from the U.S. Environmental Protection Agency. As required by the Safe Drinking Water Act of 1996, IDNR prepares an annual report of violations of national primary (finished) drinking water standards by public water supplies in the state (reports are available at http://www.state.ia.us/epd/wtrsuply/report/report.htm). In addition, several public water supplies using surface water sources in Iowa have generated long-term databases for the quality of raw water used at their facilities. For example, the municipal water supplies at Cedar Rapids and Des Moines routinely collect data on levels of toxic contaminants in the Cedar River and the Raccoon/Des Moines rivers, respectively, which can influence their water treatment processes.

Since 1994, Syngenta, Inc. has sponsored a voluntary program to monitor levels of atrazine in Iowa impoundments used as a source of potable water for a municipal water supply. During the period 2003-2004, this program included surface water supplies for ten Iowa municipalities: Centerville, Chariton, Corydon, Creston, Lamoni, Leon, Montezuma, Osceola, Rathbun, and Winterset.

- **Data from special studies of water quality and aquatic communities**

  Special/intensive studies of water quality are typically conducted over a finite time period and are targeted toward understanding or characterizing specific water quality issues. This type of study differs from "routine" monitoring that is conducted over a long time frame and that typically generates information necessary to describe general water quality conditions. The sampling protocol for intensive studies is site-specific and is based on the contaminant(s) of concern. These studies typically require multiple samples per site over a relatively short time frame. If the contaminants of concern have significant seasonal or daily variation, season of the year and time of day variation are accounted for in sampling design. The number of sampling sites, sampling frequency and parameters vary depending on the study.

  Each year, a number of special water quality studies are conducted in the state; these studies include monitoring conducted in support of TMDL development. Results of special studies may be summarized in the form of a published document, an unpublished report, or may exist only as raw data. For example, IDNR has recently published reports on the water quality of Sny Magill Creek in Clayton County (Fields et al. 2005) and Walnut Creek in Jasper County (Schilling et al. 2006). Surveys of aquatic communities are occasionally conducted by IDNR staff as part of special studies. In addition, a number of water quality reports have been generated during the period 1997-2002 from the U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program. Special water quality studies conducted by colleges and universities as part of undergraduate and graduate projects are also sources of water quality data and other water-related information.

- **Best professional judgment of IDNR staff**

  IDNR utilizes observations of professional staff of the IDNR bureaus of Fisheries and Wildlife, as well as professional staff in other agencies, to assess support of aquatic life uses in certain types of Iowa waterbodies that have historically lacked chemical, physical, and/or biological water quality data. For example, due to the lack of water quality monitoring at Iowa wetlands, and due to the lack of relevant criteria for assessing wetland quality, water quality assessments for these waterbodies have been based entirely on observations of biologists in the IDNR Wildlife Bureau.

- **Results of volunteer monitoring**

  The Iowa volunteer monitoring program (IOWATER) was established in 1999 by the IDNR. This program provides training, equipment and supplies to volunteers for monitoring streams throughout Iowa. Data generated by the IOWATER program can be found on the IDNR web site at *http://www.iowater.net/defaultExp.htm*. A review of the IOWATER database by IDNR staff in 2002 showed considerable variation in data quality within this database. Due to the often unexplained variation, and due to the data quality requirements imposed by Iowa's credible data law, IDNR staff decided not to use results of volunteer monitoring for Section 305(b) assessments or Section 303(d) listings. In addition, Iowa's credible data law passed in 2000 resulted in state regulations that place restrictions on the use of volunteer data for purposes of adding waterbodies to Iowa's Section 303(d) list; these regulations became effective in 2003. These regulations can be found under "Volunteer Monitoring Data Requirements" in the *Iowa Water Quality Standards* (Chapter 61.10, IAC). These restrictions include a requirement for preparation of a monitoring plan by the volunteer monitor and review and approval of this plan by IDNR before the volunteer data can be used for purposes of Section 303(d) listing. If, however, volunteer monitors encounter and document instances of gross pollution such that water quality conditions that appear to violate Iowa's narrative water quality standards at IAC 61.3(2), IDNR will consider use of this information for purposes of Section 303(d) listing as described in the section of this methodology on "overwhelming evidence of impairment". IDNR staff that direct the IOWATER program are consulted to help identify instances of gross pollution discovered through IOWATER monitoring.

- **Water quality-related data and information received from the public**

  Additional water quality-related data and information are received from the public. While potentially useful for developing Section 305(b) water quality assessments, these data and information are more often used only to initiate investigations by IDNR field staff. Results of these investigations may influence or direct future water quality monitoring activities. In all cases, the value, accuracy and potential utility of these data for purposes of CWA reporting are evaluated by the IDNR on a case-by-case basis before such information is used for either developing 305(b) water quality assessments or for identifying Section 303(d) impairments.

Identifying impairments:

As specified in U.S. EPA's regulations for TMDLs (40 CFR 130.7), sources of existing and readily available water quality-related data and information to be considered as part of Section 303(d) listing include but are not limited to the following:

- the state's most recent CWA Section 305(b) report;
- CWA Section 319 nonpoint source assessments;
- dilution calculations, trend analyses, or predictive models for determining the physical, chemical or biological integrity of streams, rivers, lakes, and estuaries; and
- water quality-related data and information from local, State, Territorial, or Federal agencies [in Iowa, especially the U.S. Geological Survey's National Water Quality Assessment Program (NAWQA) and National Stream Quality Accounting Network (NASQAN)), tribal governments, members of the public, and academic institutions].

The majority of information used by IDNR to develop the Section 303(d) list of impaired waters (IR Category 5) is taken from the most recent Section 305(b) assessments for the state of Iowa. As noted in this methodology, IDNR staff attempt to utilize water quality data and related information from a variety of sources. IDNR has not, however, used results of dilution calculations or predictive models to add waterbodies to Iowa's Section 303(d) list. Due to the importance of data quality and quantity in developing accurate assessments, and due to requirements of Iowa's credible data law, only a subset of the available 305(b) information is used for purposes of placing waters into Category 5. The process of determining whether or not data from the above data sources are appropriate for placing waterbodies in Category 5 is described below.

Types of Assessments: *Evaluated* and *Monitored*:

For purposes of developing Section 305(b) assessments, the existing and readily available water quality data described above are used to make two types of water quality assessments: "evaluated" and "monitored." As described in guidelines for Section 305(b) reporting (U.S. EPA 1997, pages 1-5 and 1-9),

Evaluated waters are

> those for which the use support decision is based on water quality information other than current site-specific data such as data on land use, location of sources, predictive modeling using estimated input values, and some questionnaire surveys of fish and game biologists. As a general rule, if an assessment is based on older ambient data (e.g., older than five years), the State should also consider it "evaluated."
>
> For example, water quality assessments based on results from only a few grab samples or on professional judgment of local biologists, in the absence of any supporting data, would be considered "evaluated" assessments.

Monitored waters are

> those waterbodies for which the use support decision is principally based on current, [five years old or less] site-specific ambient monitoring data believed to accurately portray water quality conditions. Waters with data from biosurveys should be included in this category along with waters monitored by fixed-station chemical/physical monitoring or toxicity testing. To be considered "monitored" based on fixed station chemical/physical monitoring, waters generally should be sampled quarterly or more frequently.

Although EPA's guidelines for the 2006 integrated report (U.S. EPA 2005) do not distinguish between "monitored" and "evaluated" assessments, Iowa DNR feels that the distinction remains important for determining the relative scientific strength and confidence of the water quality assessments developed. Thus the Iowa Assessment Database (ADB+) is designed to track "monitored" versus "evaluated" assessments while still complying with the integrated reporting format recommended by U.S. EPA (2005).

In terms of the ability of Section 305(b) assessments to characterize current water quality conditions, IDNR considers "evaluated" assessments as having relatively lower confidence while "monitored" assessments are of relatively higher confidence. IDNR considers "monitored" assessments as sufficiently accurate to be appropriate for both Section 305(b) assessments and Section 303(d) listing (i.e., for placing waters into Category 5 of the integrated report). The lower confidence "evaluated" assessments, however, are viewed as appropriate only for Section 305(b) reporting. Thus, any waters "evaluated" as "impaired" are placed in IR Categories 2 or 3 (i.e., categories for waterbodies with insufficient information for determining whether uses are met). Such waters are added to Iowa's list of "waters in need of further investigation" as provided for in Iowa's credible data law and will be considered for follow-up monitoring to better determine current water quality conditions and the existence of any impairments.

Data *quantity* considerations ("data completeness" guidelines):

For purposes of Section 303(d) listing in Iowa (i.e., placing waters in Category 5), data quantity issues are addressed in this methodology. Beginning with Iowa's Section 305(b) report for 1990, IDNR staff developed "data completeness" guidelines to avoid basing water quality assessments on inadequate amounts of water quality data and to reduce errors in assessments (for example, incorrectly concluding that an impairment exists). For the various parameters used to develop water quality assessments, these guidelines establish the minimum number of data points needed over a given assessment period to adequately determine whether the applicable water quality standards are being met. Assessments that meet these data completeness guidelines are of relatively high confidence and are considered "monitored." Assessments based on an insufficient amount of data to meet these guidelines are of relatively low confidence and are thus considered "evaluated." IDNR's Section 305(b) data completeness guidelines are presented in Table 5. The significance of data completeness guidelines and Iowa's credible data law to Iowa's Section 305(b) water quality assessments and Section 303(d) listings is summarized in Figure 1.

Data *quality* considerations ("credible data" requirements):

As defined by U.S. EPA, *data quality objectives* are qualitative and quantitative statements that clarify objectives, define appropriate types of data, and specify levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. Iowa's credible data law (Attachment 1) defines data quality objectives for the state's Section 303(d) listings. These objectives are as follows:

- "*Credible data*" means scientifically valid chemical, physical, or biological monitoring data collected under a scientifically accepted sampling and analysis plan, including quality control and quality assurance procedures.

- Data dated more than five years before the department's date of listing or other determination under section 455B.194, subsection 1 (Iowa's credible data law), shall be presumed not to be credible data unless the department identifies compelling reasons as to why the data is credible.

As stated in the 2001 Iowa Code, Section 455B.194, subsection 1, the department shall use "credible data" when doing any of the following:

- Developing and reviewing any water quality standard.
- Developing any statewide water quality inventory or other water assessment report. (Note: Iowa's Section 305(b) assessments are not subject to the provisions of Iowa's credible data law.)
- Determining whether any water of the state is to be placed on or removed from any Section 303(d) list.
- Determining whether any water of the state is supporting its designated use or other classification. (Note: the credible data law does not require the use of credible data for establishment of a designated use or other classification of a water of the state.)
- Determining any degradation of a water of the state under 40 CFR 131.12.
- Establishing a total maximum daily load (TMDL) for any water of the state.

Rationale for any decision not to use existing and readily available data for Section 303(d) listings:

IDNR reviews all existing and readily available water quality-related data and information for purposes of water quality reporting and impaired waters listing as required by Sections 305(b) and 303(d) of the Clean Water Act (see section on *sources of existing and readily available water quality data* in this methodology). Certain categories of water quality information, however, do not meet requirements of either Iowa's credible data law or IDNR's data completeness guidelines for water quality assessments and impaired waters listings. The ultimate reasons for not using certain "existing and readily available data" are (1) the need for reasonably accurate assessments of water quality and (2) the desire to add only waterbodies to the state's Section 303(d) list (Category 5) that are actually "impaired." Placing waters on the state's Section 303(d) list on the basis of inaccurate and/or incomplete data increases the risk that the department's limited resources, including staff time and monitoring dollars, will be used unwisely. Examples of water quality information that typically would not be considered appropriate as the basis for Section 303(d) listing include the following:

- **Best professional judgment of IDNR staff:** IDNR utilizes observations of professional staff of the IDNR bureaus of Fisheries and Wildlife, as well as professional staff in other agencies for purposes of water quality (Section 305(b)) reporting. Best professional judgment is used to assess support of aquatic life uses in certain types of Iowa waterbodies that have historically lacked chemical, physical, and/or biological water quality data (primarily wetlands). To be added to Iowa's list of impaired waters (Category 5), all assessments of impairment based solely on best professional judgment will be further investigated to better document any failure to meet water quality standards. Past experience with assessments based primarily on best professional judgment has demonstrated that such follow-up investigations are necessary to (1) better determine whether a water quality impairment actually exists and (2) more accurately identify the causes and sources of any existing impairment. Waters assessed as "impaired" based only on the basis of best professional judgment will be added to Categories 2b or 3b of the Integrated Report; these two categories comprise the list of "waters in need of further investigation" as provided for in Iowa's credible data law.

- **Data or information older than five years from the end of the most recent Section 305(b) reporting cycle:** Data dated more than five years before the end of the most recent (2006) Section 305(b) data consideration period (the end of calendar year 2004) are presumed under state law to be "not credible" unless IDNR identifies compelling reasons as to why these older data are credible. Data older than five years may, however, be used for identifying water quality trends for any water of the state for which credible data exist. This provision of Iowa's credible data law was based on, and is consistent with, U.S. EPA's (1997) recommendation that data older than five years should not be used to make the type of water quality assessment (a "monitored" assessment) that is believed to accurately portray site-specific water quality conditions. Historically, data older than five years have been routinely used for Section 305(b) reporting in Iowa but have not been used to identify new Section 303(d) listings. All such assessments are considered "evaluated" and are thus of relatively lower confidence than "monitored" assessments which are based primarily on recent, site-specific ambient monitoring.

  As the data upon which non-303(d) assessments are based age beyond five years—and if more recent data are not available—the assessment type is changed from "monitored" (higher confidence) to "evaluated" (lower confidence) as part of the biennial Section 305(b) assessment process. Once placed in IR Category 5 (i.e., on the state's Section 303(d) list), however, a waterbody will not be moved to a non-TMDL category without "good cause" as defined by U.S. EPA regulations at 40 CFR 130.7 (e.g., a TMDL for the waterbody is approved by EPA or new monitoring data suggest that the impairment no longer exists).

The issue of "old" data is seldom relevant to Section 303(d) listing in Iowa. Water quality data are used for developing Section 305(b) assessments as they become available and are thus considered for Section 303(d) listing when the data most likely represent current water quality conditions. This process occurs long before the data age beyond their ability to represent current water quality conditions. As the data age beyond five years, the Section 305(b) assessment type is changed from "monitored" to "evaluated" to reflect the lowered level of confidence in assessments based on older data that, potentially, may not represent current water quality conditions. Any non-303(d) Section 305(b) assessments based on data that have aged beyond 10 years are not included in the current assessment cycle, but the previous assessments based on these data remain in IDNR's assessment database (ADB+).

Data that do not meet "completeness guidelines" developed for Section 305(b) reporting: In order to improve the accuracy of water quality assessments, IDNR has identified "data completeness guidelines" for using results of routine water quality monitoring for Section 305(b) reporting (Table 5). These guidelines identify the numbers of samples needed for water quality assessments that can support Section 303(d) listings (i.e., *monitored* assessments). These guidelines also identify assessments appropriate only for Section 305(b) reporting (i.e., *evaluated* assessments). These criteria were first developed for Iowa's 1990 Section 305(b) report and are designed to improve, within the constraints of resources available for monitoring and the designs of existing monitoring networks, the accuracy of Section 305(b) water quality assessments. This improvement in assessment accuracy increases the confidence with which waterbodies are added to Iowa's Section 303(d) list. Although IDNR ambient water quality monitoring networks, and networks of other agencies, are designed to produce sufficient data to meet Iowa's "completeness guidelines," not all monitoring activities are so-designed. Thus, the use of these criteria will eliminate certain data from consideration for Section 303(d) listing. Any waterbodies assessed as "impaired" only on the basis of incomplete data, however, will be placed in IR Categories 2b or 3b and will be added to the state list of "waters in need of further investigation" as provided for in Iowa's credible data law.

- **Results of volunteer monitoring that do not meet requirements specified in Iowa's credible data legislation and/or Section 305(b) data completeness guidelines:** Results from volunteer monitoring can only be used for Section 303(d) listing if requirements of Iowa's credible data law are met or if overwhelming evidence of impairment is indicated. To be considered for Section 303(d) listing, IDNR rules [IAC 61.10 through IA 61.13 (455B)] require that volunteer monitoring must be supported by an IDNR-approved sampling and analysis plan that includes quality control and quality assurance procedures. Waterbodies assessed as "impaired" only the basis of volunteer data from non-qualified volunteers will not be added the Iowa's Section 303(d) list but may be added to the state list of waters in need of further investigation. If, however, results of volunteer monitoring show cases of gross pollution, such that Iowa's narrative criteria are violated, such waters can be added to Iowa's Section 303(d) list due to "overwhelming evidence of impairment."

- **Results of habitat assessment:** Although detailed information on the quality of aquatic habitats is collected as part of biological monitoring conducted for the IDNR/UHL stream biocriteria and REMAP projects, IDNR has not yet developed methodologies for using results of habitat assessments to identify water quality impairments. IDNR does, however, incorporate observations on the quality of aquatic habitat into Section 305(b) water quality assessments. This information is also used in the identification of causes and sources of impairments of aquatic life uses identified through biological monitoring.

- **Assessments of "general use" waters based on criteria methods applicable to "designated use" waters.** The aquatic environment of most of Iowa's general use-only streams is one of extremes ranging from flood flow to no flow, from completely frozen in winter to extremely warm water temperatures in summer. Due to their position in relation to sources of groundwater, many general use-only stream reaches experience no-flow conditions at least once per year. Occasionally, chemical or biological monitoring is conducted on Iowa's general use-only waters. Typically this situation occurs in intermittent headwater reaches upstream from stream reaches designated for Class B(LR) aquatic life uses. General use waters are protected only against acutely toxic conditions, aesthetically objectionable/nuisance conditions, and other forms of gross pollution attributable to pollution sources as described in the narrative criteria of the *Iowa Water Quality Standards*, Section 61.3(2) (IAC 2003). In contrast, Class B(LR) waters are also protected by numeric criteria designed to guard against chronically toxic as well as acutely toxic conditions.

  Due to the lack of numeric water quality criteria and assessment methodologies for general use waters, IDNR sometimes uses Class B(LR) water quality criteria and assessment protocols developed for Class B(LR) streams to make use of the available data and to assess aquatic life conditions in general use-only waters. Although not entirely appropriate, the use of Class B(LR) criteria and methods to assess general use-only streams can indicate the existence of pollution-caused water quality problems in general use-only streams. Unfortunately, however, results of monitoring from general use streams do not often indicate whether a failure to meet Class B(LR) water quality standards or ecoregional expectations for fish and macroinvertebrates is due to man-made pollution sources or is simply due to the naturally-reoccurring extreme environmental conditions inherent in general use-only streams.

These extremes are sometimes reflected in results of water quality monitoring and biological assessments that suggest impairment. For example, as streams move toward no-flow conditions during summer due to low amounts of precipitation, chemical water quality can degrade drastically, especially regarding levels of dissolved oxygen and pH. As stream flow ceases and the only remaining water exists as isolated pools, violations of Class B(LR) criteria for dissolved oxygen and/or pH—not unexpectedly—become more common, often with sufficient frequency to suggest impairment of aquatic life uses. Also, due to seasonally reoccurring intermittent flow, the types of aquatic life that inhabit general use streams are often only those able to withstand extremes environmental conditions (the so-called "pioneer species"). Consequently, general use-only streams tend to have biological diversity that is low relative to the larger and more ecologically stable environments of Class B(LR) and Class B(WW) streams. Thus, the use of biological assessment methods developed for the more stable and diverse Class B(LR) streams to assess general use-only reaches will likely overstate the existence of impairment.

For these reasons, general use-only stream reaches that show impairment based on a comparison of monitoring data to Class B(LR) water quality criteria, or that show failure to meet regional expectations for aquatic biota (fish or aquatic macroinvertebrates) of Class B(LR) streams, will not be added to Iowa's Section 303(d) list of impaired waters. The assessment type for these waters will be considered "evaluated" (indicating an assessment with relatively lower confidence) as opposed to "monitored" (indicating an assessment with relatively higher confidence). Such waters will be placed in either IR Category 2 or Category 3 and will be added to the state's list of "waters in need of further investigation" as provided for in Iowa's credible data law. Once on this list, the assessments can be reviewed to better determine the nature of the water quality problems suggested by chemical or biological monitoring and to determine whether follow-up monitoring is justified. See Attachment Two of this methodology for additional information on IDNR's approach to assessing Iowa's "general use-only" streams. In addition, IDNR staff continue to pursue development of an assessment protocol for general use-only streams.

List of waters in need of further investigation:

Although not appropriate for identifying Category 5 waters (=Section 303(d) listing), the above types of water-related information are used for Section 305(b) water quality assessments and thus can be used to place waterbodies on a separate list of Iowa waterbodies in need of further investigation. As provided for in Iowa's credible data law, this list is not part of the Section 303(d) process in Iowa and includes waterbodies where limited information suggests, but does not conclusively (credibly) demonstrate, a water quality impairment. If the results of further investigative monitoring demonstrate, with credible data, that a water quality impairment exists, the affected waterbody can be added to Iowa's Section 303(d) list (IR Category 5).

The state list of waters in need of further investigation (WINOFI) is comprised of those waterbodies assessed (evaluated) as "impaired" and placed in subcategories 2b and 3b of the Integrated Report. The assessments of any impairments in waterbodies in these subcategories are based on less than complete information; thus, the assessment is of relatively low confidence and is not appropriate for addition to the list of Section 303(d) waterbodies in need of TMDLs in IR Category 5.

Overwhelming evidence of impairment:

Situations exist where reliable information can accurately indicate an impairment of beneficial uses even though this information does not meet requirements for Section 305(b) reporting and/or Section 303(d) listing (Table 5). The following are examples of instances where overwhelming evidence of an impairment justifies determination of impairment in the absence of complete data. Such waterbodies would be considered for addition to IR Category 4 (water is impaired, but a TMDL is not needed) or IR Category 5 (=Section 303(d) list) of Iowa's integrated assessment/listing report.

- Presence of reoccurring, man-made circumstances that result in acutely toxic conditions for aquatic life. For example, the addition of untreated septic waste is to a stream via an illegal connection to a storm sewer such that the aquatic community is being severely impacted would constitute overwhelming evidence of impairment.

- Man-made alterations of hydrology, flow, or habitat that degrade the quality of aquatic habitats as reflected in significant, adverse deviations in biotic integrity from the reference condition or from the pre-modification aquatic communities. For example, an illegal channel change that adversely affects the aquatic community of a stream reach would constitute overwhelming evidence of impairment.

- Chronic de-watering of a considerable section of a waterbody related to man-made alterations of local hydrology. For example, an illegal water withdrawal for irrigation that severely impacts or eliminates the aquatic life of a stream or river constitutes overwhelming evidence of impairment.

- Presence of exotic species (e.g., common carp (*Cyprinus carpio*) or purple loosestrife (*Lythrum salicaria*) at levels that are believed to impair one or more designated uses. For example, the infestation of a wetland with purple loosestrife such that the value of a wetland for use by waterfowl is degraded constitutes overwhelming evidence of impairment.

- Summer median trophic state index (Carlson 1977, 1991) values for chlorophyll-a or secchi depth that are based on less than three years of data but that are more than five TSI points greater than the TSI value used to identify impairment with a complete dataset (a "complete dataset" is three or more years of data resulting from three to five samplings per year). For example, if a lake's median based summer chlorophyll-a TSI value from one year's monitoring (minimum of three samples) exceeds the IDNR's trigger value of TSI = 65 by more than five points, the lake would be assessed as Section 303(d) impaired due to overwhelming evidence of impairment (for more information on IDNR's use of Carlson's trophic state index, see Attachment 3 of this methodology).

<u>How water quality data and other water-related information are summarized to determine whether waters are Section 303(d) "impaired":</u>

- **Physical, chemical, and bacterial data from fixed station water quality monitoring networks**

  These types of data are used with methods for Section 305(b) water quality assessments developed by U.S. EPA, with some of these methods being modified by IDNR (see Tables 5 through 10).

Conventional Parameters: U.S. EPA (1997) guidelines specify that aquatic life uses of surface waters with more than 10% of samples in violation of state water quality criteria for conventional parameters (for example, dissolved oxygen, pH, temperature) should be assessed as "impaired." This assessment approach is sometimes referred to as "the 10 percent rule". IDNR has historically not used the 10-percent rule to assess water quality with datasets of less than 10 samples due to the large degree of uncertainty associated with basing impairment decisions on small datasets. The IDNR requirement for at least 10 samples was based on the resultant improvement in the ability of U.S. EPA's recommended assessment approach to accurately identify an impairment based on a critical value of 10% violation. For example, at sample sizes less than 10, the probability of incorrectly concluding that impairment exists (Type 1 error) with U.S. EPA's approach is approximately 60%; with 10 samples, the probability of this type of error decreases to approximately 30% (Smith et al. 2001). Despite this approach, the percentage of a Type I error remains high (30 percent). In addition, comparison of raw percentages to water quality criteria have often been problematic in that they seem to give a contradictory signal of impairment. The most common scenario is the following: more than 10 percent of samples exceed the criterion for pH or dissolved oxygen (thus indicating "impairment") while all other water quality indicators suggest "full support."

Recently, however, alternative approaches have been developed that (1) avoid the need to compare raw percentage values to state criteria to identify impairments and (2) incorporate estimates of the numbers of samples and the corresponding number of violations that represent a significant exceedance of the 10 percent rule. The state of Nebraska (NDEQ 2006), drawing on information from Lin et al. (2000), has adopted an assessment approach where the sample sizes and the corresponding number of violations needed to identify a significant exceedance of the 10%-rule with greater than 90 percent confidence are specified. This approach is based on the binomial method for estimating the probability of committing Type I and Type II errors. Nebraska's 2006 assessment methodology is available at http://www.deq.state.ne.us/. Table 1 from the Nebraska methodology (*Sample size and number of exceedances required to determine an impaired beneficial use (10% exceedance)*) is included in this methodology as Table 11. IDNR used this binomial-based approach for identifying impairments based on violations of the 10% rule for the 2006 assessment/listing cycle.

***Toxic parameters**:* U.S EPA (1997) guidelines state that, for toxic parameters (e.g., ammonia, toxic metals, pesticides), more than one violation of an acute or chronic water quality criterion over a three-year period suggests impairment of aquatic life uses. IDNR has historically used, and continues to use, these U.S. EPA guidelines for identifying impairments due to toxic parameters.

U.S. EPA (1997, 2002a) also developed separate assessment methodologies for using results of fixed station and other ambient monitoring to determine support of fish consumption, primary contact recreation, and drinking water uses. IDNR has largely adopted U.S. EPA's assessment methodology as recommended for primary contact and fish consumption uses (see Tables 9 and 10). IDNR has modified U.S. EPA's (1997, 2002a) Section 305(b) water quality assessment guidelines for assessing drinking water uses with data for nitrate in surface water sources (see Table 10). Also, IDNR has developed assessment methods for data types and assessment categories for which U.S. EPA does not provide specific assessment methods (e.g., using fish kill information and results of biological monitoring to assess support of aquatic life uses (see below and Attachment 2)).

- **Data from biological monitoring being conducted by IDNR in cooperation with UHL as part of a current effort to establish biological criteria for Iowa's ecoregions and subecoregions**

  Benthic macroinvertebrate and fish sampling data from the IDNR/UHL stream biocriteria and REMAP sampling sites are used to identify impairments of warmwater stream aquatic life uses. IDNR uses a benthic macroinvertebrate index of biotic integrity (BM-IBI) and a fish Index of biotic integrity (F-IBI) to summarize biological sampling data. The BM-IBI and F-IBI combine several quantitative measurements or "metrics" that provide a broad assessment of stream biological conditions. A metric is a characteristic of the biological community that can be measured reliably and responds predictably to changes in stream quality. The BM-IBI and F-IBI each contain twelve metrics that relate to species diversity, relative abundance of sensitive and tolerant organisms, and the proportion of individuals belonging to specific feeding and habitat groups. The metrics are numerically ranked and their scores are totaled to obtain an index rating from 0 (poor) – 100 (optimum). Qualitative scoring ranges of poor, fair, good, and excellent have been established that reflect the biological community characteristics found at each level. The category of "fair," however, may or may not indicate impairment. The category of "poor", however, indicates an impairment of the aquatic life use. A framework for using these data to assess support of aquatic life uses was first developed for Iowa's 2000 Section 305(b) reporting cycle. The same basic framework used for the 2002 and 2004 reporting/listing cycles will be used for the 2006 cycle; a description of this framework is included in this methodology as Attachment 2.

- **Data from the IDNR-sponsored lake monitoring conducted by Iowa State University**

  The IDNR–sponsored statewide lake water quality monitoring program began in 2000 and continued through 2004. Each of 131 lakes was sampled three times during summer seasons to assess seasonal variability of chemical, physical, and biological parameters (e.g., plankton populations). Samples were taken at the deepest point in each lake basin.

  Due to year-to-year variability in lake water quality, state limnologists participating in the U.S. EPA Region 7 technical assistance group (RTAG) for nutrient criteria development have recommend that the combined data from at least three years of monitoring results from this type of lake survey is needed to identify nutrient-related water quality impairments. Thus, IDNR uses median water quality values from a three to five-year period to calculate a trophic state index (TSI) (Carlson 1977). Median-based TSI values will be used with the lake assessment framework described in Attachment 3 to determine the existence of an impairment. This framework is based on numeric translators for Iowa's existing narrative water quality criteria protecting against aesthetically objectionable conditions and/or nuisance aquatic life. For the 2006 reporting/listing cycle, lake data for the five-year period from 2000 through 2004 will be used to identify lake water quality impairments. The 2006 assessment/listing cycle is the third such cycle in which the trophic state index has been used to identify impairments at Iowa lakes.

- **Data from monitoring of bacterial indicators in rivers, lakes, and beach areas**

  In July 2003, Iowa DNR adopted criteria for *E. coli* in place of the previous criterion for fecal coliform bacteria into the *Iowa Water Quality Standards* (Table 7). This change was a response to a long-standing recommendation from U.S. EPA (2002b). In addition, a proposal was made to subdivide the current Class A (primary contact) use designation to three designations:

- Class A1 (primary contact recreation) (same as the previous Class A designation),
- Class A2 (secondary contact recreational use),
- Class A3 (children's recreational use).

The implementation of this change in the Class A (primary contact recreation) use designation began in the July 2003 version of the *Iowa Water Quality Standards* that was in effect during most of the 2002-2004 assessment period. Table 12 contains a complete list of Iowa streams to which either the Class A2 or Class A3 designation was added in the July 2003 version of the *Standards*.

With the revisions to the *Iowa Water Quality Standards* of July 2003, the state of Iowa now considers Class A1 waters with geometric mean levels of *E. coli* greater than 126 organisms per 100 ml to present an unacceptable risk of waterborne disease to swimmers, water skiers, and other persons using surface waters for primary body contact recreational activities where ingestion of water is likely to occur (Section 61.3(3), *Iowa Water Quality Standards*). In addition, Iowa once again has water quality criteria for protection of secondary contact recreational uses (such as wading) in surface waters designated for Class A2 uses.

In the context of Section 305(b) reporting, U.S. EPA (1997, 2002) recommends that support of primary contact recreation uses be based on (1) a comparison of the geometric mean of at least five samples collected over a 30-day period to state water quality criteria for indicator bacteria (fecal coliforms, *E. coli*, and/or enterococci) and (2) the percentage of samples that exceed a single-sample maximum value. In cases where the geometric mean exceeds the state water quality criterion, or significantly more than 10% of the samples exceed the single-sample maximum criterion (Table 11), the Class A primary contact uses should be assessed as "impaired."

While U.S. EPA's recommended approach is preferred, differences in monitoring frequencies at different types of Iowa waterbodies require that different approaches be used when developing assessments of support of primary contact recreation uses.

For example, Iowa's river reaches and some of its lakes designated for primary contact recreation are typically sampled once per month as part of ambient water quality monitoring activities; none of these river or lake stations are monitored more than twice per month. Thus, a maximum of two samples of indicator bacteria are collected from these stations during any 30-day period. This amount of data is not sufficient for use with U.S. EPA's recommended approach for assessing support of primary contact uses.

Swimming beaches at selected Iowa lakes, however, are monitored more frequently than rivers. Beginning in 1999, IDNR began a weekly sampling program during summer months (May through September) at swimming beaches of selected state-owned lakes. This program now includes weekly sampling at public beaches of 35 state-owned lakes. This program generates the minimum amount of data needed for use with U.S. EPA's recommended assessment methods (i.e., 5 samples collected over a 30-day period).

Thus, because of these varying monitoring frequencies, IDNR uses different procedures to determine the level of use support of the Class A (primary contact recreation) uses at lake beaches versus river reaches and non-beach areas of lakes. The assessment approaches used for the less frequently monitored rivers and the more frequently monitored lake beaches are discussed below.

Rivers and non-beach areas of lakes: To be assessed as "fully supported" the designated Class A1 primary contact uses, the following conditions should be met: (1) the geometric mean of at least ten samples collected during the recreational seasons (March 15 to November 15) of the current data gathering period (calendar years 2002 through 2004) should not exceed the respective water quality criterion of 126 *E. coli* organisms per 100 ml of *E. coli* and (2) no more than 10 percent of these samples should exceed Iowa's single sample maximum allowable density of 235 *E. coli* organisms per 100 ml. For the first time, Iowa's 2006 assessment methodology will use an assessment approach for implementing the 10-percent rule that accounts for uncertainty in the use of small sample sizes to identify impairments (see Lin et al. 2000). In addition, no swimming area closures can have been issued during the three-year assessment period. While not entirely consistent with the assessment approach recommended by U.S. EPA (1986, 1997, 2002), the IDNR approach appropriately uses the available monitoring data while incorporating the basic elements of U.S. EPA's recommended approach.

Lake beaches:

Two types of bacteria-related water quality information are used to assess support of the Class A (primary contact recreation) use at Iowa's lake beaches: (1) data for indicator bacteria from weekly beach monitoring and (2) information on the closure of beach areas for swimming.

In general, the same approach used for the 2002 and 2004 Section 305(b) reporting cycles and Section 303(d) lists will be used for the 2006 cycle: If either of the following exist, the Class A uses of that beach and lake would be assessed as "not supporting" and would be a candidate for Section 303(d) listing:

1. A geometric mean of at least five samples collected over a 30-day period during the recreation season exceeds the Iowa geometric mean water quality criterion of 126 *E. coli* / 100.

2. Significantly more than 10% of the sample values collected during a given recreation season exceed Iowa's single-sample maximum criterion of 235 *E. coli* / 100 ml. Statistical methods developed by Liu et al. (2000) and used by the state of Nebraska for determining significant exceedances of the 10 percent rule will be used in the process of identifying impairments based on violations of Iowa's single-sample maximum criterion.

3. In the event that a beach was closed to swimming during either year, the Class A uses would be assessed as "not supporting." Levels of indicator bacteria that result in IDNR's posting of signs at beaches warning about increased health risk associated with swimming—including both the "Caution: Water Quality Advisory" and the "Water Quality Notice" signs—do <u>not</u> constitute impairment of the Class A uses. Neither of these signs are intended to indicate closure of

beaches but are posted to warn swimmers of the potential for an increased health risk from swimming. See http://wqm.igsb.uiowa.edu/activities/beach/BeachAdvisoryPolicy2005.htm for a description of IDNR's beach advisory policy.

For additional information on how IDNR determines support of primary contact recreation uses, see Table 10.

- **Data from programs to monitor fish tissue for toxic contaminants**

  The existence of, or potential for, a fish consumption advisory has been, and remains, the basis for Section 305(b) assessments of support of fish consumption uses in Iowa's rivers and lakes. If a waterbody is covered by a consumption advisory, the fish consumption use is assessed as "impaired" (Table 10). Prior to 2006, IDNR used action levels for PCBs, mercury, and chlordane published by the U.S Food and Drug Administration to determine whether consumption advisories should be issued for fish caught as part of recreational fishing in Iowa. In recent years, however, many states have abandoned the use of the FDA action levels in favor of a more protective "risk-based" approach. Thus, in late 2005, the Iowa Department of Public Health (IDPH), in an effort to make Iowa's advisory protocol more protective and more compatible with the various protocols used by adjacent states, developed a risk-based advisory system for Iowa that covers these contaminants (see Table 13 and http://www.iowadnr.gov/fish/news/consump.html for more information on Iowa's revised fish consumption advisory protocol). The new IDNR/IDPH advisory protocol has resulted in the issuance of new consumption advisories for several Iowa lakes and rivers and resulted in modifications of Iowa's existing consumption advisories at Cedar Lake at Cedar Rapids and Ottumwa Lagoon at Ottumwa.

  Other than the changes to a risk-based advisory levels and the addition of a "restricted consumption" category, Iowa's advisory protocol remains the same:

  - Decisions to issue consumption advisories remain based on results of annual fish contaminant monitoring conducted either as part of the USEPA/IDNR Regional Ambient Fish Tissue (RAFT) monitoring program or as part of other fish tissue contaminant monitoring programs in Iowa.

- Due to the large amount of variation in contaminant levels within fish populations, two consecutive samplings exhibiting contaminant levels greater than IDNR/IDPH advisory levels are needed to justify issuance of an advisory.

- Similarly, two consecutive samplings showing that contaminant levels are less than the IDNR/IDPH advisory levels are needed to remove an advisory.

In general, these "consecutive" samples are collected in consecutive years as part of the annual U.S. EPA Region VII/IDNR Regional Ambient Fish Tissue (RAFT) monitoring program or as part of special follow-up studies conducted by IDNR. The need to schedule follow-up samplings one year after the first sampling is related to the length of time required for sample analysis and data reporting. Samples of Iowa fish tissue for RAFT monitoring are typically collected by IDNR biologists in late summer; samples are sent to the U.S. EPA Region VII laboratory in Kansas City for analysis in early fall. Results from this analysis are supplied to IDNR in late spring or early summer of the following year. Decisions to conduct follow-up sampling at a given site is thus based on results of the previous year's sampling. Waterbodies covered by consumption advisories are monitored on an every-other-year basis as part of RAFT "follow-up" monitoring to identify any changes in contaminant levels and to justify the need to continue or rescind the advisory.

In order to implement the new IDNR/IDPH advisory protocol, the most recent five years of fish contaminant data (2000-2004) were reviewed by IDNR staff to identify lakes and river reaches with samples in which contaminant levels exceeded the new advisory trigger levels. Based on this review, additional (follow-up) monitoring was conducted in 2005 to confirm the existence of these elevated levels of contaminants. Based on this information, four new consumption advisories were issued in January 2006 and the consumption advisories at Cedar Lake at Cedar Rapids and Ottumwa Lagoon at Ottumwa were modified. Data collected as part of RAFT monitoring from 1994 through 2000 are being reviewed to identify other rivers and lakes that require additional monitoring to confirm the existence of elevated levels of contaminants.

- **Reports of pollutant-caused fish kills**

  Occurrence of a single pollutant-caused fish kill, or a fish kill of unknown origin, on a waterbody or waterbody reach during the most recent three-year period (2002-2004) indicates a severe stress to the aquatic community and suggests that the aquatic life uses should be assessed as "impaired". Each report of a fish kill will be reviewed to determine whether development of a TMDL is appropriate. If a cause of the kill was not identified during the IDNR investigation, or if the kill was attributed to non-pollutant causes (e.g., winterkill), the assessment type will be considered "evaluated." Such assessments, although suitable for Section 305(b) reporting, either are inappropriate for Section 303(d) listing (no pollutant load to allocate) or lack the degree of confidence to support addition to the state Section 303(d) list of impaired waters (IR Category 5). Waterbodies affected by such fish kills will be placed in IR subcategories 2b or 3b and will be added to the state list of waters in need of further investigation.

If, however, a cause of the kill is identified, and the cause is either known, or suspected, to be a "pollutant", the assessment type is considered "monitored" and the affected waterbody is a candidate for Section 303(d) listing. Waterbodies affected by this type of kill will be handled as follows:

- TMDLs will not be developed for kills caused by a one-time illegal or unauthorized release of manure or other toxic substance where enforcement actions were taken. The rationale for this approach is as follows:

  (1) A consent order has been issued to the party responsible for the kill and monetary restitution sought for the fish killed. A consent order is issued in settlement of an administrative order or as an alternative to issuing an administrative order. A consent order indicates that IDNR has voluntarily entered into a legally enforceable agreement with the other party. IDNR feels that these enforcement actions are more appropriate, efficient, and effective for addressing a spill-related impairment than is the TMDL process.

  (2) no allocation process is possible with a pollutant that is discharged only once or at irregular intervals.

Such waterbodies will be placed into Integrated Report subcategory 4d as defined by IDNR. In this way, the impairment status of the affected waterbody remains highlighted.

- Fish kills attributed to a pollutant, but where a source of the pollutant was not identified, will be placed into Integrated Report subcategory 5b. The intent of placing these waterbodies into Category 5 is not to necessarily require a TMDL but to keep the impairment highlighted due to the potential for similar future kills from the unaddressed causes and/or sources.

- If no fish kill has occurred over the last three years (i.e., no kill occurred in the period 2002-2004), the toxic impact that caused the kill has likely dissipated. Thus, good cause for de-listing exists, and the assessment should be considered "evaluated" (i.e., of lower confidence). The affected waterbody should be moved from IR Category 5 and be placed into IR Categories 2b or 3b (list of waters in need of further investigation).

- If no fish kill has occurred over the last six years, any impact from the fish kill upon which the impairment was based has long-ago dissipated. Thus, the assessment that was based on the fish kill will not be included in either the new Section 305(b) assessments or Section 303(d) listings. The affected waterbody should be moved to IR Category 3a.

- Fish kills attributed to authorized discharges (i.e., a wastewater discharge meeting permit limits) are considered for Section 303(d) listing (subcategory 5a) as the existing, required pollution control measures are not adequate to address this impairment, and a TMDL is needed.

- **Data from the statewide survey of freshwater mussels from 1998-1999**

  Information from *Statewide Assessment of Freshwater Mussels (Bivalva: Unionidae) in Iowa Streams: Final Report* (Arbuckle et al. 2000) was again used to assess support of aquatic life uses of Iowa streams and rivers. The survey conducted by Arbuckle et al. (2000) involved re-sampling of sites visited in the mid-1980s by Frest (1987). For purposes of identifying candidates for Section 303(d) listing, the number of mussel species reported for a given waterbody by Frest was compared to the number of species reported for the same waterbody by Arbuckle et al. (2000). The degree to which the aquatic life use was supported was based on the percent change in the number of mussel species from the 1984-85 period to the 1998-99 period. If the mean waterbody species richness (SR) was four or greater in the 1984-1985 survey period, then the following assessment approach using percent change from the 1984-85 to 1998-99 survey periods was used to identify candidates for Section 303(d) listing:

If species richness (SR) in 1984-85 is ≥ 4, and the percent decline in SR from 1984-85 to 1998-99 is:	**Then use support category is:**	**Integrated Report Category**
< 25%	Fully Supporting	1
26-50%	Fully Supporting or Fully Supporting / Threatened with a declining trend (potentially "impaired")	1 or 5b
51%-75%	Partially Supporting ("impaired")	5b
> 75%	Not Supporting ("impaired")	5b

The decision to consider only those sites having four or more species reported in the 1984-85 survey is based on (1) a review of the historical distributions of freshwater mussels in Iowa as shown by Cummings and Mayer (1992) and (2) the framework (i.e., percent decline approach) described in table above. For the Iowa ecoregions that show historical presence of a stream/river community of freshwater mussels (i.e., all ecoregions except 47e and the portions of ecoregions 47f and 40 in Missouri River drainage), a species richness of approximately four appears to characterize average species richness from the 1984-85 survey by Frest. The decision to identify a waterbody as impaired due to a decline in species richness between the 1984-85 and 1998-99 survey periods is based on quartiles (i.e., from a 25% to 50% decline: "fully supported/threatened with a declining trend"; from a 50% to 75% decline, "partially supported"; more than a 75% decline, "not supported." Any decision to add a waterbody to the state list of impaired waters based on a percent decline of between 26 and 50 percent will be made on a case-by-case basis, with impairment and listing more likely as the percent decline approaches 50 percent. Using four species as a minimum for this assessment approach allows for some decline between the survey periods, which may be due to problems with sampling efficiency as opposed to the actual elimination of species, without identifying waterbody as "impaired."

As presented by Arbuckle et al. (2000), the potential causes of declines in species richness of Iowa's freshwater mussels include siltation, destabilization of stream substrate, stream flow instability, and high in-stream levels of nutrients (phosphorus and nitrogen). Their study also suggested the importance of stream shading provided by riparian vegetation to mussel species richness. For purposes of Section 305(b) reporting and Section 303(d) listing, the following causes and sources will be identified for all waters assessed as "impaired" due to declines in the mussel community: siltation from agricultural and natural sources; flow modification due to hydromodification of the watershed; and nutrients from agricultural and natural sources. Because site-specific causes and sources of these impairments were not identified, any waters assessed as impaired due to declines in the freshwater mussel community will be placed into subcategory 5b. As is typical for Section 305(b) water quality assessments, the sources of impairment identified for Iowa's freshwater mussel community are only *potential* sources. The logistics of a statewide water quality assessment process does not often allow precise site-specific determinations of pollutant sources. More accurate information on sources would typically be gathered during the stressor identification phase of TMDL development.

- **Data from public water supplies on the quality of raw and finished water**

  Data for the quality of raw (untreated) water from a surface water source will be used with the methodology for identifying impairments in Class C (drinking water use) waters described in Table 10. Impairments related to the quality of finished (treated) water will be determined through review of annual IDNR public drinking water program compliance reports (available at *http://www.state.ia.us/epd/wtrsuply/report/report.htm*). Information from these reports on violations of Class C water quality criteria and issuance of drinking water advisories will be used with methods described in Table 10 to determine the existence of impairment of drinking water uses.

- **Data from special studies of water quality and aquatic communities**

  Results of special water quality studies that meet all requirements of Iowa's "credible data" law, including the availability of a quality assurance project plan (or equivalent plan or methodology for sampling and analysis), will be considered on a case-by-case basis. IDNR will review all relevant quality assurance/project plans for special studies prior to the decision to use study results for purposes of Section 303(d) listing. Results from special studies that meet "credible data" requirements will be compared to water quality criteria as specified in the *Iowa Water Quality Standards* with the methods described in this document.

- **Results of volunteer monitoring that meet "credible data" requirements**

  Results of volunteer monitoring that meet all requirements of Iowa's "credible data" law, including the availability of a DNR-approved quality assurance project plan (or equivalent plan or methodology for sampling and analysis), will be considered on a case-by-case basis. IDNR will review all relevant quality assurance/project plans for volunteer monitoring studies prior to the decision to use study results for purposes of Section 303(d) listing. Results from volunteer monitoring studies that meet "credible data" requirements will be compared to the appropriate water quality criteria as specified in the *Iowa Water Quality Standards* with the methods described in this document.

Exclusion (de-listing) of waters from the 2006 Section 303(d) list:

According to U.S. EPA regulations (40 CFR 130.7), a state must demonstrate "good cause" for exclusion of previously impaired waterbodies. According to these regulations, "good cause" includes, but is not limited to, more recent or accurate data; more sophisticated water quality modeling; flaws in the original analysis that led to the water being listed; or changes in conditions; e.g., new control equipment or the elimination of discharges. Thus, the following can be used to demonstrate good cause for not listing a waterbody on the Section 303(d) list or to decrease the scope of impairment to a listed waterbody:

- **More recent or accurate data**. Additional monitoring data or information from a waterbody may demonstrate that it now meets applicable water quality standards. These data must be generated from monitoring studies and programs consistent with Iowa's "credible data" law and must be in sufficient quantity to be used with Section 305(b) water quality assessment procedures (see Table 5). Special conditions include the following:

For Iowa lakes, TSI values for both chlorophyll-a and Secchi depth must be 63 or less before a lake can be removed from the state's Section 303(d) list (IR Category 5) (see Attachment 3 of this methodology for more information).

For waters impaired by fish kills, no fish kills can have been reported during the last three years from the end of the data gathering period for the current assessment and listing cycle.

For waters assessed as impaired by indicator bacteria, geometric mean levels must be less than the state water quality criterion, and the percentage of samples that exceed the state's single-sample maximum criterion must be significantly less than 10% at the 90 percent confidence level.

- **Flaws in original analysis or errors in listing**. Errors in the data or flaws in assessment procedures used to list the waterbody invalidate the basis for listing.

- **New conditions.** Examples of new conditions include revised water quality standards, the elimination of discharges, and new control equipment such that a listed waterbody no longer meets the criteria for Section 303(d) listing.

For any waterbody listed on the 2004 Section 303(d) list and not included on the 2006 list, a waterbody-specific rationale for the exclusion or de-listing will be incorporated into Iowa's Section 305(b) Assessment Database (ADB+).

Waterbodies added to an Iowa 303(d) list will be placed on subsequent lists unless (1) there are sufficient credible data to reassess the waterbody and demonstrate that 303(d) listing is not appropriate or (2) some other "good cause" is demonstrated for not including the water on the 303(d) list. Age of data alone is not an adequate justification for not including a previously-listed water on a new list of impaired waters. This provision is especially relevant to waterbodies included on lists based on results of one-time surveys (e.g., results of biological assessments conducted as part of biocriteria development). For example, if a waterbody was added to Iowa's 2004 303(d) list based on a biological assessment conducted in 2002, this waterbody should remain on Iowa's subsequent 303(d) lists until (1) a TMDL is completed, (2) additional monitoring is conducted that shows "full support" of aquatic life uses, or (3) a flaw in the original data analysis or assessment is discovered.

In addition, lack of sufficient data to develop a "monitored" assessment for a previously-listed waterbody is not adequate justification for excluding a waterbody from Section 303(d) listing. For example, if a routinely-monitored waterbody was added to Iowa's 2004 303(d) list based on a "monitored" assessment showing violations of the Iowa water quality criterion for indicator bacteria, this waterbody should remain on Iowa's 2006 list even though more recent routine monitoring failed to generate a sufficient number of samples to develop a "monitored" assessment for the 2006 reporting/listing cycle.

Prioritization and scheduling of waters for TMDL development:

CWA Section 303(d) requires that each *"state shall establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters."* A system of prioritization for waterbodies included in Category 5 of the Integrated Report has been developed by the IDNR based on several factors. Included in these factors are the required elements of *"the severity of the pollution and the uses to be made of such waters."* The methods developed are described below; these methods are the same as used to prioritize waterbodies on Iowa's 2002 and 2004 Section 303(d) lists. These criteria are a guide. Other factors, such as best professional judgment of IDNR staff, results of volunteer monitoring, and public comments, may also be considered when prioritizing waters. If a waterbody meets any one criterion in a priority category, that does not necessarily mean the water will be prioritized as such, since many waters fit some criteria from all categories.

Priorities **Applicable Criteria**

High

- Waters where sufficient water quality information exists to understand and analyze causes and effects of the problems and opportunities are available to correct or substantially improve water quality;
- Waters with imminent human health or aquatic health problems;
- Waters with documented widespread local support for water quality improvement; or
- Waters where state or federally threatened or endangered species are impacted.

Medium

- Waters where sufficient water quality information exists to understand and analyze causes and effects of the problems; however, opportunities are not immediately available to correct or substantially improve water quality; or

- Waters where local support for TMDL development is expected but not known.

Low

- Waters where insufficient water quality information exists to understand and analyze causes and effects of the problems and limited opportunities are available, at this time, to correct or substantially improve water quality;
- Waters with no evident local support for water quality improvements.

Addressing interstate inconsistencies in Section 303(d) lists:

Inconsistency in the Section 303(d) listings of border rivers and other interstate waters is a national problem (see GAO 2002). IDNR faces potential listing consistency issues with the following states and rivers that border Iowa: South Dakota (Big Sioux River), Nebraska (Missouri River), Missouri (Des Moines River), and Illinois and Wisconsin (Upper Mississippi River). Thus, IDNR will either (1) request and/or review the draft 303(d) lists of, or (2) consult directly with, states with which Iowa shares border waters. Where the listing in another state is different than in Iowa, the IDNR will review the assessment data, supporting information, and assessment methodology that support the listing in the other state. These data will be reviewed and applied to Iowa's Section 303(d) listing methodology outlined in this document. The Iowa 303(d) list will, or will not, be changed pending the review of this additional information.

IDNR will also review the Section 303(d) listings from adjacent states for waters that either enter Iowa from Minnesota or leave Iowa into Minnesota or Missouri (e.g., the Cedar River in Mitchell County and the Chariton River in Appanoose County), or that are shared with Iowa by either state (e.g., Tuttle Lake in Emmet County). Where Section 303(d) listing decisions differ across a state line, the supporting assessment data and methodology will be requested from the appropriate state. IDNR will review these data using Iowa's Section 303(d) listing methodology outlined in this document to determine whether modifications to Iowa's Section 303(d) list are justified.

This process of reviewing Section 303(d) listings for waters that border or are shared with adjacent states is designed to reduce between-state inconsistencies in Section 303(d) listings and to provide a basis for cooperation on future development of TMDLs for these interstate waters.

Public participation:

A draft of this methodology was provided to the public for review and comment as part of the public comment period for the draft 2006 Section 303(d) list. The draft methodology was available in hard copy by contacting the IDNR. The draft was also available at the IDNR website at *http://wqm.igsb.uiowa.edu/WQA/303d/2006/draft_2006_Methodology.pdf*. Comments on the draft methodology were received for a period of sixty days. The methods used to assess water quality, however, are always changing, due both to recommendations from U.S. EPA and due to changes at the state level (e.g., changes in Iowa's Water Quality Standards). Thus, IDNR will accept comments at any time regarding this methodology.

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Table 1. Summary of changes in Iowa DNR's Section 303(d) listing methodology between the 2004 and 2006 listing cycles.

Change in Methodology:	**2004 Listing Cycle**	**2006 Listing Cycle**
1. Use of "fully supported / threatened" assessments	Considered "not impaired" unless adverse trend was present.	Considered "impaired" due to adverse water quality trends.
2. Indicator bacterium for determining support of primary contact recreation uses	Fecal coliform bacteria for recreational season of April 1 to October 31.	*Escherichia coli* for recreational season of March 15 to November 15.
3. Use of a high-flow exemption for implementing state water quality standards for indicator bacteria (*E. coli*)	Standard for indicator bacteria does not apply when surface waters are materially affected by surface runoff	No implementable high-flow exception for Iowa's water quality criterion for indicator bacteria exists
4. Use of single-sample maximum violations for beach assessment	Not used	If > 10% of samples exceed the Iowa criterion (235 *E. coli* / 100 ml), beach is assessed as "partially support" (impaired).
5. Assessment reaches for the Iowa reach of the Upper Mississippi River (UMR)	Included 14 assessment segments defined by IDNR and not consistent with adjacent states	IDNR's assessment segments are redefined to be consistent with segments proposed by the UMRBA Water Quality Task Force for all UMR states.
6. IR categories comprising Iowa's list of impaired waters	Limited to waters in IR Category 5	Includes impaired waters in IR Categories 4a and 4c as well as those in IR Category 5.
7. Basis for fish consumption advisories and thus basis for impairment of fish consumption uses:	Impairments were based on consumption advisories due to levels of contaminants that exceed action levels from the U.S. Food & Drug Administration	Impairments are based on consumption advisories due to levels of contaminants that exceed IDNR/IDPH risk-based trigger levels
8. Approach to defining lake waterbodies:	Lakes were defined and assessed as a single waterbody, regardless of size.	Depending on data availability, lakes are sub-segmented and assessed accordingly.
9. Identifying impairments based violation frequency of greater than 10 percent	Impairment decisions were based on a simple percentage of samples that violate a criterion	Impairment decisions account for uncertainty in estimating percent violations for small sample sizes.
10. Identifying impairments on border rivers based on listings of adjacent states	Required site-specific water quality data to list	Base listing on either site-specific data or current (2006) listings of adjacent states

Table 2. Summary of U.S. EPA's "integrated reporting" format as used for Iowa's 2004 and 2006 Section 305(b) and Section 303(d) cycles.

Integrated Report Category	**Source of Category**	**Description of Category**
1	U.S. EPA	All designated uses are met.
2a	U.S. EPA	Some of the designated uses are met but there is insufficient data to determine if remaining designated uses are met.
2b	IDNR	At least one use assessed as supported with at least one other use potentially impaired based on an "evaluated" assessment. This subcategory, along with subcategory 3b, forms the state list of waters in need of further investigation.
3a	U.S. EPA	Insufficient data to determine whether any designated uses are met.
3b	IDNR	Insufficient data exist to determine whether any designated uses are met, but at least one use is potentially impaired based on an "evaluated" assessment. This subcategory, along with subcategory 2b, forms the state list of waters in need of further investigation.
4a	U.S. EPA	Water is assessed as impaired or threatened but a TMDL is not needed because a TMDL has been completed.
4b	U.S. EPA	Water is assessed as impaired but a TMDL is not needed because other required control measures are expected to result in attainment of water quality standards in a reasonable period of time.
4c	U.S. EPA	Water is assessed as impaired but a TMDL is not needed because the impairment or threat is not caused by a "pollutant."
4d	IDNR	Water is assessed as impaired due to a pollutant-caused fish kill but a TMDL is not needed because enforcement actions were taken against the party responsible for the kill.
5a	U.S. EPA	Water is assessed as impaired or threatened by a pollutant stressor and a TMDL is needed [along with Category 5b, the state's Section 303(d) list].
5b	IDNR	Water is assessed as impaired or threatened based on results of biological monitoring or a fish kill investigation where specific causes and/or sources of the impairment have not yet been identified [along with Category 5a, the state's Section 303(d) list].

Table 3. Comparison of Iowa DNR's assessment reaches for the Upper Mississippi River to those agreed upon in 2004 by the Upper Mississippi River Basin Association (UMRBA) as part of the memorandum of understanding on interstate assessment reaches developed by the UMRBA Water Quality Task Force.

IDNR Waterbody ID Number	Waterbody Description	Length (miles)	UMRBA Assessment Reach	Segment Description	Length (miles)*	Hydrologic Unit Code (HUC)
IA 03-SKM-0010-1	Iowa/Missouri state line (Des Moines R.) to Sugar Cr. nr. Ft. Madison	17.3	Flint-Henderson	Des Moines R. to Iowa R.	74.75	07080104
IA 03-SKM-0010-2	Sugar Cr. to Skunk R.	19.5				
IA 02-ICM-0010-1	Skunk R. to water supply intake at Burlington	8.75				
IA 02-ICM-0010-2	Burlington water supply intake to Iowa R.	29.2				
IA 01-NEM-0010-1	Iowa R. to L&D 15 at Davenport	49.3	Copperas-Duck	Iowa R. to Lock & Dam 13 at Clinton	89.3	07080101
IA 01-NEM-0010-2	L&D 15 to L&D 14 at LeClaire	10.7				
IA 01-NEM-0010-3	L&D 14 to Wapsipinicon R.	13.1				
IA 01-NEM-0010-4	Wapsipinicon R. to L&D 13 at Clinton	16.2				
IA 01-NEM-0020-1	L&D 13 to Catfish Cr. at Dubuque	54.0	Apple-Plum	Lock & Dam 13 to Lock & Dam 11	59.68	07060005
IA 01-NEM-0020-2	Catfish Cr. to L&D 11 at Dubuque	5.68				
IA 01-NEM-0030-1	L&D 11 to L&D 10 at Guttenberg	30.9	Grant-Maquoketa	Lock & Dam 11 to Wisconsin R.	46.0	07060003
IA 01-NEM-0030-2	L&D 10 to Wisconsin R.	15.1				
IA 01-NEM-0040-1	Wisconsin R. to L&D 9 at Harpers Ferry	19.0	Coon-Yellow	Wisconsin R. to Root R.	42.9	07060001
IA 01-NEM-0040-2	L&D 9 to IA/MN state line	23.9				

*The length of the UMRBA assessment reaches was adjusted to correspond to the total mileage in the respective IDNR assessment reaches.

Table 4. Iowa tributaries to the Upper Mississippi River monitored from 2002-2004 as part of the Long-Term Resource Monitoring Program by staff from the Bellevue Field Station.

No.	**Waterbody, Location**	**Designated Uses****	**County**	**Station No.**
1.	Catfish Cr., near mouth,	B(WW)	Dubuque	CF00.3M
2.	Elk R., near mouth	B(WW)	Clinton	ER02.4M
3.	Maquoketa R., near mouth	A1,B(WW)	Jackson	MQ02.1M
4.	Mill Cr. near mouth	B(WW)	Jackson	MC01.0M
5.	Rock Cr., upstream PCS Nitrogen	B(LR)	Clinton	RK03.7M
6.	Rock Cr., near mouth	B(LR)	Clinton	RK00.1M
7.	Tete de Mortes Cr.	B(WW)	Jackson	TM4.2M
8.	Turkey R., near mouth	B(WW)	Clayton	TK04.8M
9.	Upper Iowa R. near mouth	A1,B(WW)	Allamakee	UI02.9M
10.	Yellow R, near mouth	A1,B(WW)	Allamakee	YL01.5M
11.	Wapsipinicon R., near mouth,	A1,B(WW)	Clinton	WP02.M

**Designated Uses (from *Iowa Water Quality Standards* (IAC 2003)):
Class A1 = primary human contact/recreation;
Class B(WW) = significant resource warmwater aquatic life;
Class B(LR) = limited resource warmwater aquatic life;

Table 5. Data completeness guidelines for using results of routine ambient water quality monitoring to make "monitored" assessments of designated beneficial uses for Section 305(b) water quality assessments in Iowa. "Monitored" assessments are used to place waters in Category 4 (impaired but TMDL not required) and Category 5 (the Section 303(d) list) of Iowa's 2006 Integrated List/Report.*

DESIGNATED USE	TYPE OF INFORMATION	DATA REQUIRED
Aquatic Life	Data for levels of toxics in waterbodies	Data collected quarterly or more frequently during calendar years 2002-2004; a minimum of 10 samples is needed.
	Data for levels of conventional pollutants (DO, pH, temp.)	Data collected monthly or more frequently during calendar years 2002-2004; a minimum of 10 samples is needed.
	Data from DNR biocriteria sampling at reference, test, and watershed sites.	At least one valid fish index of biotic integrity (IBI) or macroinvertebrate IBI for calibrated segments sampled during the most recent 5 complete calendar years (see Attachment 2 for more information).
	Data from the ISU/Iowa DNR statewide lake survey	Data collected at least 3 times per summer for at least 3 years (minimum of 10 samples).
	Results of fish kill investigations	Reports of pollutant-caused fish kills from 2002-2005.
Fish Consumption	Data for site-specific levels of toxic contaminants in fish tissue	All data on levels of toxic contaminants in fish tissue during the period covered by the 2006 assessment cycle (2002-2004).
Primary Contact Recreation	Data for levels of indicator bacteria (*E. coli*) from river waterbodies or non-beach areas of publicly-owned lakes or flood control reservoirs	Data collected monthly or more frequently during March-November periods of the calendar years 2002-2004; at least 10 samples need to be collected.
	Data for levels of indicator bacteria (*E. coli*) from beach areas of publicly-owned lakes and flood control reservoirs	At least five samples approximately equally spaced over a 30-day period during March-November periods of calendar years 2002-2004.
	Data from the ISU/Iowa DNR statewide lake survey	Data collected at least 3 times per summer for at least 3 consecutive years.
Drinking Water	Data for levels of <u>toxics</u>	Data collected **quarterly** or more frequently during calendar years 2002-2004; a minimum of 10 samples is needed.
	Data for levels of <u>nitrate</u>	Data collected **monthly** or more frequently during calendar years 2002-2004; a minimum of 10 samples is needed.

*Data that do not meet IDNR's completeness guidelines can be used to develop "<u>evaluated</u>" (versus "monitored") assessments for purposes of Section 305(b) water quality reporting. These "evaluated" assessments, however, are of generally lower confidence and are not appropriate for adding waters to IR Categories 4 or 5 (impairment categories) of the Integrated Report (IR). Evaluated assessments are, however, appropriate for adding waters to IR Categories 1, 2 and 3.

Table 6. Summary of Iowa water quality criteria used to make assessments of support of beneficial designated uses of Iowa surface waters for purposes of the 2006 Section 305(b) / Section 303(d) reporting/listing cycles. The criteria listed are only for those parameters used for the 2006 Section 305(b)/303(d) assessment/listing cycle. For a complete list and description of Iowa water quality criteria, see the *Iowa Water Quality Standards*.

	DESIGNATED USE					
PARAMETER	**Class A1, A2 and A3: swimmable**	**Class B(WW): significant resource aquatic life**	**Class B(LR): limited resource aquatic life**	**Class B(CW): coldwater aquatic life**	**Class B(LW): aquatic life of lakes and wetland**	**Class C: source of a water supply**
dissolved oxygen (mg/l) 16-hour minimum / 24-hour minimum)	none	5.0 / 5.0	5.0 / 4.0	7.0 / 5.0	5.0 / 5.0	none
temperature (added heat)	none	no increase > 3 C; increase < 1 C / hr; no increase above 32 C	no increase > 3 C; increase < 1 C / hr; no increase above 32 C	no increase > 2 C; increase < 1 C / hr; no increase above 20 C	no increase > 2 C; increase < 1 C / hr; no increase above 20 C	none
pH	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	not < 6.5; not > 9. max. change = 0.5 units	none
ammonia-nitrogen (mg/l)	none	criteria are dependent on the pH and temperature of the lake, stream or river; see Tables 3a through 3c of the *Iowa Water Quality Standards* (IAC 2003) for criteria for Class B(CW), B(WW), B(LW) and B(LR) waters.				none
nitrate-nitrogen (mg/l)	none	none	none	none	none	MCL: 10

Table 6 (continued)						
	DESIGNATED USE					
PARAMETER	**Class A1, A2 & A3: swimmable**	**Class B(WW): significant resource aquatic life**	**Class B(LR): limited resource aquatic life**	**Class B(CW): coldwater aquatic life**	**Class B(LW): aquatic life of lakes and wetland**	**Class C: source of a water supply**
chloride (mg/l)	none	none	none	none	none	MCL: 250
fluoride (ug/l)	none	none	none	none	none	MCL: 4,000
E.coli (indicator bacteria)	[See Table 7.]	none	none	none	none	none
TOXIC METALS (all values in ug/l; chronic / acute / human health criteria (HHC) are given; NA = value not applicable)						
arsenic	none	200 / 360 / NA	1000 / 1800 / NA	200 / 360 / NA	200 / 3360 / NA	HHC: 0.18
cadmium	none	15 / 75/ 168	25 / 100 / NA	1 / 4/ 168	1 / 4/ 168	MCL: 5
chromium	none	40 / 60/ 3365	200 / 300 / NA	40 / 60/ 3365	10 / 15/ 3365	MCL: 100
copper	none	35 / 60/ 1000	55 / 90 / NA	20 / 30/ 1000	10 / 20/ 1000	HHC: 1300
cyanide	none	10 / 45 / NA	10 / 45 / NA	5 / 20 / NA	10 / 45 / NA	HHC: 700
lead	none	30 / 200 / NA	80 / 750 / NA	3 / 80 / NA	3 / 80 / NA	MCL: 50
mercury	none	2.1 / 4.0 / 0.15	3.7 / 6.9	3.5 / 6.5 / 0.15	0.91 / 1.7 / 0.15	HHC: 0.05
zinc	none	450 / 500 / 5000	2000 / 2200 / NA	200 / 220 / 5000	100 / 110 / 5000	HHC: 9100
PESTICIDES (all values in ug/l; chronic / acute / human health criteria (HHC) are given; NA = value not applicable)						
2,4-D	none	none	none	none	none	HHC: 100
2,4,5-TP (Silvex)	none	none	none	none	none	HHC: 10
alachlor	none	none	none	none	none	MCL: 2
atrazine	none	none	none	none	none	MCL: 3

Table 6 (continued)

	DESIGNATED USE					
PARAMETER	**Class A1, A2 & A3: swimmable**	**Class B(WW): significant resource aquatic life**	**Class B(LR): limited resource aquatic life**	**Class B(CW): coldwater aquatic life**	**Class B(LW): aquatic life of lakes and wetland**	**Class C: source of a water supply**
carbofuran	none	none	none	none	none	MCL: 40
chlorpyrifos	none	0.041 / 0.083 /NA	0.041 / 0.083 / NA	0.041 / 0.083 / NA	0.041 / 0.083 / NA	none
DDT+DDD+DDE	none	0.001 / 0.8 / 0.0059	0.029 / 0.95 / NA	0.001 / 0.9 / 0.0059	0.001 / 0.55 / 0.0059	HHC: 0.0059
dieldrin	none	0.056 / 0.24 / 0.0014	0.056 / 0.24 / NA	0.056 / 0.24 / 0.0014	0.056 / 0.24 / 0.0014	HHC: 0.0014
dinoseb	none	none	none	none	none	MCL: 7
lindane	none	NA / 0.95 / 0.63	NA / 0.95 / NA	NA / 0.95 / 0.63	NA / 0.95 / 0.63	HHC: 0.19
parathion	none	0.13 / 0.65 / NA	0.13 / 0.65 /NA	0.13 / 0.65 /NA	0.13 / 0.65 /NA	none
picloram	none	none	none	none	none	MCL: 500
simazine	none	none	none	none	none	MCL: 4

Table 7. Summary of Iowa water quality criteria for indicator bacteria (*E. coli*) in surface waters designated in the *Iowa Water Quality Standards* (IAC 2003) for either primary contact recreation, secondary contact recreation, or children's recreational use. The *E. coli* content shall not exceed the following levels when the Class A uses can reasonably be expect to occur.			
	Class A1: primary contact recreational use*	**Class A2: secondary contact recreational use***	**Class A3: children's recreational use***
Geometric Mean (No. of *E. coli* organisms/100 ml of water)	126	630	126
Sample Maximum (No. of *E. coli* organisms/100 ml of water):	235	2,880	235

* Criteria apply from March 15 through November 15 (i.e., the "recreational season") except year-round for Class A2 waters that are also designated for Class B(CW) [coldwater aquatic life] uses or are designated as "high quality" waters in the *Iowa Water Quality Standards*.

Table 8. General water quality criteria to protect beneficial general uses for all Iowa surface waters (from the *Iowa Water Quality Standards*, IAC, Section 61.3(2)).
The following criteria are applicable to all surface waters including general use and designated use waters, at all places and at all times, to protect livestock and wildlife watering, aquatic life, noncontact recreation, crop irrigation, and industrial, domestic, agricultural, and other incidental water withdrawal uses not protected by specific numerical criteria in the subrule 61.3(3) of the *Iowa Water Quality Standards*:
1. All waters of the state shall be "free from" the following:
▪ substances attributable to point source wastewater dischargers that will settle to form sludge deposits;
▪ floating debris, oil, grease, scum and other materials from wastewater discharges or agricultural practices in amounts sufficient to create a nuisance;
▪ materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor, or other aesthetically objectionable conditions;
▪ substances attributable to wastewater discharges or agricultural practices in concentrations or combinations which are acutely toxic to human, animal, or plant life;
▪ substances attributable to wastewater discharges or agricultural practices in quantities which would produce undesirable or nuisance aquatic life;
2. The turbidity of a receiving water shall not be increased by more than 25 nephelometric turbidity units by any point source discharge;
3. Total dissolved solids shall not exceed 750 mg/l in any lake or impoundment or in any stream with a flow rate equal to or greater than three times the flow rate of upstream point source dischargers;
4. Water which enters a sinkhole or losing stream segment shall not exceed a fecal coliform bacteria content of 200 organisms per 100 ml, except when the waters are materially affected by surface runoff; but in no case shall fecal coliform levels downstream from an existing discharge which may contain pathogens to humans be more than 200 organisms per 100 ml higher than the background level upstream from the discharge. No new wastewater discharges will be allowed on watercourses which directly or indirectly enter sinkholes or losing stream segments.

Table 9. Methods for determining support of **AQUATIC LIFE USES** for general use and designated use surface waters in Iowa for 2006 Section 305(b) reporting and 303(d) listing.

Type of waterbody	Source of Information	Fully Supported	Fully Supported/Threatened	Partially Supporting	Not Supporting
Rivers, streams, lakes & flood control reservoirs	Data from ambient water quality monitoring during current reporting period.	Up to one violation of acute or chronic toxicity criteria if grab samples are collected quarterly or more frequently. Criteria for conventional pollutants exceeded in $\leq$ 10% of samples.	Criteria for conventional pollutants are exceeded in no more than 10% of samples but levels are trending such that future impairment is likely.	Category not used for toxic pollutants. Criteria for conventional pollutants exceeded in from 11-25% of samples.	More than one violation of acute / chronic criteria if samples collected quarterly or more often; criteria for conventionals exceeded in more than 25% of samples.
Warmwater Streams and Rivers	Stream biocriteria sampling data (see Attachment 2)	Scores for fish or macroinvertebrate indexes of biotic integrity equal or exceed the ecoregion / subecoregion biological impairment criterion.	[Category not used for Section 305(b) reporting in Iowa.]	Scores for one of the indexes of biotic integrity (fish or macroinvertebrate) significantly less than the ecoregion / subecoregion biological impairment criterion.	Scores for both indexes of biotic integrity (fish and macroinvertebrate) significantly less than the ecoregion / subecoregion biological impairment criterion.
Coldwater Streams	Stream biocriteria sampling data (See Attachment 2)	Two or less of the eight biological indicators less than the 25th percentile of the respective indicator value for Iowa coldwater streams.	[Category not used for Section 305(b) reporting in Iowa.]	From five to six of the eight biological indicators less than the 25th percentile of the respective indicator value for Iowa coldwater streams.	From seven to eight of the eight biological indicators less than the 25th percentile of the respective indicator value for Iowa coldwater streams.
Rivers, streams, lakes & flood control reservoirs	Fish kill reports*	No pollutant-caused fish kills during the most recent 3-year period (2002 through 2004).	[Category not used for Section 305(b) reporting in Iowa.]	One pollutant-caused fish kill during the most recent 4-year period (2002-2005).	More than one pollutant-caused fish kill during the most recent 4-year period (2002-2005).

* Sources of fish kills will be reviewed to determine whether the affected waterbody is a candidate for 303(d) listing.

Table 10. Methods for determining support of classified, beneficial uses for **FISH CONSUMPTION, PRIMARY CONTACT RECREATION, and DRINKING WATER** for surface waters in Iowa for 2006 Section 305(b) reporting and 303(d) listing.

Type of Waterbody	Source of Information	Fully Supported	Fully Supported/Threatened	Partially Supporting	Not Supporting
FISH CONSUMPTION USES					
Streams, rivers, lakes, & flood control reservoirs	monitoring of levels of toxic contaminants in fish tissue	Levels of all toxics are less than IDNR/IDPH advisory trigger levels; waterbody is not covered by a fish consumption advisory	Results of monitoring have not resulted in issuance of an advisory but results of monitoring show an adverse trend suggesting that issuance of an advisory is imminent.	Levels of one or more toxics have exceeded the respective IDNR/IDPH advisory trigger levels in two consecutive samplings and a "one meal/week" advisory is in effect for the general population	Levels of one or more toxics have exceeded the respective IDNR/IDPH advisory trigger levels in two consecutive samplings and a "do not eat" advisory is in effect for the general population
PRIMARY CONTACT RECREATION (SWIMMABLE) USES					
Streams, rivers, lakes, & flood control reservoirs	monthly monitoring data for fecal coliform bacteria	Geometric mean of *E. coli* samples ≤ 126 orgs / 100 ml and ≤ 10% of samples exceed 235 orgs/100 ml.	Geometric mean of *E. coli* samples ≤ 126 orgs / 100 ml and ≤ 10% of samples > 235 orgs/100 ml but worsening trend suggests that future impairment is likely.	Geometric mean of *E. coli* samples ≤ 126 orgs/100 ml but more than 10% of samples exceed 235 orgs/100 ml (90% confidence level).	Geometric mean of *E. coli* samples > 126 orgs/100.
lake beaches	weekly monitoring data for fecal coliform bacteria	Geometric mean of at least 5 *E. coli* samples collected over a 30-day period ≤ 126 orgs / 100 ml and ≤ 10% of samples exceed 235 orgs/100 ml.	Geometric mean of *E. coli* samples ≤ 126 orgs/100 ml and ≤ 10% of samples > 235 orgs/100 ml but worsening trend suggests that future impairment is likely.	Seasonal geometric mean of *E. coli* samples ≤ 126 orgs/100 ml but > 10% of samples exceed 235 orgs/100 ml.	Geometric mean of at least 5 *E. coli* samples over a 30-day period ≥ 200 orgs / 100 ml.
Streams, rivers, lakes, & flood control reservoirs	Closure* of beaches and other swimming areas	No swimming area closures in effect during the biennial reporting period	Geometric mean of *E. coli* samples ≤ 126 orgs / 100 ml and ≤ 10% of samples > 235 orgs/100 ml but worsening trend suggests that future impairment is likely.	One swimming area closure of less than one week duration during the biennial reporting period	More than one swimming area closure, or one swimming area closure of more than one week duration during the biennial period

*Elevated levels of indicator bacteria at beaches of Iowa's state-owned lakes can trigger the posting of a "swimming is not recommended" sign. The posting of this sign, however, does not mean that the beach is closed. IDNR can, and will, close beaches in case of an emergency health risk such as a wastewater bypass, spill of a hazardous chemical, or a localized outbreak of an infectious disease (see IDNR 2004: *Understanding beach monitoring*).

Table 10. (continued).

Type of Waterbody	Source of Information	Fully Supported	Fully Supported/Threatened	Partially Supporting	Not Supporting
DRINKING WATER USES					
Waterbodies designated for use as a source of potable water (=raw water source)	ambient monitoring data for <u>toxics</u>	Average levels of toxic metals or pesticides are less than human health criteria (HHC) or maximum contaminant levels (MCLs).	Average levels of toxic metals or pesticides $\leq$ HHC or MCLs, but the average levels of at least one toxic is trending upward toward its respective HHC or MCL; waterbody is considered "impaired"	[category not used for Section 305(b) reporting]	Average level of toxic metals or pesticides greater than the MCL.
Waterbodies designated for use as a source of potable water (=raw water source)	ambient monitoring data for <u>nitrate</u>	No more than 10% of samples violate the maximum contaminant level (MCL) for nitrate.	No more than 10% of samples violate the MCL for nitrate but nitrate levels are trending upward such that impairment is likely.	From 11-25% of samples violate the MCL for nitrate.	More than 25% of samples exceed the MCL for nitrate.
Municipal drinking water (=finished water)	public water supplies using surface waters	No drinking water supply closures or advisories in effect; water not treated beyond reasonable levels	[Category not used for Section 305(b) reporting or 303(d) listing.]	One drinking water advisory lasting 30 days or less per year, or other problems not requiring closure but affecting treatment costs	One or more drinking water supply advisory lasting more than 30 days per year, or one or more drinking water supply closures per year

Table 11. Sample size and number of exceedances required to determine an impaired beneficial use (10% exceedance) as reported by Lin et al. (2000) (table excerpted from NDEQ 2006).

Minimum number of exceedances required to maintain a >90% confidence that a designated use is impaired (10% exceedance).					
Sample Size (n)	**Number of observations exceeding required to define an impaired use**	**Confidence Level**	**Sample Size (n)**	**Number of observations exceeding required to define an impaired use**	**Confidence Level**
10	3	0.930	56	10	0.951
11	3	0.910	57	10	0.945
12	4	0.974	58	10	0.940
13	4	0.966	59	10	0.933
14	4	0.956	60	10	0.927
15	4	0.944	61	10	0.920
16	4	0.932	62	10	0.913
17	4	0.917	63	10	0.905
18	4	0.911	64	11	0.948
19	5	0.965	65	11	0.943
20	5	0.957	66	11	0.938
21	5	0.948	67	11	0.932
22	5	0.938	68	11	0.926
23	5	0.927	69	11	0.920
24	5	0.915	70	11	0.913
25	5	0.902	71	11	0.906
26	6	0.960	72	12	0.947
27	6	0.953	73	12	0.942
28	6	0.945	74	12	0.937
29	6	0.936	75	12	0.931
30	6	0.927	76	12	0.926
31	6	0.917	77	12	0.920
32	6	0.906	78	12	0.913
33	7	0.958	79	12	0.907
34	7	0.952	80	13	0.946
35	7	0.945	81	13	0.942
36	7	0.937	82	13	0.937
37	7	0.929	83	13	0.931
38	7	0.920	84	13	0.926
39	7	0.911	85	13	0.920
40	7	0.900	86	13	0.914
41	8	0.952	87	13	0.908
42	8	0.946	88	13	0.901
43	8	0.939	89	14	0.941
44	8	0.932	90	14	0.937
45	8	0.924	91	14	0.932
46	8	0.916	92	14	0.927
47	8	0.907	93	14	0.921
48	9	0.954	94	14	0.915
49	9	0.948	95	14	0.910
50	9	0.942	96	14	0.903
51	9	0.936	97	15	0.941
52	9	0.929	98	15	0.937
53	9	0.922	99	15	0.932
54	9	0.914	100	15	0.927
55	9	0.906			

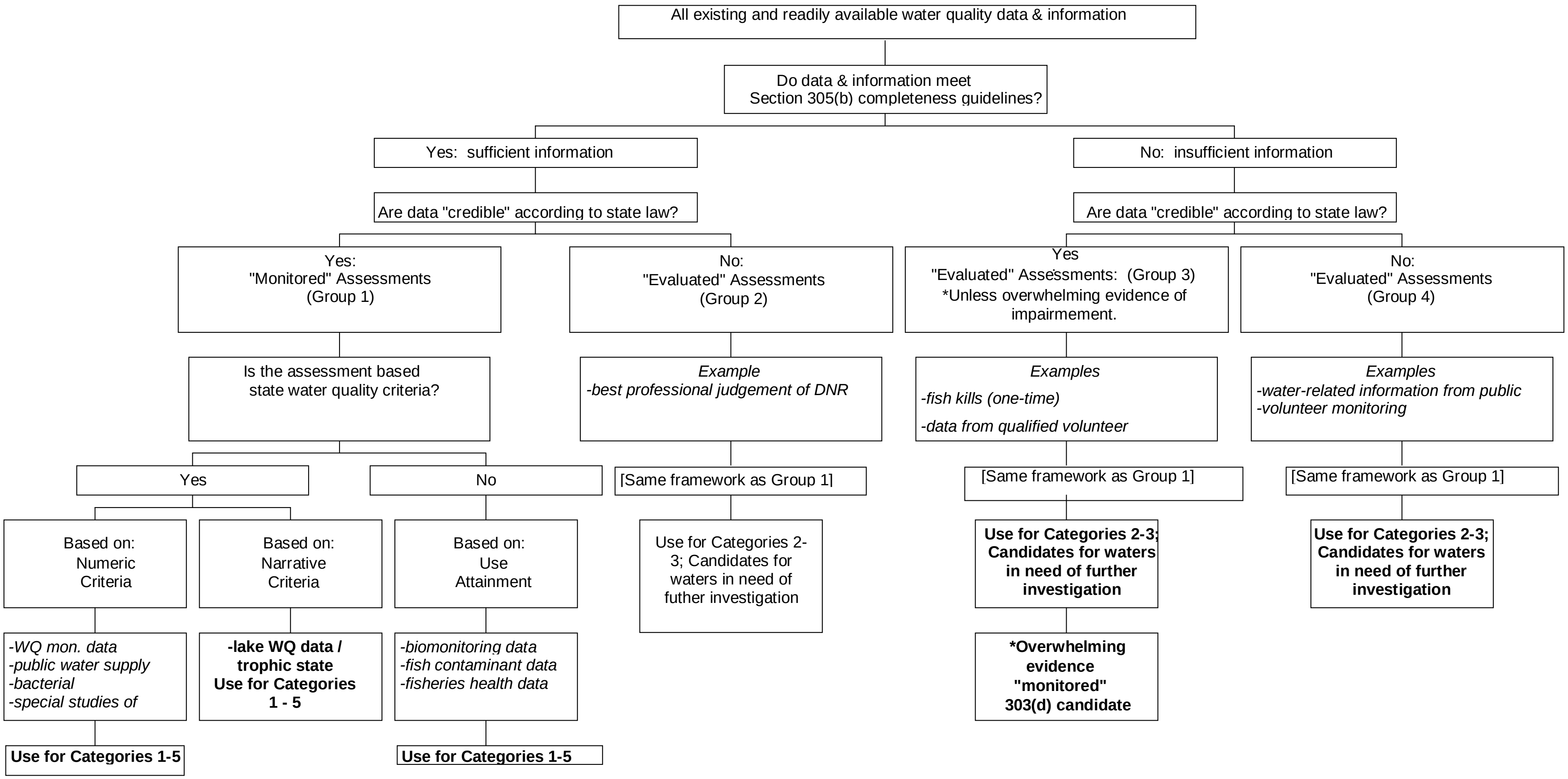
Table 12. Summary of stream segments to which either the new Class A2 or Class A3 primary contact use designations were added beginning with the July 2003 version of the Iowa Water Quality Standards.

Stream Name	Segment Description	Previous Class A Designation	Current Class A Designation	Section 305(b) Waterbody ID
Fourmile Creek	Mouth to First Street in Ankeny, Polk Co.	A	A3	IA 04-LDM-0320-1
Walnut Creek	Mouth to I-35/80, Des Moines, Polk Co.	A	A3	IA 04-RAC-0020-1
Prairie Creek	Mouth to Co. Rd in S28, T88N, R28W, Webster Co.	A	A3	IA 04-UDM-0280-1
Big Creek	Mouth to Saunders Br., Henry Co.	A	A3	IA 03-SKU-0080-1
Big Creek	Saunders Branch to Brandywine Cr., Henry Co.	A	A3	IA 03-SKU-0080-2
Black Hawk Creek	Mouth to Hwy 58, Black Hawk Co.	A	A3	IA 02-CED-0370-1
Duck Creek	Mouth to Co. Rd. in S16-21, T78N, R3E, Scott Co.	A	A3	IA 01-NEM-0060-1
Turkey River	From 2 miles downstream from Big Springs Hatchery to Big Springs Hatchery, Clayton Co.	A	A2	IA 01-TRK-0210-2

Table 13. Summary of Iowa's revised (2006) protocol for issuing fish consumption advisories. Issuance of an advisory requires two consecutive samplings that show contaminant levels above advisory trigger levels. This protocol was developed by the Iowa Department of Public Health in cooperation with IDNR.

Parameter	Unrestricted	One meal per week	Do Not Eat
PCBs	0 to 0.2 ppm	0.2 to 2.0 ppm	> 2.0 ppm
Mercury	0. to 0.3 ppm	0.3 to 1.0 ppm	> 1.0 ppm
Chlordane	0. to 0.6 ppm	0.6 to 5.0 ppm	> 5.0 ppm

Figure 1. Use of water quality data and information for Iowa's 2006 Integrated Report (Section 305(b)/303(d) report/list).



Attachment 1.
Excerpt from Senate File 2371: Iowa's credible data legislation

SENATE FILE 2371

AN ACT

RELATING TO THE ESTABLISHMENT OF A WATER QUALITY INITIATIVE PROGRAM BY THE DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP AND THE DEPARTMENT OF NATURAL RESOURCES, DEFINING AND PROVIDING FOR THE USE OF **CREDIBLE DATA** FOR QUALITY CONTROL AND ASSURANCE PROCEDURES, AND PROVIDING FOR OTHER PROPERLY RELATED MATTERS, AND PROVIDING AN APPLICABILITY DATE.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF IOWA:

Sec. 9. Section 455B.171, Code 1999, is amended by adding the following new subsections:

NEW SUBSECTION. 10A. **"Credible data"** means scientifically valid chemical, physical, or biological monitoring data collected under a scientifically accepted sampling and analysis plan, including quality control and quality assurance procedures. Data dated more than five years before the department's date of listing or other determination under section 455B.194, subsection 1, shall be presumed not to be credible data unless the department identifies compelling reasons as to why the data is credible.

NEW SUBSECTION. 14A. "Historical data" means data collected more than five years before the department's date of listing or other determination under section 455B.194, subsection 1.

NEW SUBSECTION. 19A. "Naturally occurring condition" means any condition affecting water quality which is not caused by human influence on the environment including, but not limited to, soils, geology, hydrology, climate, wildlife influence on the environment, and water flow with specific consideration given to seasonal and other natural variations.

NEW SUBSECTION. 31A. "Section 303(d) list" means any list required under 33 U.S.C. } 1313(d).

NEW SUBSECTION. 31B. "Section 305(b) list" means any report or list required under 33 U.S.C. } 1315(b).

NEW SUBSECTION. 39A. "Total maximum daily load" means the same as in the federal Water Pollution Control Act.

Sec. 10. NEW SECTION. 455B.193 QUALIFICATIONS FOR COLLECTION OF CREDIBLE DATA.

For purposes of this part, all of the following shall apply:

1. Data is not credible data unless the data originates from studies and samples collected by the department, a professional designee of the department, or a qualified volunteer. For purposes of this subsection, "professional designee" includes governmental agencies other than the department, and a person hired by, or under contract for compensation with, the department to collect or study data.

2. All information submitted by a qualified volunteer shall be reviewed and approved or disapproved by the department. The qualified volunteer shall submit a site specific plan with data which includes information used to obtain the data, the sampling and analysis plan, and quality control and quality assurance procedures used in the monitoring process. The qualified volunteer must provide proof to the department that the water monitoring plan was followed. The department shall review all data collected by a qualified volunteer, verify the accuracy of the data collected by a qualified volunteer, and determine that all components of the water monitoring plan were followed.

3. The department shall retain all information submitted by a qualified volunteer submitting the information for a period of not less than ten years from the date of receipt by the department. All information submitted shall be a public record.

4. The department shall adopt rules establishing requirements for a person to become a qualified volunteer.

The department of natural resources shall develop a methodology for water quality assessments as used in the section 303(d) listings and assess the validity of the data.

Sec. 11. NEW SECTION. 455B.194 CREDIBLE DATA REQUIRED.

1. The department shall use credible data when doing any of the following:

a. Developing and reviewing any water quality standard.

b. Developing any statewide water quality inventory or other water assessment report.

c. Determining whether any water of the state is to be placed on or removed from any section 303(d) list.

d. Determining whether any water of the state is supporting its designated use or other classification.

e. Determining any degradation of a water of the state under 40 C.F.R. } 131.12.

f. Establishing a total maximum daily load for any water of the state.

2. Notwithstanding subsection 1, credible data shall not be required for any section 305(b) report and credible data shall not be required for the establishment of a designated use or other classification of a water of the state.

3. This section shall not be construed to require credible data as defined in section 455B.171, subsection 10A, in order for the department to bring an enforcement action for an illegal discharge.

Sec. 12. NEW SECTION. 455B.195 USE OR ANALYSIS OF CREDIBLE DATA.

1. For any use or analysis of credible data described in section 455B.194, subsection 1, all of the following shall apply:

a. The use of credible data shall be consistent with the requirements of the federal Water Pollution Control Act, 33 U.S.C. } 1251 et seq.

b. The data quality for removal of water of the state from any list of impaired waters including any section 303(d) list shall be the same as the data quality for adding a water to that list.

c. A water of the state shall not be placed on any section 303(d) list if the impairment is caused solely by violations of national pollutant discharge elimination system program permits or stormwater permits issued pursuant to section 455B.103A and the enforcement of the pollution control measures is required.

d. A water of the state shall not be placed on any section 303(d) list if the data shows an impairment, but existing technology-based effluent limits or other required pollution control measures are adequate to achieve applicable water quality standards.

e. If a pollutant causing an impairment is unknown, the water of the state may be placed on a section 303(d) list. However, the department shall continue to monitor the water of the state to determine the cause of impairment before a total maximum daily load is established for the water of the state and a water of the state listed with an unknown status shall retain a low priority for a total maximum daily load development until the cause of the impairment is determined unless the department, after taking into consideration the use of the water of the state and the severity of the pollutant, identifies compelling reasons as to why the water of the state should not have a low priority.

f. When evaluating the waters of the state, the department shall develop and maintain three separate listings including a section 303(d) list, a section 305(b) report, and a listing for which further investigative monitoring is necessary. The section 305(b) report shall be a summary of all potential impairments for which credible data is not required. If credible data is not required for a section 305(b) report, the placement of a water of the state on any section 305(b) report alone is not sufficient evidence for the water of the state's placement on any section 303(d) list. When developing a section 303(d) list, the department is not required to use all data, but the department shall assemble and evaluate all existing and readily available water quality-related data and information. The department shall provide documentation to the regional administrator of the federal environmental protection agency to support the state's determination to list or not to list its waters.

g. The department shall take into consideration any naturally occurring condition when placing or removing any water of the state on any section 303(d) list, and establishing or allocating responsibility for a total maximum daily load.

h. Numerical standards shall have a preference over narrative standards. A narrative standard shall not constitute the basis for determining an impairment unless the department identifies specific factors as to why a numeric standard is not sufficient to assure adequate water quality.

i. If the department has obtained credible data for a water of the state, the department may also use historical data for that particular water of the state for the purpose of determining whether any trends exist for that water of the state.

2. This section shall not be construed to require or

authorize the department to perform any act listed in section 455B.194, subsection 1, not otherwise required or authorized by applicable law.

Sec. 13. LEGISLATIVE STUDY. The legislative council is requested to establish an interim study relating to the use of plant nutrients on Iowa soil. The committee is directed to submit its findings, with any recommendations, in a report to the general assembly not later than January 15, 2001.

Sec. 14. **APPLICABILITY OF SECTION 303(d) LISTS**. This Act takes effect July 1, 2000. However, any requirements under this Act which apply to a section 303(d) list shall not apply for the section 303(d) list for the year 2000, but any requirements shall take effect for all section 303(d) lists created after the year 2000 list.

MARY E. KRAMER
President of the Senate

BRENT SIEGRIST
Speaker of the House

I hereby certify that this bill originated in the Senate and is known as Senate File 2371, Seventy-eighth General Assembly.

MICHAEL E. MARSHALL
Secretary of the Senate

Approved , 2000

THOMAS J. VILSACK
Governor

Attachment 2

GUIDELINES FOR DETERMINING SECTION 305(B) AQUATIC LIFE USE SUPPORT (ALUS) USING STREAM BIOCRITERIA SAMPLING DATA FOR THE 2006 SECTION 305(B) REPORTING AND SECTION 303(D) LISTING CYCLES

Introduction:

Since the late 1980s, U.S. EPA has encouraged states to develop and adopt narrative and biological criteria (biocriteria) for surface waters. Biocriteria are narrative or numeric expressions that describe the best attainable biological integrity (reference condition) of aquatic communities inhabiting waters of a given designated aquatic life use (U.S. EPA 1990a). Supported by a water quality planning grant from the U.S. EPA Region VII, geographers of the U.S. EPA Corvallis Environmental Research Laboratory collaborated with DNR staff to revise and subdivide the ecoregions in Iowa (see Omernik et al. 1993; Griffith et al. 1994). As part of this effort, a list of candidate stream reference sites was generated. Reference sites are located on the least impacted streams within an ecoregion or subecoregion. Reference sites can thus serve as benchmarks to which water quality-impaired streams can be compared. A pilot reference site sampling study was conducted in 1994 to develop standardized data collection procedures for assessing the quality of aquatic habitat and for sampling benthic macroinvertebrate and fish communities (Wilton 1996). Approximately 100 reference sites were sampled during the initial reference site sampling period 1994-1998; an additional 75 sites were sampled with the biocriteria sampling protocol as part of test site sampling and sampling for watershed projects. These data, as well as more recent reference site sampling data from 1999-2004, were used to develop and calibrate indicators of stream biological integrity (Wilton 2004) and biological assessment criteria used in assessments of aquatic life use support for the 2006 Section 305(b) report. For a discussion of the process used to calculate the bioassessment criteria, please see the addendum to this attachment.

The bioassessment indicators were originally calibrated for assessing support of Class B(LR) and Class B(WW) warmwater aquatic life uses in wadeable stream segments. The indicators were not calibrated for small headwater "General Use" streams or nonwadeable warmwater rivers having watershed drainage areas $\geq$ 500 mi^2. In the absence of specifically calibrated indicators for these types of warmwater lotic systems, the current indicators and criteria have been applied; however, these assessments are considered "evaluated" rather than "monitored" assessments to reflect a greater degree of uncertainty in the assessment conclusions. Separate indicators and guidelines described later in this section have been developed for determining the level of support for the Class B(CW) coldwater aquatic life uses designated for trout streams of northeastern Iowa.

Uses designated for individual stream and river reaches in Iowa are summarized in the "Water Use Designations" portion of the *Iowa Water Quality Standards* (IAC 2003); definitions of designated uses [e.g., Class B(WW), Class B(LR), and Class B(CW)] are presented in the *Iowa Water Quality Standards* (IAC 2003).

The Iowa DNR uses a Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and a Fish Index of Biotic Integrity (FIBI) to summarize biological sampling data. The BMIBI and FIBI combine several quantitative measurements or "metrics" that provide a broad assessment of stream biological conditions. A metric is a characteristic of the biological community that can be measured reliably and responds predictably to changes in stream quality. The BMIBI and FIBI each contain twelve metrics that relate to species diversity, relative abundance of sensitive and tolerant organisms, and the proportion of individuals belonging to specific feeding and habitat groups. The metrics are numerically ranked and their scores are totaled to obtain an index rating from 0 (poor) – 100 (optimum). Qualitative scoring ranges of poor, fair, good, and excellent have been established that reflect the biological community characteristics found at each level (Table 2-1a, 2-1b). These qualitative ranges are general interpretative guidelines only. To assess support of aquatic life uses, sample site IBI scores are compared against Biological Impairment Criteria (BIC) (Table 2-2), which more specifically reflect reference conditions defined by ecoregion and habitat class.

<u>Determining Support of General Use, Class B(LR) and B(WW) Aquatic Life Uses</u>

Aquatic life use assessments for the 2006 Integrated Report cycle were updated using biological assemblage sampling data from 2003 and 2004. The primary types and sources of data are: a) benthic macroinvertebrate and fish assemblage data collected as part of the

DNR/UHL stream biocriteria project; b) fish assemblage data collected by staff of the DNR Fisheries Bureau. Before making assessments, data completeness and quality are evaluated. "Comparable" data are considered as having completeness and quality that is comparable to biocriteria project data used to develop reference biotic indexes and impairment criteria. These data are used to make "monitored" (higher confidence) assessments. "Tentative" data are considered as having lesser or uncertain levels of completeness and quality documentation. These data are used to make "evaluated" (lower confidence) assessments.

To determine the level of aquatic life use support for a stream sampling site, the BMIBI and/or FIBI scores from that stream are compared against index levels measured at reference stream sites located in the same ecological region. Reference sites are also stratified by habitat class in certain ecoregions where statistically significant differences have been found between reference sites having abundant coarse substrates and riffle habitat versus those lacking these habitat characteristics. A set of biological assessment criteria were specifically developed for the 2006 305(b) report using stream reference site data from 1994-2004. The 25^{th} percentile values of the reference site BMIBI and FIBI index scores within a given ecoregion or habitat class were used as the biological impairment criteria (BIC) for 305(b) assessment purposes (Table 2-2). Use of the reference 25^{th} percentile as an impairment threshold is consistent with biocriteria development guidance (U.S. EPA 1996), and has demonstrated efficacy in state bioassessment programs (Yoder and Rankin 1995). Biotic index performance evaluation in Iowa found little or no overlap of index interquartile ranges between reference sites and test (impacted) sites, which suggests that reference 25^{th} percentile levels are appropriate for assessing biological impairment.

Generally, a stream is considered biologically impaired if one or both of its index scores are significantly lower than the BIC. An uncertainty adjustment value (UAV) equal to 8 BMIBI points or 7 FIBI points is applied in cases where single sample data are used to assess aquatic life use support status. The UAV reflects the typical year-to-year IBI scoring variation observed among least disturbed reference sites throughout Iowa. It is used to identify stream segments that are within a reasonable margin of error from the lower 25^{th} percentile of reference site IBI scores and may be considered a higher priority for follow-up sampling in order to better determine the status of aquatic life uses.

"Monitored" assessments are those for which biocriteria project comparable data are available to assess a "calibrated" stream segment, which is defined as wadeable streams designated as B(LR) or B(WW) in 2004 and have a watershed drainage area < 500 square miles. "Evaluated" assessments are generally of two kinds: 1) cases in which data of lesser or uncertain comparability are used to assess a "calibrated" segment; 2) cases where biotic index data are used to assess "uncalibrated" segments (i.e., general use segments or non-wadeable river segments having watershed drainage area $\geq$ 500 mi^2).

Aquatic Life Use Support Guidelines

The following guidelines are used to make aquatic life use status recommendations on the basis of biological sampling data only. In many cases, water quality monitoring data are also available to evaluate aquatic life use status from the perspective of chemical and physical water quality standards attainment. In these cases, a weight of evidence approach is taken to make adjustments and assign the most appropriate aquatic life use status category.

Fully Supporting "Monitored"

- Assessments for calibrated stream segments having comparable data consisting of at least one valid BMIBI score and at least one valid FIBI score, and the single score(s) or the average(s) of multiple scores equal or exceed the BIC.

Fully Supporting "Evaluated"

- Assessments for calibrated segments having comparable data consisting of at least one valid BMIBI or FIBI score but not both index scores, and the single score and/or the average of multiple scores for that index equal or exceed the BIC; *OR,*
- Assessments for calibrated segments having tentative data consisting of at least one valid BMIBI score and/or FIBI score, and the single score(s) and/or the average(s) of multiple scores equal or exceed the BIC; *OR,*
- Assessments for uncalibrated segments having comparable or tentative data consisting of at least one valid BMIBI score and/or FIBI score, and the single score(s) or the average(s) of multiple scores equal or exceed the BIC.

Partially Supporting "Monitored"

- Assessments for calibrated segments having comparable data consisting of at least one valid BMIBI score and/or FIBI score.
    - If valid score(s) for only one index, the single score plus the applicable UAV is less than the BIC or the average of multiple scores is less than the BIC; *OR*,
    - If valid score(s) for both indexes, then: 1) the single score(s) plus the applicable UAV(s) is less than the BIC or the average(s) of multiple scores is less than the BIC, and 2) the single score or the average of multiple scores for at least one index does not fall in the qualitative range indicating "poor" biocondition (see Tables 2-1a and 2-1b).

Partially Supporting "Evaluated"

- Assessments for uncalibrated segments having comparable or tentative data consisting of at least one valid BMIBI score and/or FIBI score.
    - If valid score(s) for only one index, the single score plus the applicable UAV is less than the BIC or the average of multiple scores is less than the BIC; *OR,*
    - If valid score(s) for both indexes, then: 1) the single score(s) plus the applicable UAV(s) is less than the BIC or the average(s) of multiple scores is less than the BIC, and 2) the single score or the average of multiple scores for at least one index does not fall in the qualitative range indicating poor biocondition.
- Assessments for calibrated segments having tentative data consisting of at least one valid BMIBI score and/or FIBI score.
    - If valid score(s) for only one index, the single score plus the applicable UAV is less than the BIC or the average of multiple scores is less than the BIC; *OR,*
    - If valid score(s) for both indexes, then: 1) the single score(s) plus the applicable UAV(s) is less than the BIC or the average(s) of multiple scores is less than the BIC, and 2) the single score or the average of multiple scores for at least one index does not fall in the qualitative range indicating poor biocondition.

Not Supporting "Monitored"

- Assessments for calibrated segments having comparable data consisting of at least one valid BMIBI score and one valid FIBI score, and both of the following conditions are true: 1) the single score(s) plus the applicable UAV(s) is less than the BIC or the average(s) of multiple scores is less than the BIC; and 2) the single score or the average of multiple scores for <u>both</u> the BMIBI and the FIBI fall in the qualitative range indicating poor biocondition.

Not Supporting "Evaluated"

- Assessments for uncalibrated segments having comparable or tentative data consisting of at least one valid BMIBI score and one valid FIBI score, and both of the following conditions are true:
  - 1) the single score(s) plus the applicable UAV(s) is less than the BIC or the average(s) of multiple scores is less than the BIC;
  - 2) the single score or the average of multiple scores for <u>both</u> the BMIBI and the FIBI fall in the range indicating poor biocondition.
- Assessments for calibrated segments having tentative data consisting of at least one valid BMIBI score and one valid FIBI score, and both of the following are true:
  - 1) the single score(s) plus the applicable UAV(s) is less than the BIC or the average(s) of multiple scores is less than the BIC,
  - 2) the single score or the average of multiple scores for <u>both</u> the BMIBI and the FIBI fall in the qualitative range indicating poor biocondition.

<u>Abbreviations and terms</u>: ***ALUS***, Aquatic Life Use Support; ***BIC***, Biological Impairment Criteria/Criterion; ***BMIBI***, Benthic Macroinvertebrate Index of Biotic Integrity; ***FIBI***, Fish Index of Biotic Integrity; ***UAV***, Uncertainty Adjustment Value [8 pts. BMIBI, 7 pts. FIBI)
Calibrated - Stream segments designated as B(LR) or B(WW) in 2004 and have a watershed drainage area < 500 square miles.
Uncalibrated - General use segments or non-wadeable river segments having watershed drainage area $\geq$ 500 mi^2.
Comparable - Data considered as having completeness and quality that is comparable to biocriteria project data used to develop reference biotic indexes and impairment criteria.
Tentative - Data considered as having lesser or uncertain levels of completeness and quality documentation.

Table 2-1(a). BMIBI qualitative scoring ranges.

Biological Condition Rating	**Characteristics of Benthic Macroinvertebrate Assemblage**
76-100 (Excellent)	High numbers of taxa are present, including many sensitive species. EPT taxa are very diverse and dominate the benthic macroinvertebrate assemblage in terms of abundance. Habitat and trophic specialists, such as scraper organisms, are present in good numbers. All major functional feeding groups (ffg) are represented, and no particular ffg is excessively dominant. The assemblage is diverse and reasonably balanced with respect to the abundance of each taxon.
56-75 (Good)	Taxa richness is slightly reduced from optimum levels; however, good numbers of taxa are present, including several sensitive species. EPT taxa are fairly diverse and numerically dominate the assemblage. The most-sensitive taxa and some habitat specialists may be reduced in abundance or absent. The assemblage is reasonably balanced, with no taxon excessively dominant. One ffg, often collector-filterers or collector-gatherers, may be somewhat dominant over other ffgs.
31-55 (Fair)	Levels of total taxa richness and EPT taxa richness are noticeably reduced from optimum levels; sensitive species and habitat specialists are rare; EPT taxa still may be dominant in abundance; however, the most-sensitive EPT taxa have been replaced by more-tolerant EPT taxa. The assemblage is not balanced; just a few taxa contribute to the majority of organisms. Collector-filterers or collector-gatherers often comprise more than 50% of the assemblage; representation among other ffgs is low or absent.
0-30 (Poor)	Total taxa richness and EPT taxa richness are low. Sensitive species and habitat specialists are rare or absent. EPT taxa are no longer numerically dominant. A few tolerant organisms typically dominate the assemblage. Trophic structure is unbalanced; collector-filterers or collector-gatherers are often excessively dominant; usually some ffgs are not represented. Abundance of organisms is often low.

Table 2-1(b). Fish Index of Biotic Integrity (FIBI) qualitative scoring guidelines.

71-100 (Excellent)	Fish (excluding tolerant species) are fairly abundant or abundant. A high number of native species are present, including many long-lived, habitat specialist, and sensitive species. Sensitive fish species and species of intermediate pollution tolerance are numerically-dominant. The three most abundant fish species typically comprise 50% or less of the total number of fish. Top carnivores are usually present in appropriate numbers and multiple life stages. Habitat specialists, such as benthic invertivore and simple lithophilous spawning fish are present at near optimal levels. Fish condition is good; typically less than 1% of the total number of fish exhibit external anomalies associated with disease or stress.
51-70 (Good)	Fish (excluding tolerant species) are fairly abundant to very abundant. If high numbers are present, intermediately tolerant species or tolerant species are usually dominant. A moderately high number of fish species belonging to several families are present. The three most abundant fish species typically comprise two-thirds or less of the total number of fish. Several long-lived species and benthic invertivore species are present. One to several sensitive species are usually present. Top carnivore species are usually present in low numbers and often one or more life stages is missing. Species that require silt-free, rock substrate for spawning or feeding are present in low proportion to the total number of fish. Fish condition is good; typically less than 1% of the total number of fish exhibit external anomalies associated with disease or stress.
26-50 (Fair)	Fish abundance ranges from lower than average to very abundant. If fish are abundant, tolerant species are usually dominant. Native fish species usually equal ten or more species. The three most abundant species typically comprise two-thirds or more of the total number of fish. One or more sensitive species, long-lived fish species or benthic habitat specialists such as Catostomids (suckers) are present. Top carnivore species are often, but not always present in low abundance. Species that are able to utilize a wide range of food items including plant, animal and detrital matter are usually more common than specialized feeders, such as benthic invertivore fish. Species that require silt-free, rock substrate for spawning or feeding are typically rare or absent. Fish condition is usually good; however, elevated levels of fish exhibiting external anomalies associated with disease or stress are not unusual.
0-25 (Poor)	Fish abundance is usually lower than normal or, if fish are abundant, the assemblage is dominated by a few or less tolerant species. The number of native fish species present is low. Sensitive species and habitat specialists are absent or extremely rare. The fish assemblage is dominated by just a few ubiquitous species that are tolerant of wide-ranging water quality and habitat conditions. Pioneering species, introduced species, and short-lived fish species are typically the most abundant types of fish. Elevated levels of fish with external physical anomalies are more likely to occur.

Table 2-2. Biological Impairment Criteria (BIC) used for the assessment of warmwater rivers and streams in the 2006 section 305(b) reporting and section 303(d) listing cycles. For a discussion of how the BIC were derived, please see the addendum to this Attachment.

Ecoregion:	FIBI	BMIBI
40a – Central Irregular Plains	33	41
47 – Western Corn Belt Plains (WCBP) Subregions:		
47(a) – WCBP /Northwest Iowa Loess Prairies	43	54
47(b) – WCBP / Des Moines Lobe (Stable Riffle Habitat*) (No Stable Riffle Habitat)	 53 32	 62 62
47(c) – WCBP / Iowan Surface (Stable Riffle Habitat) (No Stable Riffle Habitat)	 65 44	 70 52
47(d) – WCBP / Missouri Alluvial Plain	-	-
47(e) – WCBP / Loess Hills and Rolling Loess Prairies	31	54
47(f) – WCBP / Southern Iowa Rolling Loess Prairies (Mississippi Drainage System) (Missouri Drainage System)	 36 31	 51 54
52b – Paleozoic Plateau (Driftless Area)	52	61
72d – Central Interior Lowland	-	-

Determining Support of B(CW) [coldwater] Aquatic Life Uses

Nine coldwater streams where biocriteria sampling was done from 1994-1998 were used to establish criteria used to determine the status of Class B(CW) aquatic life use. Eight biological indicators that reflect coldwater stream water quality and habitat suitability were calculated, and a ranking system was used to determine the level of B(CW) use support.

Coldwater stream biological indicators used to determine B(CW) aquatic life use status.

1. Number of sensitive benthic macroinvertebrate taxa.
2. Number of coldwater obligate benthic macroinvertebrate taxa
3. Benthic macroinvertebrate biotic index of organic enrichment.
4. Percent dominance of three most abundant benthic macroinvertebrates.
5. Number of coldwater fish species.
6. Percent abundance of coldwater fish species
7. Presence/absence of trout.
8. Trout reproduction rating for stream.

The degree of B(CW) use support for a given stream site was assessed by determining the number of biological indicator values that ranked below the 25^{th} percentile of indicator values from all nine coldwater stream sampling sites. Sites with $\leq$ 2 indicators ranking below the 25^{th} percentile level are assessed as fully supporting or fully supporting/threatened (=FS or FS/T); sites with 2-4 indicators ranking below the 25^{th} percentile level are assessed as fully supporting/threatened (=FS/T); sites with 5 or 6 indicators below the 25^{th} percentile level are assessed as partially supporting (=PS); sites with 7 or 8 indicators below the 25^{th} percentile level are assessed as not supporting (=NS).

II. Applying the site assessment results to a Section 305(b) stream segment.

a) Stream segment assessments derived from a single sampling event. When data from one sampling event at one sampling site are the only data available, the assessment result for that site (e.g., fully supporting/threatened) is applied to the entire stream segment length. Most of the stream segments assessed for Section 305(b) reporting with results of 1997-2002 biocriteria sampling belong to this category.

b) Stream segments with multiple sampling sites. Relatively few stream segments have data from multiple biological sampling sites, and these are examined on a case-by-case basis. In general, when data from multiple sites are available, the lowest assessment result is assigned to the entire stream segment length. For example, if one site assessment result indicates aquatic life use is partially supporting and a second site assessment result is fully supporting/threatened uses, the partially supporting assessment is applied to the entire stream segment. One exception of this is when one or more sites are judged to be unrepresentative of the stream segment as a whole (e.g., mixing zone of wastewater discharge). In this case, only the assessment results from the site or sites that are considered representative are used to make the assessment for the entire stream segment.

III. Identifying causes and sources of impairment.

As defined in guidelines for Section 305(b) reporting (U.S. EPA 1997), *causes* of water quality impairment are those pollutants and environmental stressors that contribute to the impairment of designated uses in a waterbody. *Sources* are the activities, facilities or conditions that contribute the pollutants and environmental stressors which result in the impairment of designated beneficial uses. For example, high levels of pesticides (the *cause*) from agricultural activities (the *source*) can impair a waterbody's designated beneficial uses as a source of drinking water.

Causes and sources of impairment are specified for stream segments assessed as either "partially supporting" or "not supporting" aquatic life uses. DNR Watershed Monitoring & Assessment Section staff follow U.S. EPA guidelines and use best professional judgment to identify and assign a magnitude to each cause and source of impairment. DNR staff consider available information about pollution sources and recent events affecting water quality. Summary information from stream physical habitat evaluations are also used to assess causes and sources that are related to habitat alterations. The information reviewed includes floodplain land uses, buffer strip width and vegetation, channel sinuosity and morphometry, bank conditions, sediment composition, stream flow, and instream habitat.

References for Attachment 2:

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Addendum to Attachment 2:

Establishment of Biological Impairment Criteria (BIC) for Determining Support of Warmwater Stream Aquatic Life Designated Uses

September 2007

Introduction

This document describes the rationale, procedures, and results from the recalculation of Biological Assessment Criteria (BIC) used in the 2006 biennial 305(b)/303(d) Integrated Report. Supplemental information describing sampling protocols, biotic index development, ecoregions and reference sites can be found in the IDNR stream bioassessment project report (Wilton 2004). Procedures for determining the support status of designated aquatic life uses are described in the 305(b)/303(d) Integrated Report assessment methodology (IDNR 2007). With minor modifications, the existing bioassessment framework has been used for 305(b) reporting and 303(d) impaired waters listings since the 2000 assessment cycle.

To determine the support status of warmwater stream aquatic life uses, the Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and the Fish Index of Biotic Integrity (FIBI) sample scores from a given segment are compared to applicable Biological Impairment Criteria (BIC). The BIC are statistically derived from index scores sampled at reference stream sites located in the same ecological region (Figure 1). Reference sites are chosen to represent least disturbed stream habitats that support healthy biological aquatic communities. Reference data have been used to define best aquatic life use expectations through calibration of the BMIBI and FIBI and establishment of Biological Assessment Criteria (BIC). Wadeable stream reference sites are generally sampled in a five-year rotational schedule. The first cycle of reference site sampling was conducted from 1994-1998. A few additional reference sites were sampled in 1999, and the second cycle of reference site sampling was conducted from 2000-2004.

BIC Re-calculation Rationale

Since the reference site network and bioassessment approach is relatively new in Iowa, it was reasoned that the inclusion of recent data would help insure that reference biological conditions appropriately reflect a full range of climatic and hydrologic conditions affecting stream aquatic communities. Given the cyclic nature of drought and wet years in the Midwest, it was believed that averaging of reference sampling results from a decade of sampling (1994-2004) would more appropriately reflect the natural variations in stream biological conditions and provide a robust data set for stream biological assessment. Therefore, additional results of reference site sampling from 2002-2004 were added to the previous data set of 1994-2001 data in order to update the BIC (Table 1) for the 2006 listing cycle. The additional data, in most cases, increased the number of BMIBI and FIBI samples representing each reference site from one to two samples.

Methods

A consistent approach was followed in calculating the BIC for the 2006 and previous assessment cycles. Currently, 95 reference sites are recognized by the IDNR for stream bioassessment purposes. Only data from the 87 warmwater reference sites were used to calculate the BIC. Data from eight coldwater reference sites were disregarded. Approximately 180 valid BMIBI and FIBI scores obtained during the normal July – October sampling index period were included in the BIC calculations. The respective BMIBI and FIBI scores from each site were averaged and the site averages were compiled by ecoregion. Statistical summaries of average reference site IBI scores are reported in Table 2 and Table 3. In response to previous findings (Wilton 2004), additional statistical tests were performed to examine for differences between habitat and benthic sampling gear groupings within certain ecoregions (Tables 4-6).

IDNR has chosen the 25th percentile values of the reference site BMIBI and FIBI index scores within a given ecoregion or habitat class to represent the biological impairment criteria (BIC) for 305(b)/303(d) biological assessment purposes (Table 1). Use of the reference 25th percentile as an impairment threshold is consistent with biocriteria development guidance (U.S. EPA 1996), and has demonstrated efficacy in state bioassessment programs (Yoder and Rankin 1995). Evaluation of biotic index performance in Iowa found little or no overlap of index interquartile ranges between reference sites and test (impacted) sites, which suggests that reference 25th percentile levels are appropriate for assessing biological impairment (Wilton 2004).

Recalculation Results

Table 1 provides a comparison of the BIC used in the 2006 IR assessment with the BIC used in the 2002 and 2004 assessment cycles. For the BMIBI, two BIC were raised, one was kept equal, and seven BIC were lowered in relation to the 2002/2004 BIC. Separate BIC were established by sampling gear type within ecoregion 47c after statistical analysis found a significant difference in BMIBI scores among sites sampled using the Hess sampling device (riffle habitat) versus sites sampled using Hester-Dendy artificial substrates (Table 4; rank sum test $p<0.05$). This separation resulted in both the largest BIC increase (11 points; Hess sites) and the largest decrease (7 points, Artificial Substrate sites) from the 2002/2004 BIC.

For the FIBI, four of the 2006 BIC were raised, four were kept equal, and four were lowered in relation to the 2002/2004 BIC. The largest BIC increase was 3 points (47a) and the largest decrease was 7 points (52b). Riffle and non-riffle sites within ecoregion 47f were combined to calculate a single BIC after statistical testing failed to show a difference in FIBI scores among these groups (Table 6; rank sum test $p>0.05$).

While most of the changes in BIC were small, more of them were lowered than raised or kept the same. This trend has prompted follow-up examination of trends in reference site sampling data. For example, it was determined that approximately 60% of reference sites had higher BMIBI or FIBI scores from the 1994-1998 period (cycle 1) compared with scores from the 2000-2004 sampling period (cycle 2). Mean site paired differences (cycle 1- cycle 2) of 3.9 points for the BMIBI and 4.1 points for the FIBI were both significantly greater than zero (paired t-test, $p<0.05$), thus indicating an overall decline in BMIBI and FIBI scores. This trend is cause for concern that reference conditions might be deteriorating, and simultaneously points out the value of sustained long-term monitoring projects.

The IDNR bioassessment unit has initiated an investigation of factors that may have contributed to the observed trend. Significant year-to-year differences in the magnitude of changes in IBI levels have been observed (Figure 2) suggesting that climatic variation is a potential contributing factor. Precipitation patterns, for example, can influence the flow regime, habitat and water quality conditions under which the aquatic communities develop. A correlation analysis found the largest changes in FIBI scores between sample cycles 1 and 2 were associated with the largest differences in sample date flow. This relationship might reflect differences in fish distribution or sampling effectiveness that occur under different flow regimes. Additional exploratory analysis found a lack of relationship between the direction or size of reference site changes in BMIBI scores and changes in FIBI scores (Figure 3), which might indicate the two indexes respond to environmental conditions at different spatial and/or temporal scales.

Ecoregion or stream watershed size also were not related with the direction or size of changes in IBI levels. The bioassessment unit is not currently aware of any widespread changes in land use or anthropogenic stressors in reference site watersheds that might explain the declining trend, but will continue to investigate this possibility.

Future Outlook

IDNR considers the development and verification of reference conditions to be an evolving process. Reference sites and reference conditions for bioassessment are the subject of significant research and development work throughout the United States. IDNR will continue to improve its reference condition development process and will utilize new techniques and methods as they become available.

As new data from reference sites is obtained, it will be reviewed and incorporated in each successive biennial Integrated Report. When the next cycle of warmwater reference site sampling is completed, IDNR will again review and update the BIC, if needed. At that time, there will be a minimum of three samples from each reference site covering approximately seventeen years of sampling. Other data, particularly the 2002-2006 (REMAP) random survey of perennial streams will be reviewed to determine whether additional reference sites can be gleaned and the data used to better define reference conditions and BIC. Although no specific timeframe has been set, it is anticipated that Iowa's wadeable stream bioassessment framework and BIC will be reviewed for potential incorporation within Iowa's water quality standards.

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Addendum Table 1. Warmwater stream Biological Impairment Criteria (BIC) for 305(b)/303(d) Integrated Report biological assessments.

Ecoregion	Major Drainage	Riffle?	FIBI BIC '06 ('02-'04)	Bug gear	BMIBI BIC '06 ('02-'04)
40a	All	All	33 (33)	All	41 (46)
47a	All	All	43 (40)	All	54 (53)
47b	All	Yes	53 (55)	All	62 (63)
47b	All	No	32 (32)	All	62 (63)
47c	All	Yes	65 (71)	Hess	70 (59)
47c	All	No	44 (43)	Art. Sub.	52 (59)
47e	All	All	31 (31)	All	54 (56)
47f	MSP	All	36 (41,34)*	All	51 (53)
47f	MO	All	31 (31)	All	54 (56)
52b	All	All	52 (59)	All	61 (61)
72d	All	All	36 (34)	All	51 (53)
* '02-'04 47f BIC: MSP riffle = 41 and MSP non-riffle = 34.					

Addendum Table 2. Summary statistics for 1994-2004 warmwater wadeable stream reference site FIBI scores by ecoregion.

Ecoregion	# sites	FIBI mean	FIBI min	FIBI 25th	FIBI median	FIBI 75th	FIBI max
40a	7	40.9	27.0	33.0	37.5	50.0	57.0
47a	6	46.2	42.5	42.9	46.3	49.3	50.0
47b all	20	50.8	28.5	38.3	51.3	61.0	74.5
47b riffle	11	58.8	37.0	52.5	60.0	71.5	74.5
47b non-riffle	9	41.0	28.5	31.8	42.0	48.5	55.5
47c all	20	62.8	38.0	50.2	64.8	76.4	83.0
47c riffle	8	73.1	58.5	64.9	76.6	78.9	83
47c non-riffle	12	55.9	38	44.1	54.3	69.1	76.5
47e	8	36.0	25.5	30.9	37.0	37.9	49.5
47f	17	46.7	23.5	35.5	48.5	54.5	71.0
52b	7	64.9	48.0	52.0	63.5	79.0	81.0
72d	2	45.2	43.0	44.1	45.2	46.3	47.3

Addendum Table 3. Summary statistics for 1994-2004 reference site BMIBI scores by ecoregion.

Ecoregion	# sites	BMIBI mean	BMIBI min	BMIBI 25th	BMIBI median	BMIBI 75th	BMIBI max
40a	7	48.7	34.0	41.0	50.0	56.5	68.0
47a	6	66.5	50.0	53.8	65.5	78.3	88.0
47b	20	65.6	37.5	62.0	68.9	73.4	76.5
47c art subs	9	58.7	47.0	52.3	59.5	65.2	70.5
47c hess/surber	13	73.3	62.0	70.3	72.6	78.0	81.5
47c all sites	20	67.2	47.0	60.6	69.3	73.3	81.5
47e	8	58.7	46.0	53.4	57.5	66.3	70.0
47f	17	59.2	44.0	50.3	62.5	66.8	71.0
52b	7	67.9	54.5	61.0	68.0	75.0	80.5
72d	2	43.8	39.0	41.4	43.8	46.1	48.5

Addendum Table 4. Statistical analysis of 1994-2004 reference site BMIBI scores from select ecoregions by benthic macroinvertebrate sampling gear.

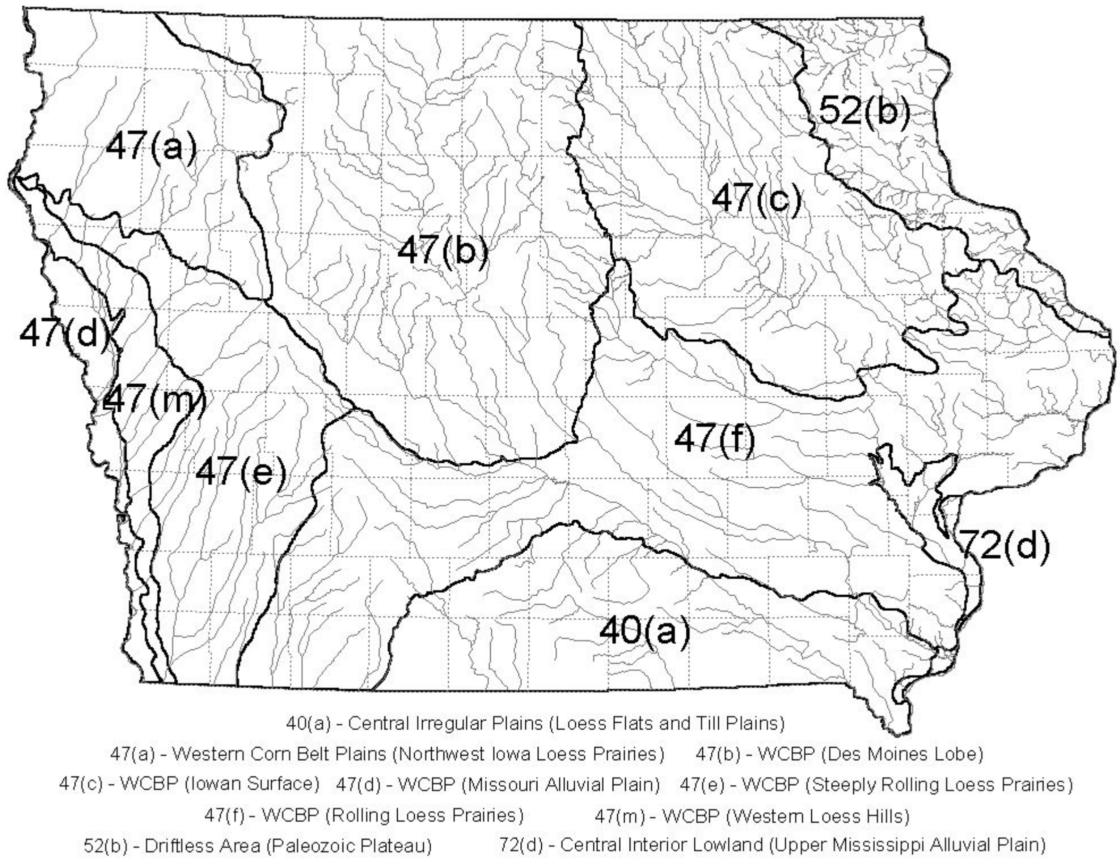
Ecoregion	# sites	BM-IBI mean	BM-IBI min	BM-IBI 25th	BM-IBI median	BM-IBI 75th	BM-IBI max	BM-IBI two sample mean TTest p-value	BM-IBI rank sum p-value
40a art subs	3	38.3	31.0	31.0	34.0	50.0	50.0	0.1186	0.1213
40a hess/surber	6	51.2	41.0	41.0	50.3	59.4	68.0		
47b art subs	9	59.6	37.5	45.0	58.0	74.0	75.0	0.0380	0.1756
47b hess/surber	14	70.0	61.0	63.7	69.4	74.0	76.5		
47c art subs	9	58.7	47.0	52.3	59.5	65.2	70.5	0.00005	0.0005
47c hess/surber	13	73.3	62.0	70.3	72.6	78.0	81.5		
47e art subs	3	58.7	46.0	46.0	62.5	67.5	67.5	0.9966	1.0000
47e hess/surber	5	58.7	52.5	54.3	56.5	64.3	70.0		
47f art subs	6	60.3	44.0	48.5	62.8	71.0	71.0	0.8107	0.7079
47f hess/surber	12	60.0	45.5	51.4	59.5	66.9	69.7		

Addendum Table 5. Statistical analysis of 1994-2004 reference site BMIBI scores from select ecoregions by stream type: riffle or non-riffle. Riffle streams include >10% riffle macrohabitat, >10% cobble substrate and >30% total coarse substrate.

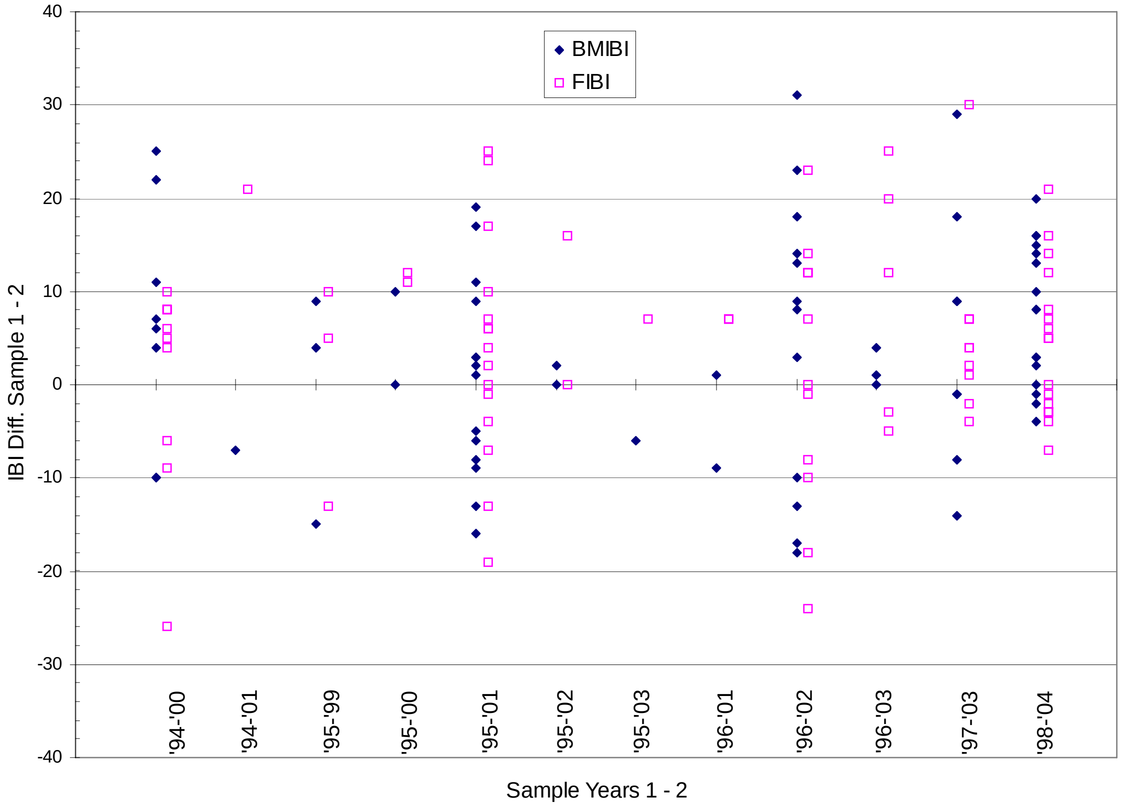
Ecoregion	# sites	BMIBI mean	BMIBI min	BMIBI 25th	BMIBI median	BMIBI 75th	BMIBI max	BMIBI two sample TTest mean p-value	BMIBI rank sum p-value
47b riffle	11	68.9	62.0	64.2	67.3	74	76.5	0.1138	0.2875
47b non-riffle	9	61.5	37.5	49.0	70.5	72.0	75.0		
47c riffle	8	74.4	62.0	72.5	74.5	79.5	81.5	0.0024	0.0014
47c non-riffle	12	62.3	47.0	56.1	63.9	69.4	71.5		
47f riffle	9	59.6	45.5	50.0	62.0	68.0	69.7	0.7650	0.8323
47f non-riffle	7	58.2	44.0	50.0	62.5	63.0	71.0		

Addendum Table 6. Statistical analysis of 1994-2004 reference site FIBI scores from select ecoregions by stream type: riffle or non-riffle. Riffle streams include >10% riffle macrohabitat, >10% cobble substrate and >30% total coarse substrate.

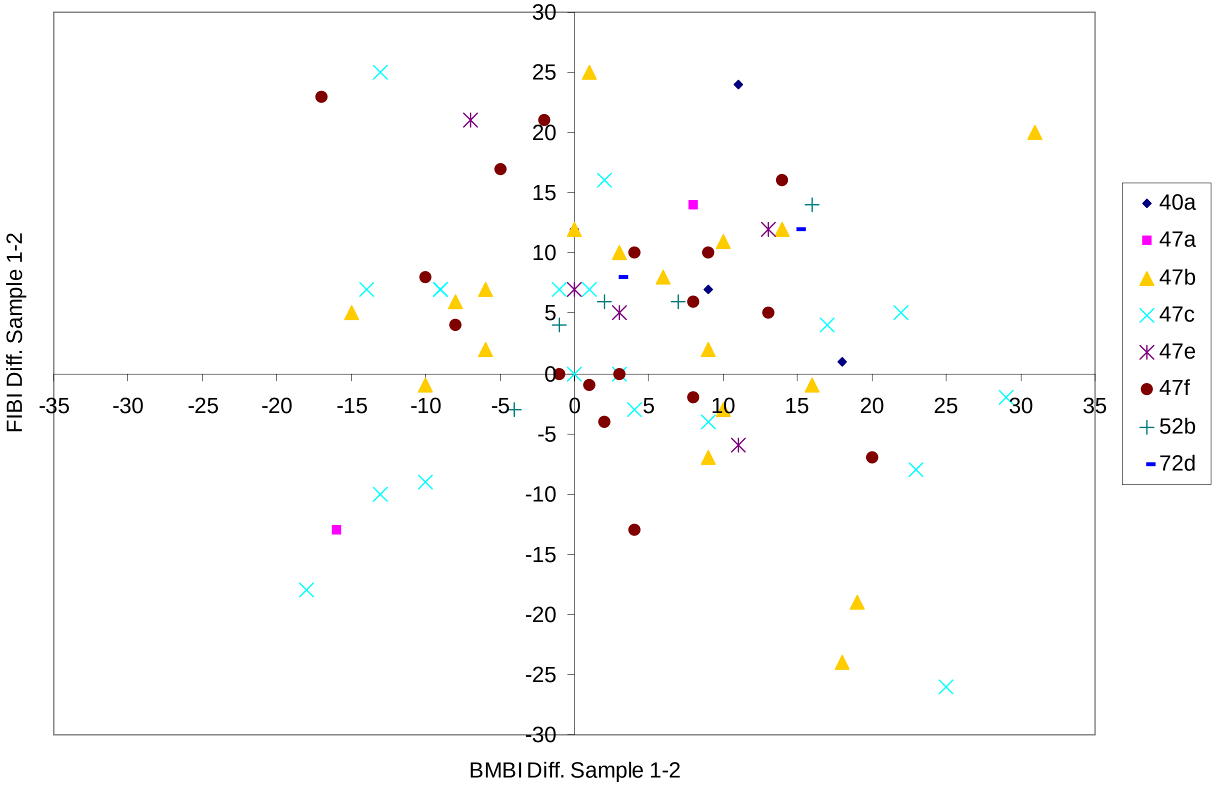
Ecoregion	# sites	FIBI mean	FIBI min	FIBI 25th	FIBI median	FIBI 75th	FIBI max	FIBI two sample mean TTest p-value	FIBI rank sum p-value
47b riffle	11	58.8	37.0	52.5	60.0	71.5	74.5	0.0018	0.0044
47b non-riffle	9	41.0	28.5	31.8	42.0	48.5	55.5		
47c riffle	8	73.1	58.5	64.9	76.6	78.9	83.0	0.0049	0.0062
47c non-riffle	12	55.9	38.0	44.1	54.3	69.1	76.5		
47f riffle	9	49.9	34.0	36.5	51.5	61.0	71.0	0.5399	0.6720
47f non-riffle	7	45.9	25.0	36.0	48.5	53.0	62.0		



Addendum Figure 1. Ecological regions of Iowa (after Chapman et al. 2002).



Addendum Figure 2. Reference site paired differences of first IBI sample minus second IBI sample. Sample years indicate the years of the first IBI sample and the second IBI sample.



Addendum Figure 3. Reference site paired differences of first IBI sample (1994-1998) minus second IBI sample (1999-2004). Site symbols correspond with the ecoregion in which the site is located.

Attachment 3

THE USE OF THE TROPHIC STATE INDEX TO IDENTIFY WATER QUALITY IMPAIRMENTS IN IOWA LAKES FOR THE 2006 SECTION 305(b) REPORTING AND SECTION 303(d) LISTING CYCLES

Iowa DNR

Watershed Monitoring & Assessment Section

Geological Survey & Land Quality Bureau

March 2007

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INTRODUCTION

Historically, relatively little water quality monitoring was conducted on Iowa lakes. Prior to the five-year survey of Iowa lakes conducted by Iowa State University that began in 2000 (Downing and Ramstack 2001, 2002, Downing, et al. 2003, Downing et al. 2004a, Downing et al. 2004b), lake surveys in Iowa have typically involved sampling in only summer seasons of one year at roughly ten-year intervals (see Bachmann 1965, Bachmann et al. 1980, and Bachmann et al. 1994). This amount of data, although providing a snapshot of lake water quality given the climatic conditions of the specific year of sampling, has not been particularly useful for developing a more accurate characterization of lake-specific water quality over the long-term. In addition, due to the general lack of historical data, accurate identification of trends in water quality parameters at most Iowa lakes is not possible. Diagnostic/feasibility studies at Iowa lakes (e.g., Bachmman et al. 1982, Downing et al. 2001), have included more intensive water quality monitoring, but such studies have been conducted on relatively few lakes and are of a relatively short duration (from one to two years). Due to this general lack of data, historical assessments of lake water quality in Iowa, such as those used for Section 305(b) reporting and Section 303(d) listing, have been based primarily on the best professional judgment of Iowa DNR fisheries biologists. The nearly total reliance on best professional judgment, while a valid assessment technique, resulted not only from this lack of routine ambient monitoring at Iowa lakes but also from the lack of state water quality criteria for the parameters that are most likely to indicate lake water quality impairments (e.g., nutrients (nitrogen and phosphorus), chlorophyll, turbidity, and impacts due to the accumulation of sediment in lake basins). Previous (pre-2000) Section 305(b) lake assessments that were based on best professional judgment were supplemented with lake monitoring data as this information was available (e.g., Bachmann et al. 1982, Bachmann et al. 1994). Beginning in 2000, however, the first routine, ambient monitoring program for Iowa lakes was initiated. This statewide lake survey funded by Iowa DNR and conducted by Iowa State University from 2000 through 2004. This study was designed as a five-year study capable of providing multiple years of data that can be used to better characterize lake water quality than was possible with the limited data from previous surveys.

This lake assessment methodology for Iowa's 2006 integrated (305(b)/303(d)) report involves the use of data from the Iowa State University statewide lake survey with Carlson's (1977) trophic state index (TSI) to identify lakes that do not fully meet the narrative criteria in Section 61.3(2) of the *Iowa Water Quality Standards* (IAC 2003). This general approach was used for Iowa's 2002 and 2004 reporting/listing cycles as well. The existence of any lake impairments suggested by a TSI value will be corroborated by IDNR field (Fisheries Bureau) staff. This approach is consistent with Iowa's credible data law and allows assessment of water quality impacts due to parameters that currently lack numeric criteria in the *Iowa Water Quality Standards*. The use of TSI values for chlorophyll and Secchi depth serves as an interim method of assessing lake water quality in Iowa until numeric criteria for nutrient parameters (phosphorus and nitrogen) and their response variables (chlorophyll-a and turbidity) are adopted into the *Iowa Water Quality Standards*.

ASSESSMENT RATIONALE

The concept of "trophic state" has long been used by limnologists to classify lakes and is based on the chemistry and biology of lakes. Although a number of approaches exist for classifying lakes according to trophic state, and although a number of controversies exist regarding how "trophic state" is defined, the use of this framework has the advantages of historical usage, general acceptance of the trophic state concept (e.g., "eutrophic" indicates nutrient enrichment), and an improved ability to describe lake condition versus a description using a single variable or number (e.g., total phosphorus concentration). Table 3-1 describes the general framework of the lake trophic state concept. For a discussion on the development and variety of trophic state indices, see Chapter 2 (*The Basis for Lake and Reservoir Nutrient Criteria*) in U.S. EPA (2000).

Carlson's (1977) trophic state index is a numeric indicator of the continuum of the biomass of suspended algae in lakes and thus reflects a lake's nutrient condition and water transparency. The level of plant biomass is estimated by calculating the TSI value for chlorophyll-a. TSI values for total phosphorus and Secchi depth serve as surrogate measures of the TSI value for chlorophyll. The focus on turbidity in general, and chlorophyll in particular, seems appropriate for assessing the degree to which Iowa lakes support their designated Class A (primary contact recreation) and Class B (aquatic life) uses. Carlson's trophic state index provides a convenient and well-established method for identifying turbidity-related impacts to Iowa lakes. As described in a more recent paper by Carlson (1991), turbidity, and especially turbidity related to large populations of suspended algae, is a key indicator of the degree to which a lake supports primary contact uses:

> *[plant] biomass is a proximate measure of the problems that plague lakes. Probably few citizens complain about the productivity of their lake and fewer yet lodge complaints about phosphorus concentrations. A biomass-related trophic state definition places the emphasis of the classification on the problem rather than on any potential cause.*

Because of this direct linkage between the perceived level of water quality and turbidity, TSI values for chlorophyll-a and Secchi depth will be used as guidelines to identify Iowa lakes that do not meet Iowa's narrative water quality standards protecting against "aesthetically objectionable conditions" related to poor water transparency. Both chlorophyll-a and Secchi depth appear applicable to Iowa's narrative water quality criterion protecting against aesthetically objectionable conditions in Iowa surface waters (IAC 2002, 61.3(2)). IDNR field (Fisheries Bureau) staff will be contacted to corroborate that the aesthetically objectionable conditions or nuisance aquatic life conditions suggested by the TSI values do, in fact, exist. Because aesthetics are more closely associated with recreational uses than to aquatic life uses of Iowa lakes, impairments based on violations of these narrative criteria are applied to Class A uses.

For two reasons, TSI values for total phosphorus were not used as the primary basis for assessing support of either primary contact recreation uses or aquatic life uses:

1. **TSI's for total phosphorus are poor predictors of impairment due to either Secchi depth or chlorophyll-*a*:** The typical use of the TSI for total phosphorus to measure trophic state (and the level of water quality) presumes that the relationship between total phosphorus and chlorophyll-a will, more or less, hold for the lake being assessed. The production of chlorophyll in Iowa's natural lakes and impoundments, however, is sometimes limited by nutrients other than phosphorus (e.g., nitrogen) and/or high levels of non-algal turbidity in the water column. The result is that lakes with very high levels of total phosphorus that suggest strong hyper-eutrophy sometimes have levels of chlorophyll-*a* and Secchi depth that suggest relatively good water quality (i.e., in the middle to lower eutrophic range). The Iowa lakes in Table 3-3 are those that have TSI values for total phosphorus in the hypereutrophic range (i.e., greater than 70) but that have TSI values for chlorophyll-a and Secchi depth less than 65. Examples of lakes in Iowa with relatively high TSI values for total phosphorus but low values for chlorophyll-a and Secchi depth include West Lake Osceola (Clarke County), Center Lake (Dickinson County), and Red Rock Reservoir (Marion County). Thus, while these lakes have very high levels of total phosphorus that might suggest impairment of designated uses, the levels of chlorophyll-a and Secchi depth are relatively low and do not suggest impairment (Figures 3-1 and 3-2). Because of this lack of correlation between TSI values for total phosphorus and TSI values for the response variables that define the aesthetically objectionable conditions, TSI values for total phosphorus were not used as the primary basis

for determining the level of use support or for identifying water quality impairments at Iowa lakes.

2. The *Iowa Water Quality Standards* lack water quality criteria—narrative or numeric—that are relevant to impacts of total phosphorus in surface waters. When developing this assessment procedure, careful consideration of Iowa's numeric and narrative criteria in the *Iowa Water Quality Standards* showed that none of these criteria are directly relevant to levels of phosphorus in the water column of a lake. That is, phosphorus is not a toxic substance at ambient levels seen in Iowa waters. In addition, high levels of phosphorus in Iowa lakes do not necessarily lead to either nuisance aquatic life or aesthetically objectionable conditions. For example, lakes with growths of aquatic macrophytes in littoral zone areas can have high levels of phosphorus but have low levels of chlorophyll-*a* and have good water transparency.

For lakes where assessment information from the IDNR Fisheries Bureau is available, TSI values were also used to supplement assessments of the designated Class B aquatic life uses based on best professional judgment of IDNR fisheries biologists. According to biologists in the IDNR Fisheries Bureau, algal blooms can also cause impairments to aquatic life uses of Iowa lakes through interference with some spawning activities of nest building species, e.g., bluegill, bullhead, crappie and largemouth) and lowered levels (sags) of dissolved oxygen that, in extreme cases, can cause fish mortality.

IDENTIFYING WATER QUALITY IMPAIRMENTS AT IOWA LAKES BASED ON TSI:

For purposes of developing water quality assessments for the 2006 Section 305(b) reporting cycle, Carlson's (1977, 1984, 1991) "trophic state index" (TSI) was used with data generated for 131 Iowa lakes as part of Iowa State University's surveys from 2000 through 2004 (Downing and Ramstack 2001, 2002, Downing et al. 2003, Downing et al. 2004a, Downing et al. 2004b). Overall (five-year) median values calculated from this dataset were used to calculate TSI values for total phosphorus, chlorophyll-a, and Secchi depth for each lake; the ranges of these values are summarized in Table 3-3. The identification of an impairment of the primary contact uses, however, was based on TSI values for chlorophyll-a and/or secchi depth. The TSI values for the indicator variable of total phosphorus are used primarily to interpret discrepancies between TSI values for chlorophyll-a and secchi depth.

Relevant state water quality criteria:

The *Iowa Water Quality Standards* do not contain numeric criteria for nutrients (e.g., nitrogen or phosphorus), chlorophyll, or turbidity that apply to either Class A or Class B uses. Thus, the assessments of the degree to which the these parameters might impair the Class A uses and/or the Class B uses are based on a comparison of lake-specific TSI values to the following narrative criteria for general use waters as defined in Section 61.3(2) of the *Iowa Water Quality Standards*:

> *Such waters shall be free from materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor, or other aesthetically objectionable conditions.*
>
> *Such waters shall be free from substances, attributable to wastewater discharges or agricultural practices, in quantities which would produce undesirable or nuisance aquatic* life;

Examples of *aesthetically objectionable conditions* include poor water transparency caused by blooms of algae or high levels of non-algal turbidity that make the lake less desirable (aesthetically unpleasing) for primary contact recreation. Blooms of bluegreen algae can also cause *aesthetically objectionable conditions* due to their ability to create unpleasant floating scums on the water surface or unpleasant odors, both of which can limit the primary contact recreation uses at a lake. In addition, bluegreen algae can be considered a form of *nuisance aquatic life* due to their ability to produce toxins that can adversely affect aquatic life and the uses of the lake for watering by livestock and wildlife. In severe cases, levels of these toxins in lake water can affect human health.

IDNR is aware that some of the *aesthetically objectionable conditions* and/or *undesirable or nuisance aquatic life* at the lakes assessed as "impaired" may not be attributable to either wastewater discharges or agricultural practices. For example, a number of lakes assessed as "impaired" based on TSI values are very shallow (mean depth less than 2 meters) natural lakes of glacial origin with very low watershed-to-surface area ratios. The turbidity-related water quality problems at these lakes, whether caused by algae or suspended inorganic sediments, are due primarily to lack of sufficient water depth to prevent internal nutrient recycling and sediment re-suspension due to either bottom-feeding fish (e.g., common carp) and/or wind/wave action. Regardless, the levels of turbidity (whether of algal or non-algal origin) at these lakes constitute limitations to the use of these lakes for their designated beneficial uses. Thus, these lakes are appropriate for addition to the state list of impaired waters.

Data sources:

The primary data source for assessing the degree to which Iowa lakes support their designated primary contact and/or aquatic life uses is the water quality dataset for chlorophyll-a and Secchi depth generated for 131 Iowa lakes sampled as part of the Iowa State University surveys from 2000 through 2004 (Downing and Ramstack 2001, 2002, Downing et al. 2003, Downing et al. 2004a, Downing et al. 2004b). Data for inorganic suspended solids and total phosphorus from this survey were also used to interpret TSI values and to provide a more complete assessment of lake water quality. Information from the IDNR Fisheries Bureau on recent water quality conditions/problems, the status of fish populations, and on lake history was used where appropriate to supplement assessments based on TSI values for chlorophyll-a and/or Secchi depth and to verify the existence of any "aesthetically objectionable condition" suggested by TSI values. In addition, information on lake plankton communities from the Iowa State surveys was used to interpret discrepancies observed between TSI values for chlorophyll-a and Secchi depth and to determine the proportion of the phytoplankton community composed of bluegreen algae.

Data requirements for listing:

Data quantity:

In 1990, in order to improve the accuracy and confidence level of water quality assessments, IDNR developed "data completeness guidelines" for using results of routine water quality monitoring for Section 305(b) reporting. These state guidelines identify the numbers of samples needed for water quality assessments that can support Section 303(d) listings (i.e., a *monitored* assessment). Assessments based on less than the recommended number of samples are considered "evaluated"; these assessments are of relatively lower confidence than "monitored" assessments and are thus not appropriate for impaired waters listing but are appropriate for Section 305(b) water quality reporting. In order to account for the year-to-year variability in lake water quality, state limnologists participating in the U.S. EPA Region 7 nutrient criteria regional technical assistance group (RTAG) (IA, KS, MO, NE) recommend in 2001 that the combined data from at least three years of monitoring conducted from three to five times per year should be used to characterize lake water quality and to identify water quality impairments. This recommendation has been incorporated into IDNR's data completeness guidelines. Thus, for purposes of Iowa's 2006 Integrated Report, overall median water quality values from the five-year period from 2000 through 2004 (approximately 15 samples) will be used to calculate TSI values to determine the existence of an impairment. As is typical in all monitoring networks, special circumstances occasionally prevent either sample collection (e.g., adverse weather conditions) or the reporting of data (e.g., laboratory accidents). For purposes of identifying candidate lakes for Iowa's 2006 impaired waters list, only those lakes with at least 10 samples each for chlorophyll-a and Secchi depth over the 2000-2004 period will be considered to meet IDNR's data completeness guidelines. Assessments for lakes with fewer than 10 samples for this period will be considered "evaluated" and thus will not be used to identify candidate lakes for impaired waters listing. Other lake water quality datasets appropriate for calculating TSI values will be reviewed to determine compliance with Iowa DNR's data completeness guidelines.

Data quality:

As specified in the 2001 Iowa Code, Section 455B.194, subsection 1, (Iowa's credible data law) the department shall use credible data when determining whether any water of the state is to be placed on or removed from any Section 303(d) list (Category 5 of the 2004 Integrated Report). In addition, Iowa's credible data law specifies that data more than five years before the end of the most current Section 305(b) period (the end of calendar year 2004) are presumed under state law to be "not credible" unless IDNR identifies compelling reasons as to why the older data are credible. Data generated by the ISU lake survey (i.e., Downing and Ramstack 2001, 2002, Downing et al. 2003, Downing et al. 2004a, Downing et al. 2004b) meet all requirements of Iowa's credible data law and can thus be used to add waters to Iowa's 2006 impaired waters list. Other datasets appropriate for calculating TSI values will be reviewed to determine compliance with Iowa's credible data law.

Threshold TSI values:

Similar to Iowa's 2004 reporting/listing cycle, a TSI value of greater than 65 for either chlorophyll-a or Secchi depth will be used to identify candidate lakes for Category 5 of Iowa's 2006 Integrated (305(b)/303(d)) Report (see Table 1 for a description of the "Integrated Report" categories). This methodology is similar to that used by the Minnesota Pollution Control Agency for lakes in the Western Corn Belt Plains ecoregion of southern Minnesota (MPCA 2005). Nearly the entire state of Iowa lies in this same ecoregion, the exceptions being (1) the portion of south-central and southeastern Iowa in the Central Irregular Plains ecoregion and (2) the portion of northeastern Iowa in the Driftless Area ecoregion. Lakes with TSI values greater than 65 are likely to have nutrient or sediment-related water quality problems that contribute to excessive turbidity that impair either the Class A or Class B uses and are thus potential candidates for Section 303(d) listing.

Assessment categories ("monitored" and "evaluated"):

Prior to recent revisions to guidance for state compliance with Sections 305(b) and 303(d) of the Clean Water Act (U.S. EPA 2003, 2005), U.S. EPA (1997) recommended that states place water quality assessments into one of two categories: evaluated or monitored. Evaluated assessments were those based on data older than five years or other than site-specific ambient monitoring data (e.g., questionnaire surveys of fish and game biologists [=best professional judgment] or predictive modeling using estimated input values) and thus were of relatively low confidence. IDNR has historically not considered waterbodies identified as impaired based on evaluated assessments as candidates for the state's Section 303(d) list. In contrast, monitored assessments were based primarily on recent, site-specific ambient monitoring data and thus were of relatively high confidence. IDNR has, however, historically considered waterbodies identified as impaired based on monitored assessments as candidates for the state's Section 303(d) list. In order to maintain continuity with past assessment procedures, and due to the usefulness of EPA's (1997) previous approach, IDNR will continue to identify each assessment of lake water quality as either evaluated or monitored.

For purposes of preparing Iowa's 2006 list of impaired waters, the use support categories of (1) fully supported/threatened / monitored, (2) partially supported / monitored, and (3) not supported / monitored were the categories containing candidate lakes for Section 303(d) listing. The use support category of "partially supported / evaluated", however, contains lakes with marginally good water quality whose current TSI values and support status, although suggesting impairment, could be significantly affected by results of subsequent lake monitoring. The use support category of "fully supported" contain lakes with good to very good water quality that, even considering the variability present in lake monitoring data, will likely not have TSI values that justify addition to future Section 303(d) lists. IDNR's 2006 approach for considering the "fully supported / threatened" lakes as impaired represents a change in methodology (see Table 1).

Use support categories:

The following are detailed descriptions of the use support categories used for Section 305(b) lake assessments for the 2006 reporting cycle. The TSI values associated with each of these use support categories are summarized in Table 3-6. Any impairments (i.e., "aesthetically objectionable conditions") suggested by TSI values for chlorophyll-a and/or Secchi depth are verified by IDNR field (Fisheries) staff.

Not Supporting and "monitored": candidates for Section 303(d) listing:

If the overall (2000-2004) lake-specific median summer TSI value for either chlorophyll-a or Secchi depth is greater than 70, then the lake should be assessed as "not supporting" designated uses, and the lake should considered as a candidate for Section 303(d) listing. These lakes are likely to have severe turbidity-related impacts, of either algal or non-algal origin, that (1) interfere with designated uses for primary contact recreation and/or aquatic life, (2) constitute an aesthetically objectionable condition that violates narrative criteria for general use waters as defined in Section 61.3(2) of the *Iowa Water Quality Standards*. In addition, the nutrient conditions of these lakes suggest the possibility that the phytoplankton community of the lake is dominated by bluegreen algae, a potential nuisance aquatic species that also can be considered a violation of narrative criteria in Section 61.3(2) of the *Iowa Water Quality Standards*. The TSI threshold value for chlorophyll-a and/or Secchi depth is the lower limit that identifies "hyper-eutrophic" lakes (Table 3-2). Thus, this threshold value provides strong evidence of a water quality impairment.

Partially Supporting and "monitored": candidates for Section 303(d) listing:

If the overall (2000-2004) lake-specific median summer TSI value for either chlorophyll-a or Secchi depth is between 65 and 70, then the lake should be assessed as "partially supporting" designated uses, and the lake should considered as a candidate for Section 303(d) listing. These lakes are likely to have moderate turbidity-related impacts of either algal or non-algal origin that interfere with designated uses for primary contact recreation and/or aquatic life. TSI values between 65 and 70 are in the middle to upper range between eutrophic and hypereutrophic lakes. The chlorophyll-a and Secchi depth threshold values for this use support category (>65 to 70) are those used by the Minnesota Pollution Control Agency to identify Section 303(d)-impaired lakes in southern Minnesota (MPCA 2005). As such, this threshold is appropriate for identifying impairments in Iowa lakes.

Partially Supporting and "evaluated": not candidates for Section 303(d) listing:

If the overall (2000-2004) lake-specific median summer TSI value for either chlorophyll-a or Secchi depth is between 65 and 70, but the TSI value(s) is based on less than sufficient data (i.e., samples from at least three years of monitoring from three to five times per year), then the lake should be assessed as "partially supporting" designated uses but should not be considered a candidate for Section 303(d) listing. These lakes may have turbidity-related impacts, of either algal or non-algal origin, that may interfere with designated uses for primary contact recreation and/or aquatic life. Thus, while the TSI values for Iowa lakes in this category *may* be impaired for Class A or Class B uses, insufficient data are available for developing Section 305(b) assessments having the high degree of confidence needed to justify Section 303(d) listing. These lakes will be placed into Integrated Report categories 2b or 3b and will thus be added to Iowa's list of waters in need of further investigation.

Fully Supporting / Threatened and "monitored": candidates for Section 303(d) listing:

EPA (2005) recommends that states consider as "threatened" those waters that are currently attaining water quality standards, but which are expected to not meet water quality standards by the next listing cycle (every two years). For example, segments should be listed if an analysis demonstrates a declining trend in a specific water quality criterion, and the projected trend will result in a failure to meet a criterion by the date of the next list (i.e., 2008 for purposes of the 2006 assessment cycle); or, segments should be listed if there are proposed activities that will result in violations of water quality standards.

Lakes with overall (2000-2004) summer median TSI values for chlorophyll-a and Secchi depth of 65 or less, but that demonstrate adverse trends in either of these parameters such that impairment is likely for the next (2008) reporting/listing cycle, will be considered "fully supported/threatened (impaired)" and considered candidates for addition to IR Category 5 (Section 303(d) list).

Identifying water quality trends in "threatened" lakes: For the majority of Iowa lakes, sufficient data do not exist to determine the existence of water quality trends prior to 2000. This lack of historical data stems from the design of previous statewide surveys of Iowa lakes which involved sampling during only one summer season at approximately 10-year intervals (e.g., see Bachmann et al. 1980, Bachmann et al. 1994). The year-to-year variability in lake data—due largely to climatic factors—makes the existing historical (i.e., pre-2000) data of little use for trend determination. Due, however, to the continuity of the ISU lake survey, sufficient data exist since 2000 to begin to identify trends in lake water quality over time. Although this five-year period provides barely enough data to determine trends, the lake-specific data will be examined to determine the existence of any potential changes in water quality over time. Specifically, the individual sample-based TSI values will be plotted for the five-year period, and this graph will be evaluated to determine the potential for trends in water quality (i.e., water transparency (as measured by Secchi depth) and chlorophyll). This information will be used to in the development of the Section 305(b) assessment for each lake.

Fully Supporting (not threatened); "evaluated" or "monitored": <u>not</u> candidates for Section 303(d) listing:

Lakes with overall (2000-2004) summer median TSI values for chlorophyll-a and Secchi depth of less than 65 are assessed as "fully supporting" their designated uses for primary contact recreation and/or aquatic life. These lakes have moderately good (TSI approaching 65) to sometimes exceptional (TSI < 50) water quality with only brief episodes of marginal water quality conditions. The TSI threshold values for both chlorophyll-a and Secchi depth in this category range from the middle range between eutrophic and hyper-eutrophic lakes to the upper range of mesotrophic lakes. The range of lake quality in this assessment category is considerable.

<u>MANAGEMENT AND ACCESSIBILITY OF ASSESSMENTS:</u>

The Section 305(b) assessments of the degree of support of the Class A and Class B uses for the 131 lakes sampled as part of the ISU survey are entered into Iowa DNR's Section 305(b) assessment database (ADB+). The narrative descriptions of these assessments in this database use qualitative characterizations of TSI values (e.g., "good"," poor", "high"; "low") ; Table 3-5 summarizes these characterizations.

Table 3-1. Changes in temperate lake attributes according to trophic state (modified from U.S. EPA 2000, Carlson and Simpson 1995, and Oglesby et al. 1987).

TSI Value	Attributes	Primary Contact Recreation	Aquatic Life (Fisheries)
50-60	eutrophy: anoxic hypolimnia; macrophyte problems possible	[none]	warmwater fisheries only; percid fishery; bass may be dominant
60-70	bluegreen algae dominate; algal scums and macrophyte problems occur	weeds, algal scums, and low transparency discourage swimming and boating	Centrarchid fishery
70-80	hyper-eutrophy (light limited). Dense algae and macrophytes	weeds, algal scums, and low transparency discourage swimming and boating	Cyprinid fishery (e.g., common carp and other rough fish)
>80	algal scums; few macrophytes	algal scums, and low transparency discourage swimming and boating	rough fish dominate; summer fish kills possible

Table 3-2. Iowa lakes with overall median TSI values for total phosphorus greater than 70 (=hyper-eutrophic) that have TSI values for chlorophyll-a and Secchi depth that do not suggest impairment of primary contact recreation and/or aquatic life uses (i.e., TSI values of 65 or less). TSI values are based on data from the Iowa State University statewide summer surveys of 131 Iowa lakes from 2000 through 2004 (N approximately equal to 15); lakes are ranked by the TSI value for total phosphorus.

Lake Name	County	TSI for total phosphorus	TSI for chlorophyll-a	TSI for Secchi depth
Rodgers Park Lake	Benton	70.2	56.0	58.6
West Lake (Osceola)	Clarke	70.6	55.4	59.3
Lake Hendricks	Howard	70.6	64.7	62.9
Briggs Woods Lake	Hamilton	70.7	58.9	54.2
Beeds Lake	Franklin	71.0	63.9	58.0
Center Lake	Dickinson	71.6	58.8	58.0
Meyers Lake	Winneshiek	71.6	59.5	63.2
Casey Lake	Tama	74.9	57.9	59.8
Lake Smith	Kossuth	74.9	64.3	58.0
Dog Creek Lake	O'Brien	75.0	62.5	62.8
Saylorville Reservoir	Polk	75.3	52.2	62.3
Red Rock Reservoir	Marion	79.0	41.8	60.7

Table 3-3. Ranges of TSI values for Iowa lakes based on overall median values from the first five years of the statewide survey (2000-2004) of 131 Iowa lakes by Iowa State University (Downing and Ramstack 2001, 2002; Downing et al. 2003, Downing et al. 2004a, Downing et al. 2004b). Lakes were sampled approximately three times per summer over the five-year period.

	TSI Values:		
	total phosphorus	**chlorophyll-a**	**Secchi depth**
minimum	46	39	34
10th percentile	56	50	50
25th percentile	62	56	57
median	***68***	***61***	***62***
75th percentile	75	64	69
90th percentile	81	68	75
maximum	89	79	87
mean of medians	68	60	62
standard deviation	9.4	7.5	9.9

Table 3-4. Summary of ranges of TSI values and measurements for chlorophyll-a and Secchi depth used to define Section 305(b) use support categories for the 2004 and 2006 reporting cycles.

Level of Support	**TSI value**	**Chlorophyll-a (ug/l)**	**Secchi Depth (m)**
fully supported	<=55	*<=12*	*>1.4*
fully supported / threatened	55 → 65	*12 → 33*	*1.4 → 0.7*
partially supported (evaluated: in need of further investigation)	65 → 70	*33 → 55*	*0.7 → 0.5*
partially supported (monitored: candidates for Section 303(d) listing)	65-70	*33 → 55*	*0.7→ 0. 5*
not supported (monitored or evaluated: candidates for Section 303(d) listing)	>70	*>55*	*<0.5*

Table 3-5. Narrative descriptions of TSI ranges for Secchi depth, phosphorus, and chlorophyll-a for Iowa lakes used for the 2004 and 2006 Section 305(b) reporting cycles. These characterizations were used in developing lakes-specific assessments that are included in the Iowa's Section 305(b) assessment database (ADB+).

TSI value	Secchi description	Secchi depth (m)	Phosphorus & Chlorophyll-a description	Phosphorus levels (ug/l)	Chlorophyll-a levels (ug/l)
> 75	extremely poor	< 0.35	extremely high	> 136	> 92
70-75	very poor	0.5 – 0.35	very high	96 - 136	55 – 92
65-70	poor	0.71 – 0.5	high	68 – 96	33 – 55
60-65	moderately poor	1.0 – 0.71	moderately high	48 – 68	20 – 33
55-60	relatively good	1.41 – 1.0	relatively low	34 – 48	12 – 20
50-55	very good	2.0 – 1.41	low	24 – 34	7 – 12
< 50	exceptional	> 2.0	extremely low	< 24	< 7

Figure 3-1. Overall median-based trophic state index (TSI) values for 131 Iowa lakes sampled in summers from 2000-2004: total phosphorus versus secchi depth.

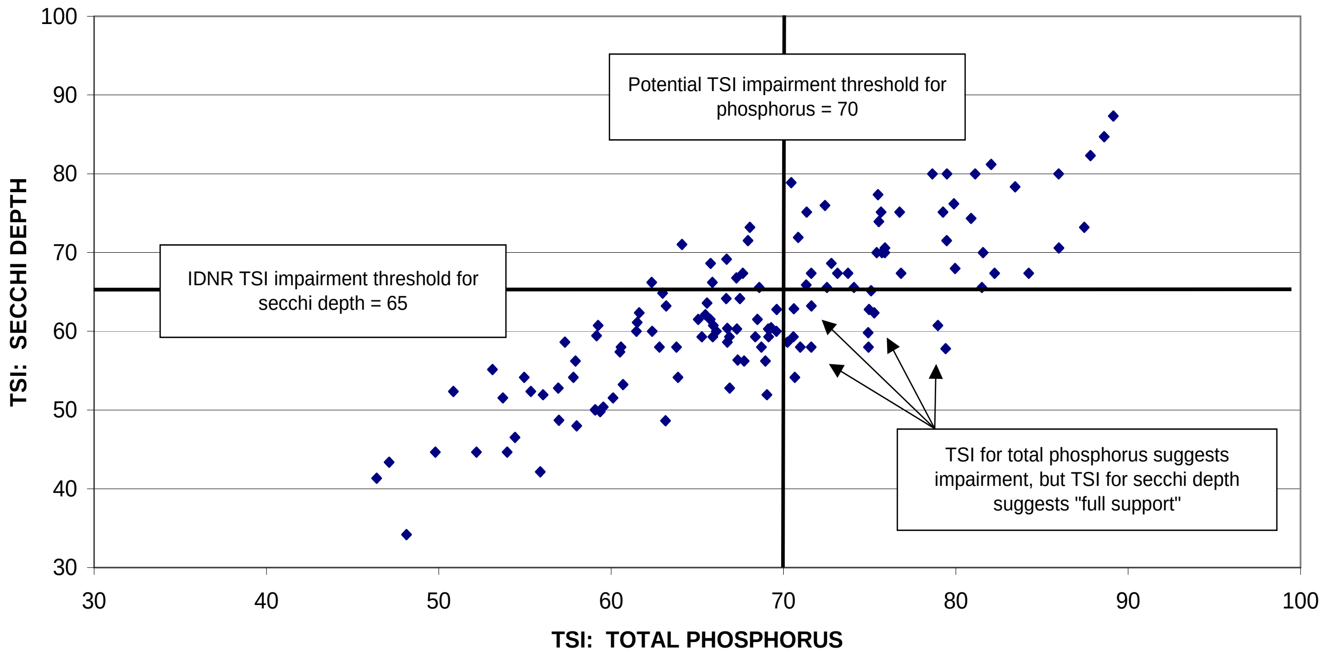
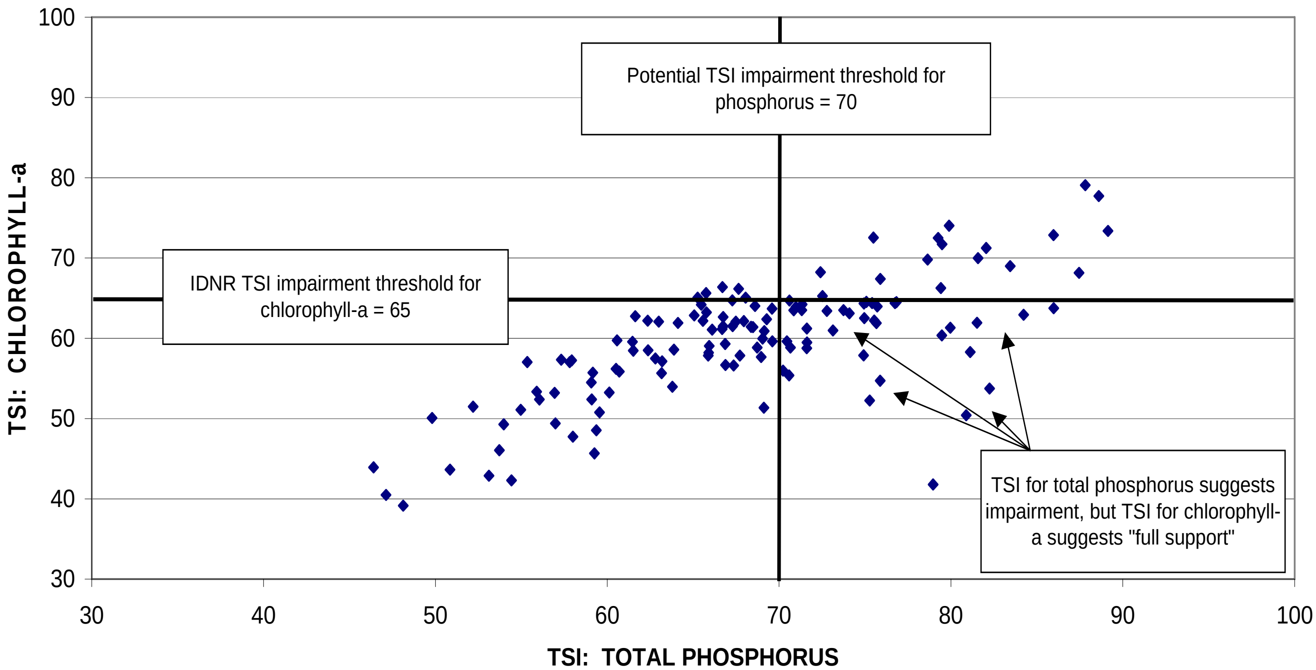


Figure 3-2. Overall median-based trophic state index (TSI) values for 131 Iowa lakes sampled in summers from 2000-2004: total phosphorus versus chlorophyll-a.



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Attachment 4

Iowa DNR interpretations of Section 305(b) causes of impairment as identified by U.S. EPA (1997).

Information is also included on the historical use of the individual cause categories for water quality assessments in Iowa and on the existence of numeric criteria in the *Iowa Water Quality Standards*.

Cause Code	Cause Category	Historically Used?	Numeric Criteria?	Description
0000	cause unknown	yes	no	Causes of impairment are identified as "unknown" where results of water quality monitoring suggest an impact, but no cause of the impact is apparent. Most often, this cause category is used when results of biological monitoring identify an impact to biotic integrity but do not suggest a specific cause of the impact. In such cases, follow-up monitoring is often needed to determine the specific cause or causes of the impairment.
0100	unknown toxicity	yes	no	"Unknown toxicity" is identified as a cause of impairment when results of monitoring results suggest some type of toxic impact but the identities of the substances causing toxicity are unknown. For example, results of a biological assessment that shows a complete lack of aquatic life in a stream strongly suggest the presence of toxic substances; the cause of impairment in such a case would be identified as "unknown toxicity."
0200	pesticides	yes	yes	"Pesticides" refers to any substance, either currently or historically, used to kill plants, insects, algae, fungi, and other organisms; includes herbicides, insecticides, algalcides, fungicides, and other substances. For purposes of 305(b)/303(d) reporting in Iowa, this category includes priority pesticides* (as defined in Section 307a of the Clean Water Act) as well as non-priority pesticides (e.g., cyanazine, and metolachlor).
0250	atrazine	yes	yes	a subcategory of the "pesticides" cause category (0200).
0300	priority organics	yes	yes	"Priority organics" are toxic organic pollutants listed in Section 307a of the federal Clean Water Act: "Priority organics" includes the following pollutant groups: chlorinated benzenes, chlorinated ethanes, chlorinated phenols, other chlorinated organics, haloethers, halomethanes, nitrosamines, non-chlorinated phenols, phthalate esters, polynuclear aromatic hydrocarbons (PAHs), pesticides and metabolites*, DDT and metabolites, polychlorinated biphenyls (PCBs), and other organics. . For purposes of 305(b)/303(d) reporting in Iowa, this cause category does not include the following groups of priority organics: pesticides and metabolites (cause code 0200), DDT and metabolites (cause code 0200), or polychlorinated biphenyls (PCBs) (cause code 0410).
0400	nonpriority organics	no	no	"Nonpriority organics" include toxic organic pollutants not listed in Section 307a of the federal Clean Water Act
0410	PCBs	yes	yes	"Polychlorinated biphenyls" or PCBs; a subcategory of the "priority organics" cause category (0300).
0420	dioxins	no	yes	
0500	metals	yes	yes	Includes the following toxic metals: aluminum, antimony, arsenic, asbestos, beryllium, cadmium, chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, thallium, zinc. All but aluminum are identified as "priority pollutants" under Section 307a of the Clean Water Act.
0600	ammonia (un-ionized)	yes	yes	The identification of ammonia as a cause of fish kills is typically based on the presumed presence of high levels of ammonia in most types of untreated wastewater, especially in the high-strength waste generated by animal feeding operations.

Cause Code	Cause Category	Historically Used?	Numeric Criteria?	Description
0700	chlorine	yes	yes	"Chlorine" and chloramines are widely used in treatment of potable water supplies and wastewater treatment plant effluents and are used in a variety of industrial applications, including power generating facilities and paper mills. Although the *Iowa Water Quality Standards* contain numeric criteria to protect aquatic life uses from adverse impacts of total residual chlorine, analytical difficulties have precluded analysis for total residual chlorine as part of ambient surface water monitoring since 1999. Currently, the only scenario that would lead to identification of chlorine as the cause of an impairment is the accidental release of chlorine to surface waters such that a fish kill occurs (e.g., as would potentially occur following a water main break).
0720	cyanide	no	yes	a subcategory of the "metals" cause category (0500).
0750	sulfates	no	no	"Sulfate" is a naturally-occurring dissolved constituent of water. At high levels (e.g., greater than 600 mg/l), sulfate in drinking water can have laxative effects on consumers. Levels of sulfate in Iowa surface waters are relatively low; the *Iowa Water Quality Standards* do not contain numeric criteria for sulfate.
0800	other inorganics	no	yes	
0900	nutrients	yes	no	High levels of plant nutrients (primarily, nitrogen and phosphorus) indicate the potential for water quality problems in surface waters that result from excessive production of plant biomass. In lakes, high levels of nutrients can lead to excessive growth of aquatic plants, especially algae (cause 2210), which can interfere with recreational uses of a lake (e.g., boating, swimming, and fishing). Excessive plant growth can also lead to oxygen depletion (cause 1200) of lake water through respiration related to bacterial decomposition of plant material and other organic matter that accumulates on the lake bottom. Severe cases of oxygen depletion can lead to fish kills. High levels of plant nutrients are generally attributed to agricultural nonpoint source pollution and to naturally-occurring conditions, especially the internal nutrient recycling that occurs in the shallow glacial lakes of northern Iowa. Urban point sources and urban runoff, however, also contribute excessive amounts of nutrients to Iowa lakes. Both the origin of high levels of plant nutrients and the nutrient concentrations that can impair aquatic life uses of Iowa's surface waters are poorly understood. Due to the natural fertility of Iowa's soils, levels of plant nutrients were likely relatively high prior to settlement in the mid-19th century (Menzel 1983). Application of fertilizers, however, especially for row crop agriculture, has increased nutrient levels in the state's surface waters over that during presettlement times. The threshold levels at which plant nutrients cause problems in Iowa's surface waters have not been identified. The *Iowa Water Quality Standards* does not contain water quality criteria for either levels of phosphorus or nitrogen related to protection for primary contact recreation (Class A) or for aquatic life (Class B) beneficial uses. DNR, however, has recently been involved with a U.S. EPA effort to develop regionally-based water quality criteria for nutrients for inclusion into state water quality standards.
0910	phosphorus	yes	no	a subcategory of the "nutrients" cause category (0900).
0920	nitrogen	yes	no	a subcategory of the "nutrients" cause category (0900).
0930	nitrate	yes	yes	High levels of nitrate in drinking water can lead to infant methemoglobinemia (blue baby syndrome) in infants. To protect against this condition, the U.S. EPA recommends that nitrate levels in water

Cause Code	Cause Category	Historically Used?	Numeric Criteria?	Description
				delivered by a public water supply to consumers should not exceed a maximum contaminant level (MCL) of 10 mg/l as nitrogen. The *Iowa Water Quality Standards* identify this 10 mg/l MCL as the water quality criterion to protect surface waters used as a source of a municipal water supply.
1000	pH	yes	yes	"pH" is a measure of the hydrogen ion activity in a water sample. The pH of natural waters is a measure of acid-base equilibrium achieved by the various dissolved compounds, salts, and gases.
1100	siltation	yes	no	Silt delivered to streams and rivers through nonpoint source runoff and/or through streambank erosion can degrade aquatic habitat through covering of coarse substrates and through deposition in pools. Siltation impacts in lakes refer to the erosion of soil particles by precipitation and movement of soil particles in runoff to lake basins where accumulation of silt occurs. The amount of silt delivered to Iowa's lakes, especially man-made lakes, is an important factor in determining the quality of a lake for fishing, swimming and for use as a source of drinking water. Water quality impacts related to high rates of siltation/sedimentation include the delivery of excessive levels of plant nutrients (primarily phosphorus) to lakes, loss of lake volume, loss of surface area, a shortened useful life of the lake, interference with reproduction and growth of certain fish species, and impairments to recreational uses such as boating and fishing. While the delivery and accumulation of sediment is often the most serious problem in man-made lakes, it is generally less of a problem in the natural lakes of north-central and northwest Iowa. Natural lakes generally have smaller watersheds relative to lake surface area, and their watersheds have less topographic relief and lower erosion rates than do lake watersheds in other regions of the state. Man-made lakes with low sedimentation rates tend to have clearer water and more productive fisheries than do lakes receiving large amounts of sediment. The man-made lakes in Iowa with the best water quality have relatively steep sides, small watersheds, and have well-controlled watersheds with a high percentage either in approved soil conservation practices or in non-crop land uses (e.g., pasture or forest) (see Hill 1981). Ideally, a man-made lake in Iowa would have a watershed-to-surface area ratio of approximately 20:1.
1200	organic enrichment / low dissolved oxygen	yes	yes	Impairments due to organic enrichment occur when the amount of organic material delivered to the waterbody exceeds the capacity of the stream to mineralize and assimilate this organic material. In the absence of excessive inputs of oxygen-demanding organic material—as commonly measured through biochemical oxygen demand or "BOD"—streams, rivers, and lakes can process organic material without serious consequences to either chemical water quality or aquatic life. When inputs of organic materials exceed the stream or river's assimilative capacity, however, degradation of water quality will occur. The high rates of bacterial respiration resulting from the excessive amounts of organic material can lower the level of dissolved oxygen below that needed to support aquatic life. Organic enrichment is a common problem in the shallow natural lakes of glacial origin in northcentral Iowa and in shallow man-made impoundments throughout the state. Most of the lakes with impacts due to organic enrichment are the relatively shallow natural lakes in northcentral and northwest Iowa (Figure 3-18). Wind action at shallow lakes in summer tends to circulate lake water at all depths, thus resuspending sediments and nutrients that have settled to the bottom of the lake back into the water column. The increased levels of nutrients in the water column can increase plant production, usually in the form of algae. Continued resuspension of sediment and nutrients can lead to poor water transparency due to high levels of planktonic algae or due to high concentrations of suspended

Cause Code	Cause Category	Historically Used?	Numeric Criteria?	Description
				sediment. The high levels of biological productivity in these lakes can lead to depletion of dissolved oxygen, and fish kills can occur. In temperate climates such as Iowa's, deeper lakes tend to thermally stratify during summer: a relatively cold and stagnant bottom layer of the lake (hypolimnion) becomes isolated from the relatively warm and wind-circulated surface layer (epilimnion) by a middle layer with a temperature gradient (metalimnion or thermocline). As summer progresses, bottom layers of stratified eutrophic lakes tend to become increasingly nutrient-rich and oxygen-poor. The isolation of this bottom layer, however, prevents movement of the poor-quality water to the surface layer of the lake. This isolation tends to improve the water quality of the surface layer of a lake that is used by aquatic life and is used for water-based recreation (e.g., swimming and water skiing). Water quality studies on Iowa lakes have shown that lakes with average depths greater than 13 feet tend to establish and maintain thermal stratification in summer and thus have better water quality than do shallower lakes (Bachmann et al. 1994).
1300	total dissolved solids / salinity / chlorides / sulfates	no	yes	"Total dissolved solids" refers to the concentration of inorganic salts, small amounts of organic material, and other dissolved materials. The principal inorganic anions dissolved in water are carbonates, chlorides, sulfates, and nitrates; the principal cations are calcium, magnesium, sodium, and potassium.
1400	thermal modification s	yes	yes	A manmade deviation from natural seasonal water temperatures such that aquatic biota may be adversely affected. This deviation can include (1) addition of heat above physiological optimum levels of resident aquatic life, (2) the addition of heat such that state water quality standards are violated, or (3) the abrupt cessation of heated effluents during cooler seasons such that aquatic life cannot acclimate to the sudden change in ambient water temperature. Scenarios that can lead to impairments due to "thermal modifications" include the following: (1) discharge of heated effluent from power generating facilities such that ambient water temperatures violate water quality standards and (2) a fish kill caused by summer storm runoff with elevated temperatures due to flow over super-heated impervious surfaces (streets, parking lots, etc) in urban areas.
1500	flow alterations	yes	no	"Flow alterations" refer to human-related deviations from natural seasonal flow regimes that can adversely affect native biota. Flow alterations can result from several activities including water withdrawal for irrigation or water supplies and regulation of stream flow at dams.
1600	habitat alterations (other than flow)	yes	no	"Habitat alterations" refer to manmade changes in the physical habitats of surface waters such that native aquatic biota may be adversely affected. When assessing impairments to Iowa surface waters for Section 305(b) reporting, "habitat alterations" refers primarily to impacts from (1) stream channelization (i.e., channel straightening), (2) removal of riparian vegetation, (3) pasturing of the riparian zone, and/or (4) streambank destabilization. All of these alterations tend to decrease the value of streams and rivers as high quality habitats for use by aquatic life through removal of important naturally-occurring habitat types (e.g., pools, riffles, sand bars, and snags). In addition, the alteration of aquatic habitat tends to increase the severity of impacts from other sources of pollution on aquatic life, especially the effects of siltation during low-flow periods.
1700	pathogens	yes	yes	"Pathogens," in the context of Section 305(b) reporting, actually refers to concentrations of indicator

Cause Code	Cause Category	Historically Used?	Numeric Criteria?	Description
	(pathogen indicators)			bacteria (e.g., fecal coliforms or *E. coli*) in surface water samples. Iowa surface waters that support swimming, water skiing, and other primary body contact recreation that involves considerable risk of ingesting surface water are designated for Class A (swimmable) uses in the *Iowa Water Quality Standards*. Levels of fecal coliform bacteria and *E. coli* are monitored by DNR in rivers and lakes designated for Class A uses to *indicate* the health risks to persons using these waters for water-based recreation. Although typically not pathogenic, pathogen indicators such as fecal coliforms and *E. coli* are present in the intestines of warm-blooded animals and are commonly monitored by state environmental agencies to indicate the degree to which surface waters may contain waterborne pathogens (e.g., *Salmonella* and *Shigella*) that can cause disease in humans.
1800	radiation	no	yes	Radiation is the energy emitted spontaneously in the process of decay of unstable atoms of radioisotopes. Sources of radiation include (1) the natural decay of primordial radioisotopes and their decay products and (2) manmade radioisotopes released into the environment beginning with testing and use of the atomic bomb in World War II. Radiation absorbed by plant and animal tissue may cause cellular and molecular damage that can adversely affect aquatic biota.
1900	oil and grease	no	no	"Oil and grease" refers to adverse impacts to public water supplies or aquatic biota due to the presence of oils of petroleum or non-petroleum origin. Scenarios that can lead to impairments due to "oil and grease" include the following: (1) a fish kill caused by a spill of fuel oil and (2) adverse impacts to aquatic life resulting from contact of surface waters with coal tar waste.
2000	taste and odor	no	no	"Taste and odor" refer to the acceptability of drinking water to the user. Most taste and odor problems are related to the presence of phenolic compounds or to the presence of odor-producing organic substances produced by microorganisms or by human and industrial wastes.
2100	suspended solids	yes	no	"Suspended solids" refers to the organic and inorganic particulate matter in the water column. Such material can originate from detritus carried by streams and rivers, atmospheric fallout, biological activity, chemical reactions, and re-suspension from bottom sediments as a result of current, wind/wave action, or movements of bottom-dwelling fish.
2200	noxious aquatic plants**	yes	no	"Noxious aquatic plants" refers to excessive growths of aquatic macrophytes or algae (e.g., bluegreen algae) that are known to be potentially harmful to human health as well as to the health of aquatic biota. Scenarios that can lead to impairments due to "noxious aquatic plants" include the following: dominance of a lakes' phytoplankton community by bluegreen algae.
2210	excessive algal growth / chlorophyll-a	yes	no	"Excessive algal growth" refers to an unusually large concentration of algal organisms (planktonic or benthic) that can adversely affect either the aesthetic quality of the surface water for water-based recreation or the ability of the waterbody to support the expected types and numbers of aquatic biota (see explanation for cause code 2500 (Turbidity) below). Scenarios that can lead to impairments due to "excessive algal growth" include the following: (1) occurrence of a trophic state index value (TSI) for chlorophyll-a of greater than 65 and (2) excessive growth of attached algae (periphyton) on coarse substrates in stream riffle areas.
2400	total toxics	no	no	"Total toxics" refers to the cumulative adverse impact of toxic parameters from multiple groupings on water quality and aquatic biota.
2500	turbidity	yes	no	In the context of IDNR Section 305(b) reporting, and given the existence of cause code 22120 (excessive algal growth / chlorophyll-a), turbidity refers to non-algal materials suspended in the water column, especially soil particles (silt or clay), that give the water a brown, cloudy appearance. Turbidity-related impairments due to planktonic algae (i.e., "green" water) are included in cause

Cause Code	Cause Category	Historically Used?	Numeric Criteria?	Description
				category 2210 (excessive algal growth / chlorophyll-a)). High levels of turbidity may suggest a water quality impairment. High levels of turbidity in surface waters, whether due to suspended algae or non-algal materials, can interfere with the growth and reproduction of sight-feeding game fish (e.g., bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and walleye (*Stizostedion vitreum*)), and excessive turbidity reduces the aesthetic appeal of surface waters for primary contact recreation such as swimming and water skiing. The primary sources of high turbidity in Iowa surface waters are (1) the resuspension of bottom sediments in shallow lakes through wind/wave action, (2) delivery of high amounts of silt and clay particles to the surface waters during precipitation runoff from agricultural areas, (3) contributions of silt and clay particles from erosion of stream banks or lake shorelines, or (4) bottom feeding fish (e.g., common carp (*Cyprinus carpio*) and bullheads (*Ameiurus* spp.) that increase turbidity through resuspension of sediment and nutrients during feeding and spawning activities. Surface waters that drain watersheds with certain types of clay-dominated soils may have chronic problems with turbidity regardless of the level of agricultural activity in the watershed. Historical evidence suggests that streams and rivers in the Missouri River drainage of southern and western Iowa had high levels of turbidity even during pre-settlement times. The presence of a turbidity tolerant fish fauna in these streams and rivers supports this assertion. Iowa surface waters with water quality problems due to high levels of turbidity are generally of three types: (1) man-made lakes in southern Iowa with relatively large watersheds having high rates of soil erosion (e.g., Bob White, Rock Creek, and Manteno lakes) and (2) shallow natural lakes of northern Iowa with high turbidities related to resuspension of silt and nutrients by bottom-feeding fish and/or wind/wave action (e.g., Ingham, Lower Gar, and North Twin lakes) and (3) streams and rivers with chronically high turbidities that may contribute to reduced aquatic diversity.
2600	exotic species	yes	no	For purposes of Section 305(B) water quality assessments in Iowa, "exotic species" refers to a form "introduced into an area or ecosystem outside its historic or native geographic range; this includes both foreign (i.e., exotic) and transplanted species, and is used synonymously with "alien," "nonnative," and "introduced." Examples of exotic species in Iowa include common carp, grass carp, and the plant purple loosestrife. Scenarios that can lead to impairments due to "exotic species" include the following: (1) re-suspension of sediment and nutrients in a shallow lake by a large population of common carp; (2) elimination of aquatic macrophytes from the littoral zone of a lake by grass carp such that the lake shifts from a clear-water to a phytoplankton-dominated (green) lake; and (3) the replacement of native wetland vegetation with purple loosestrife, thus degrading the quality of the wetland.

* aldrin, dieldrin, chlordane, alpha-endosulfan, beta-endosulfan, endoslufan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, alpha BHC, beta BHC, gamma-BHC (lindane), delta-BHC, and toxaphene.

** Bluegreen algae is considered a "noxious aquatic plant" by IDNR