INDIANA'S CONSOLIDATED ASSESSMENT AND LISTING METHODOLOGY

Regulatory Background

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires each state to identify those waters that do not meet the state's WQS for designated uses. For these impaired waters, states are required to establish total maximum daily loads (TMDLs) to meet the state WQS. In addition, the USEPA has released guidance recommending that states, territories, and authorized tribes submit an Integrated Water Quality Monitoring and Assessment Report that will satisfy CWA requirements for both the Section 305(b) water quality report and Section 303(d) list of impaired waters. Indiana has integrated this guidance into the IDEM's 303(d) listing methodology.

Indiana Department of Environmental Management's (IDEM's) Surface Water Quality Monitoring Strategy

IDEM has developed a surface water quality monitoring strategy to assess the quality of Indiana's ambient waters. The goals of this monitoring strategy are as follows:

1. Measure the physical, chemical, bacteriological, and biological quality of the aquatic environment in all river basins and identify factors responsible for impairment.
2. Assess the impact of human and other activities on the surface water resource.
3. Identify trends through the analysis of environmental data, and
4. Provide environmental quality assessment to support water quality management programs.

To achieve the goals listed above, IDEM has divided the state into five major water management basins. The monitoring strategy calls for rotating through each of these basins once every five years to monitor Indiana's rivers, streams, and lakes under the following data-collection sampling programs:

- Watershed Monitoring Program.
- Fixed Station Monitoring Program.
- E. coli Monitoring Program.
- Fish Community Monitoring Program.
- Fish Tissue Contaminant Monitoring Program.
- Macroinvertebrate Community Monitoring Program.
- Special Projects.
- Clean Lakes Program.

Designated Uses

IDEM, within the framework of the state's water quality monitoring strategy, monitors and assesses Indiana's surface waters to ensure they meet the state WQS for designated uses. The WQS are designed to ensure that all waters of the state, unless specifically exempted, are safe for full body contact recreation and are protective of aquatic life, wildlife, and human health.

Water Quality Assessment Methodology

Use Support/Impairment status is determined for each stream waterbody using the assessment guidelines provided in the USEPA documents *Guidelines for Preparation of the State Water Quality Assessments (305[b] Reports) and Electronic Updates: Report Contents* (EPA-841-B-97-002A) and the draft *Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* published as a memorandum on February 22, 2005. Available results from six monitoring result types listed

below are integrated to provide an assessment for each stream waterbody for 305(b) reporting and 303(d) listing purposes[1]:

- Physical or chemical water results
- Fish community assessment
- Benthic aquatic macroinvertebrate community assessments
- Fish tissue and surficial aquatic sediment contaminant results
- Habitat evaluation
- E. coli monitoring results

Hydrologic Unit Areas

Waterbody impairments are identified based on watershed areas known as 14-digit hydrologic unit areas (HUAs). These watersheds range from about 5,000 to 20,000 acres in Indiana. The average 14-digit hydrologic unit area in Indiana is about 12,000 acres or 20 square miles. River miles in a 14-digit watershed are designated as one waterbody. These waters may be broken into smaller AU to properly reflect the water quality assessment. Each lake in a watershed is reported as a separate AU.

Large rivers with over 1,000 square miles of drainage area are tracked by reach of the mainstem within hydrologic unit areas. This way the wadeable streams and nonwadeable streams are separated so that issues such as sampling techniques, which might bias results, can be considered within a class of streams.

Lakes, reservoirs, and wetlands are tracked individually. They are reported with the hydrologic unit area in which they are located whether or not the lake or reservoir is also included as a linear stream feature in the National Hydrography Dataset.

Lake Michigan is tracked both as Great Lake shoreline miles and as a lake with its own United States Geological Survey (USGS) cataloging unit (8-digit hydrologic unit area). The shoreline is assigned mileage units. Lake Michigan as a separate lake AU and is assigned acreage units. Hopefully, separate tracking will lead to better assessment and understanding of the water quality of the Indiana waters of this lake.

Water Quality Assessment Decisions

The water quality assessment process is applied to each data-sampling program. Then the individual assessments are integrated into a comprehensive assessment for each AU by use designation: aquatic life support, fish consumption, drinking water supply, and recreational use. Smaller AU are identified for stream reaches as needed when the assessment for a stream reach differed from the default waterbody segment assessment. Each AU in the 305(b) assessment database corresponds to a linear, polygonal, or point feature in the Indiana Reach Index geo-referenced with the National Hydrography Dataset.

Water quality assessments are done by evaluating and coordinating data from site-specific chemical (water, sediment, and fish tissue), physical (habitat, flow data), and biological (fish community, macroinvertebrates, and E. coli) monitoring of Indiana's rivers, streams, and lakes. Chemical data for toxicants [total recoverable or dissolved metals, polynuclear aromatic hydrocarbons (PAHs), pesticides, ammonia, and cyanide], conventional water chemistry parameters (dissolved oxygen, pH, temperature, and anions), and bacteria (E. coli) were evaluated for compliance with Indiana's WQS (327 IAC 2-1-6 and 327 IAC 2-1.5-8). USEPA 305(b) guidelines were applied to chemical and biological data as indicated in Guidelines for Preparation of the State Water Quality Assessments (305[b] Reports) and Electronic Updates: Supplement (EPA-841-B-97-002B). A complete list of criteria used for use support assessments for aquatic life and human health for the 303(d) listing is provided in Table 1.

Table 1: Criteria for Use Support Assessment for 303(d) Listing.

<table>
<tr><th colspan="3">Aquatic Life Use Support - Rivers and Streams</th></tr>
<tr><td rowspan="3">Toxicants</td><td colspan="2">Metals, pesticides, PAHs, cyanide, ammonia were evaluated on a site-by-site basis and judged according to the magnitude of the exceedance(s) of Indiana's WQS and the number of times the exceedance(s) occurred. For any one pollutant (grab or composite samples), the following assessment criteria are applied to data sets consisting of three (3) or more measurements.</td></tr>
<tr><th>Fully Supporting</th><th>Not Supporting</th></tr>
<tr><td>≤1 exceedance of the acute criteria within a three-year period, and <1 exceedance of the chronic criteria for aquatic life within a three-year period.</td><td>>1 exceedance of the acute or chronic criteria for aquatic life within a three-year period.</td></tr>
<tr><td rowspan="3">Conventional inorganics</td><td colspan="2">Dissolved oxygen, pH, sulfates, chlorides were evaluated for the exceedance(s) of Indiana's WQS. For any one pollutant, the following assessment criteria are applied to data sets consisting of three or more measurements.</td></tr>
<tr><th>Fully Supporting</th><th>Not Supporting</th></tr>
<tr><td>For dissolved oxygen, one/more samples may be <4mg/L, but no more than 10% of all measurements are <5mg/L. For other conventional inorganics, criteria are exceeded in <10% of measurements.</td><td>For dissolved oxygen, one/more samples <4mg/L and more than 10% of all measurements are <5mg/L. For other conventional inorganics, criteria are exceeded in >10% of measurements.</td></tr>
<tr><td>Nutrients</td><td colspan="2">Nutrient conditions were evaluated on a site by site basis using the benchmarks described below. In most cases, two or more of these conditions must be met on the same date in order to classify a waterbody as impaired. This methodology assumes a minimum of three sampling events.
• Total Phosphorus: One/more measurements >0.3 mg/l
• Nitrogen (measured as NO_3 + NO_2) -- One/more measurements >10.0 mg/l
• Dissolved Oxygen (DO) -- Measurements below the water quality standard of 4.0 mg/l or measurements that are consistently at/close to the standard, in the range of 4.0-5.0 mg/l or values >12.0 mg/l
• pH measurements -- Measurements above the water quality standard of 9.0 or measurements that are consistently at/close to the standard, in the range of 8.7- 9.0
• Algal Conditions -- Algae are described as "excessive" based on field observations by trained staff.</td></tr>
</table>

Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI) Scores (Range of possible scores is 0-8)	**Fully Supporting**	**Not Supporting**
	• mIBI ≥1.8 (for samples collected with an artificial substrate sampler) • mIBI ≥2.2 (for samples collected using kick methods)	• mIBI <1.8 (for samples collected with an artificial substrate sampler) • mIBI <2.2 (for samples collected using kick methods)
Fish community (IBI) Scores (Range of possible scores is 6-60)	IBI ≥36	IBI <36
Qualitative habitat use evaluation (QHEI) (Range of possible scores is 0-100)	The Qualitative Habitat Evaluation Index (QHEI) is not used to determine aquatic life use support. Rather, the QHEI is an index designed to evaluate the lotic habitat quality important to aquatic communities and is used in conjunction with mIBI and/or IBI data to evaluate the role that habitat plays in waterbodies where impaired biotic communities (IBC) have been identified. QHEI scores are calculated using six metrics: substrate, instream cover, channel morphology, riparian zone, pool/riffle quality, and gradient. A higher QHEI score represents a more diverse habitat for colonization of aquatic organisms. IDEM has determined that a QHEI total score of <51 indicates poor habitat. For streams where the macroinvertebrate and/or fish community (mIBI and/or IBI) scores indicate IBC, QHEI scores are evaluated to determine if habitat is the primary stressor on the aquatic communities or if there may be other stressors/pollutants causing the IBC.	
Aquatic Life Use Support – Lakes and Reservoirs		
Indiana Department of Natural Resources surveys of the status of sport fish communities in lakes and information on trout stocking.	**Fully Supporting**	**Not Supporting**
	Supports cold water fishery, including native cisco and stocked trout, or both.	Native cisco population is gone or lake unable to support stocked trout and lake attributes, or both, appear to contribute to warm water fishery condition.
Temperature and pH	Lakes in which thermal modifications have caused an adverse effect on aquatic life and lakes that do not meet Indiana's WQS for pH have been assessed as not supporting of aquatic life use.	
Fishable Use Support (Human Health)		
Available fish tissue data for the most recent 12 years of data collection were evaluated for 305(b)/303(d) purposes for the 2008 cycle. Only waters for which sufficient fish tissue data were available were assessed for fish consumption All samples from a given sampling reach must have results below the benchmarks for mercury and PCBs in order to be assessed as fully supporting, and all waters with a sample result exceeding the benchmark for either mercury and/or PCBs are classified as impaired.		

	Fully Supporting	Not Supporting
Mercury in Fish Tissue	Actual concentration values (including estimated values above the method detection limits) for all samples collected from sampling reach are ≤0.3 mg/kg	One or more actual concentration values (including estimated values above the method detection limits) for samples collected from sampling reach are >0.3 mg/kg
	Fully Supporting	**Not Supporting**
PCBs in Fish Tissue	Actual concentration values (including estimated values above the method detection limits) for all samples collected from sampling reach are ≤0.02 mg/kg	One or more actual concentration values (including estimated values above the method detection limits) for samples collected from sampling reach are >0.02 mg/kg
Recreational Use Support (Human Health) – All waters		
IDEM has two different criteria for recreational use assessments depending on the type of data set being used in making the assessment. For data sets consisting of five equally spaced samples over a 30-day period, we apply two tests, both of which are based on USEPA's Ambient Water Quality Criteria for Bacteria - 1986 (EPA440/5-84-002), which provides the foundation for Indiana's WQS for recreational use. For data sets consisting of 10 or more grab samples where no five of which are equally spaced over a 30-day period, the 10% rule is applied. Specific criteria are provided below.		
	Fully Supporting	**Not Supporting**
Bacteria (E. coli): at least five equally spaced samples over 30 days. (cfu = colony forming units)	Geometric mean does not exceed 125 cfu/100ml and no more than one sample >576 cfu/100ml.	Geometric mean exceeds 125 cfu/100mL.
Bacteria (E. coli): grab samples (cfu = colony forming units)	No more than 10% of measurements >576 cfu/100ml and not more than one sample >2400 cfu/100ml.	More than 10% of samples >576 cfu/100ml or more than one sample >2,400 cfu/100ml.
Drinking Water Use Support – Rivers		
Rivers are designated for drinking water uses if a community water supply has a drinking water intake somewhere along the segment. When IDEM has data for a segment with a drinking water intake, those data are compared to Indiana's WQS to determine if the drinking water use is met. Different criteria are applied depending on whether the segment is located within or outside of the Great Lakes system. The appropriate water quality criteria are applied for specific substances identified in the criteria. Information regarding non-naturally occurring taste and odor producing substances not specifically identified in the criteria are reviewed within the context of a water treatment facility's ability to meet Indiana's drinking WQS using conventional treatment.		

Toxicants	Metals, pesticides, PCBs, total cyanide were evaluated on a site by site basis and judged according to magnitude of the exceedance(s) of Indiana's WQS for point of water intake and the number of times exceedance(s) occurred. For any one pollutant (grab or composite samples), the following assessment criteria are applied.	
	Fully Supporting	**Not Supporting**
	No more than one exceedance of the acute or chronic criteria for human health within a three-year period.	More than one exceedance of the acute or chronic criteria for human health within a three-year period.
Conventional inorganics	Total dissolved solids, specific conductance, sulfate, chloride, nitrite-N and nitrogen (measured as $NO_3 + NO_2$) were evaluated for the exceedance(s) of Indiana's WQS for point of water intake and the number of times the exceedance(s) occurred. For any single pollutant (grab or composite samples), the following assessment criteria are applied to data sets consisting of three or more measurements.	
	Fully Supporting	**Not Supporting**
	No more than one exceedance of the acute or chronic criteria for human health within a three-year period.	More than one exceedance of the acute or chronic criteria for human health within a three-year period.
Taste and odor producing substances	**Fully Supporting**	**Not Supporting**
	Taste and odor substances not present in quantities sufficient to interfere with production of drinking water by conventional treatment	Taste and odor substances present in quantities requiring additional treatment by the public water supply to prevent taste and odor problems
Recreational Use Support (Aesthetics) – Lakes and Reservoirs		
Natural Lakes	**Fully Supporting**	**Not Supporting**
	No more than 10% of all TP values >54 ug/L and their associated Chla values <20ug/L	Less than 10% of all TP values <54 ug/L but their associated Chla values are >20ug/L, and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values <4ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values >4ug/L

	Fully Supporting	Not Supporting
Reservoirs	No more than 10% of all TP values >51 ug/L and their associated Chla values are <25ug/L	Less than 10% of all TP values are <51 ug/L but their associated Chla values are >25 ug/L and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values <2ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values >2ug/L
Drinking Water Use Support – Lakes and Reservoirs		
Information on the application of pesticides to surface drinking water reservoirs	Reservoirs or lakes that serve as source water for public water supplies that received pesticide (algaecide) application permits for algae were classified as not supporting because additional treatment by the public water supply was required to prevent taste and odor problems.	
Other Assessments – Lakes and Reservoirs		
Indiana Trophic State Index (TSI)	Nutrients, ammonia, dissolved oxygen, light transmission and light penetration in the water column turbidity, and algae growth were used to determine TSI scores. Trophic scores were used to classify lakes according to their trophic state. Lake trends were also assessed for lakes with two or more trophic scores if at least one of the scores was less than five years old. Trophic scores and lake trends are not used to determine use support status. These assessments are conducted to fulfill Clean Water Act Section 314 reporting requirements for publicly owned lakes and reservoirs.	

CWA Section 314 lakes assessments were based on the Indiana Trophic State (or eutrophication) Index, a modified version of the BonHomme Index developed for Indiana lakes in 1972 (Table 2). This multi-metric index combines chemical, physical, and biological data into one overall trophic score for each public lake and reservoir sampled. Scores range from zero to 75. Lower values reflect lower concentrations of nutrients (Table 3). This information is useful in evaluating watershed impacts on lakes. Declining or extirpated cisco populations and the presence of exotic and potentially toxic blue-green algae species were also considered when evaluating lake water quality for aquatic life use. For drinking water reservoirs, taste and odor was also considered as a potential indicator of other water quality problems within the waterbody.

Table 2: The Indiana Trophic State Index

Parameter	Range	Eutrophy Points
Total Phosphorus (mg/L)	<0.03	0
	0.03-0.39	1
	0.04-0.05	2
	0.06-0.19	3
	0.2-0.99	4
	≥1.0	5
Soluble Phosphorus (mg/L)	<0.03	0
	0.03-0.39	1
	0.04-0.05	2
	0.06-0.19	3
	0.2-0.99	4
	≥1.0	5
Organic Nitrogen (mg/L)	<0.5	0
	0.5-0.59	1
	0.6-0.8	2
	0.9-1.9	3
	≥2.0	4
Nitrate (mg/L)	<0.3	0
	0.3-0.39	1
	0.4-0.8	2
	0.9-1.9	3
	≥2.0	4
Ammonia (mg/L)	<0.3	0
	0.3-0.39	1
	0.4-0.5	2
	0.6-0.9	3
	≥1.0	4

Dissolved Oxygen (% saturation at depth = 5 feet)	≤114	0
	115 to 119	1
	120 to 129	2
	130 to 149	3
	≥150	4
Dissolved Oxygen (% of measured water column with at least 0.1 ppm dissolved oxygen)	<28	4
	29-49	3
	50-65	2
	66-75	1
	76-100	0
Light Penetration (Secchi disk) (depth in feet)	≤5	6
	>5	0
Light Transmission (photocell) (% at depth = 3 feet)	0-30	4
	31-50	3
	51-70	2
	>71	0
Total Plankton Sampled from a single vertical tow between the surface and the 1% light level (organisms/L)	<3,000	0
	3,000-6,000	1
	6,001-16,000	2
	16,001-26,000	3
	26,001-36,000	4
	36,001-60,000	5
	60,001-95,000	10
	95,001-150,000	15
	150,001-500,000	20
	>500,000	25
	Dominance of blue-green algae	10 additional points

Table 3: Indiana's lake classification in terms of trophic condition.

Trophic State		Indiana TSI Score
Increasing TSI scores indicate increasing eutrophication	Oligotrophic	≤15 TSI points
	Mesotrophic	16-31 TSI points
	Eutrophic	32-46 TSI points
	Hypereutrophic	≥47 TSI points
	Dystrophic	Lakes with little plant growth despite the presence of nutrients; usually due to high humic conditions

Development of New Assessment Criteria for Recreational Use of Lakes

Historically, IDEM's lakes assessments have largely been limited to CWA Section 314 assessments of lake trends and trophic state. This is been due to the absence of water quality criteria in the state's WQS. Indiana's WQS does contain narrative criteria for all waters of the state. The few designated use assessments made on lakes and reservoirs to date are based primarily on narrative criteria.

On a national scale the number one impairment of lakes and reservoirs has long been identified as nutrients. Given this, USEPA has mandated that states develop and adopt nutrient criteria their WQS. In 2001, EPA published recommended criteria for both causal (total nitrogen and phosphorus) and response (chlorophyll a and turbidity/water clarity) variables USEPA in the federal register (66 FR 1671). These criteria were developed for waterbodies in "aggregated" ecoregions based on the work of Omernik and Gallant (1988). USEPA's ecoregional approach uses lake data from a number of states. The analyses used to derive the criteria applicable to Indiana included only nine Indiana lakes, one natural lake and eight reservoirs. Given this, USEPA's published criteria are not as Indiana-specific as IDEM believes is necessary to provide for accurate assessments of water quality conditions in lakes throughout the state. USEPA recognizes these concerns and encourages states to modify or refine their criteria to reflect conditions on a smaller geographic scale (USEPA, 2000c).

In 2007, IDEM developed additional criteria for assessing recreational use support in lakes and reservoirs within the context of aesthetics in order to more fully assess the water quality condition of Indiana's lakes and reservoirs. It should be noted that new assessment criteria described here does not replace any assessment criteria currently in place for lakes and reservoirs. The assessment criteria for recreational use support with respect to human health remains unchanged as do those used to determine drinking water and aquatic life use support (Table 19).

These new criteria are based on the results of a study conducted by of Limno-Tech, Inc. (LTI). In 2004, IDEM contracted with LTI to recommend potential nutrient water quality criteria for Indiana's lakes based on data collected throughout Indiana over several decades. Under this project, a comprehensive database of lakes data was developed for use in analyzing nutrient relationships for Indiana's lakes. The final report for this study is presently in draft and is

expected to be submitted to IDEM by August 31, 2007. For the purposes of this notice, a summary of the data and analytical methods used and the resulting recommendations are provided here.

IDEM's new phosphorus thresholds for recreational use assessments and the data used to develop them.

The LTI study incorporated used both agency data[2] and volunteer data collected by the Indiana Clean Lakes Program (CLP) from 321 natural lakes and 113 reservoirs from 1989 to 2005. Of the 13,063 individual samples with water quality data, 70% of the samples were collected under the volunteer monitoring program. In order to have sufficient data for robust analyses, it was important to use volunteer data if its reliability could be verified. The Indiana CLP is funded by IDEM's Section 319 grant program and operates under an IDEM-approved Quality Assurance Project Plan (QAPP), which documents the data quality of all data collected under the program[3].

Given the importance of volunteer data to this study, data were examined to determine if there was a significant difference depending on whether the data were collected by volunteers or the agencies. LTI first plotted raw data values against each other. However, it became apparent that averaged data provided a much better representation of potential relationships. For example, Figure 1 shows the growing season (June to August) average of Secchi depth and chlorophyll a (Chla) values for lakes where at least three different sample years of Chla existed. This analysis shows that volunteer data are indistinguishable from agency data, and, therefore, no bias should exist if all datasets are combined. Similar conclusions were reached when LTI made additional comparisons between Secchi depth and total phosphorus and between Chla and total phosphorus. The absence of bias between volunteer and agency data was also confirmed by evaluating lakes where agency and volunteer data were used to calculate summer medians versus lakes where only agency data were available.

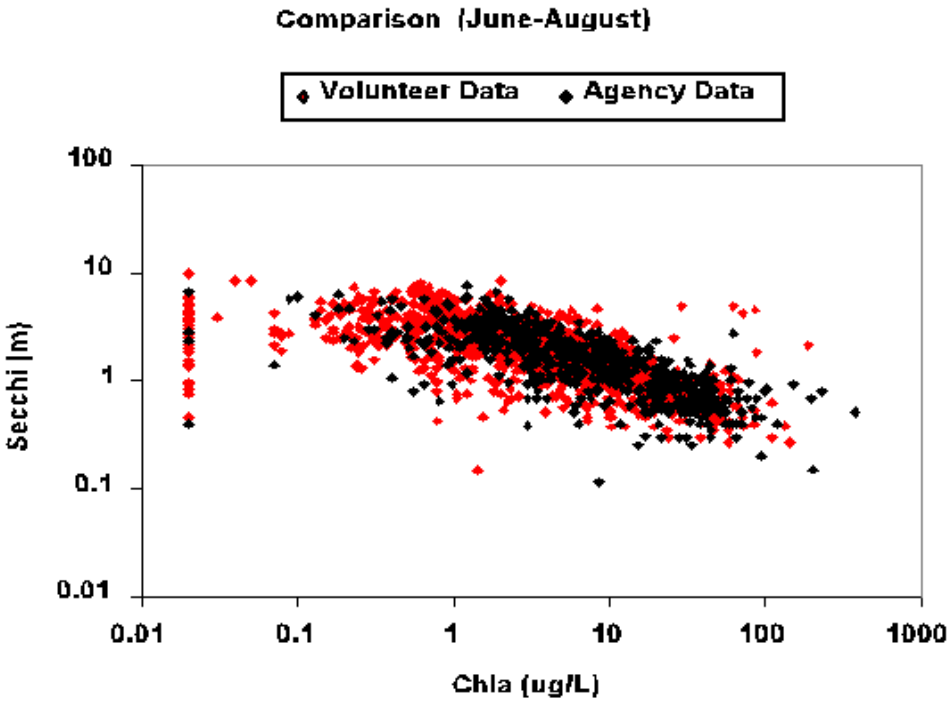

Figure 1: Comparison of volunteer and agency data (Source: LTI, 2007).

Data from all sources were reviewed for quality assurance and evaluated to identify spatial and temporal patterns. Suitable models for developing criteria were evaluated and statistical analyses were applied to establish the recommended total phosphorus thresholds, which are shown in Table 4.

Table 4: Recommended phosphorus thresholds.

Lake Type	Total Phosphorus (ug/L)	Associated Range in Chlorophyll a (ug/L)
Natural Lakes	54	4 to 20
Reservoirs	51	2 to 25

Source: Modified from LTI (2007).

The associated range of Chla represents the range of concentrations that based on LTI's analysis of natural lakes and reservoirs in Indiana that can be expected when total phosphorus concentrations are at or below 54 ug/L or 51 ug/L, respectively.

How the thresholds were determined

Multiple linear regressions analyses were conducted on total phosphorus (as a response variable) for each data set (natural lakes and reservoirs) using regression tree analysis (RTA) methods developed by Soranno, *et.al*, (personal communication). RTA was used to determine appropriate TP thresholds.

Once the TP thresholds were established, median values above and below the threshold for each lake type were calculated for two biological response variables, Secchi depth and Chla. The median values above and below represent the range of expected values for each response variable associated with its corresponding total phosphorus threshold. For example, in Figure 2, the median below line represents the median of all Chla concentration values that fall to the left of the calculated TP threshold whereas the median above line represents all of the Chla values that fall to the right of the threshold (i.e., correspond to TP "exceedances"). A simplified model of how the median values calculated for a given total phosphorus threshold are used to determine recreational use support is provided in the discussion regarding IDEM's assessment methodology for this use (Figure 3).

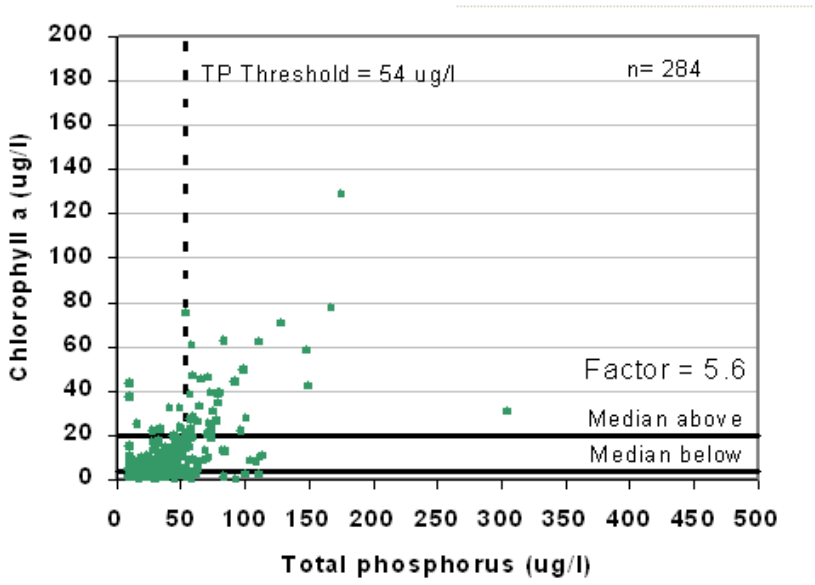

Figure 2: Relationship of Chlorophyll a concentrations to the TP threshold for natural lakes (Source: LTI, 2007).

A biological response factor for Chla was then calculated as the median of the biological response above the threshold divided by the median of the biological response below the threshold. The biological response factor for Secchi depth was calculated as the median of the biological response below the threshold divided by the median of the biological response above the threshold. Based on the work of Soranno, *et al.,* a biological response factor of 2 or greater is considered significant and could reasonably be designated as a relevant TP threshold above which action should be taken.

Table 5 shows that the thresholds calculated are very significant for Chla in both reservoirs and natural lakes. The threshold for Secchi depth in reservoirs, while still significant, is not nearly as strong as the threshold for Chla as indicated by their biological response factors (3.6 for Secchi depth vs. 13.2 for Chla). The same holds true for natural lakes (1.9 for Secchi depth and 5.6 for Chla), and the biological response factor for Secchi depth falls below that which is considered significant for the purposes of setting an appropriate TP threshold.

Table 5: Total phosphorus thresholds and median values above and below the thresholds for natural lakes and reservoirs.

Response Variable	Secchi	Chlorophyll a
Natural Lakes		
Total Phosphorus Threshold (ug/L)	36	54
Median of values above TP threshold	1.2 meters	20 ug/L
Median of values below TP threshold	2.4 meters	4 ug/L
Biological response factor	1.9	5.6
Reservoirs		
Total Phosphorus Threshold (ug/L)	31	51
Median of values above TP threshold	0.8 meters	25 ug/L
Median of values below TP threshold	2.7 meters	2 ug/L
Biological response factor	3.6	13.2

Source: Modified from LTI (2007).

Because the TP thresholds for Chla are much stronger than those for Secchi depth, IDEM's assessment methodology incorporates the total phosphorus thresholds developed for Chla. Other reasons for this decision are that Secchi depth measurements are inherently more subjective than Chla measurements, and IDEM does not have survey data regarding aesthetics, which is necessary to adequately translate secchi depth information into use support status. While there is similarly little analogous information available for Chla, IDEM considers Chla data obtained through laboratory analyses of water samples a more reliable indicator of phosphorus enrichment than secchi depth for the purposes of 305(b) assessment and 303(d) listing decisions.

In some cases, the Chla data were not consistent with expectations given the TP levels measured for a given lake (e.g., low Chla values associated with high TP values or vice versa). For these situations, IDEM's methodology used the TSI score as a surrogate response variable (in addition to Chla) to determine impairment status. The TSI score can be affected by a number of variables in addition to phosphorus (see Table 2). However, the index places additional weight on algal concentration, adding significantly more points where concentrations are high. While the TSI does not provide a direct response variable for TP, it can be a useful indicator in cases where Chla results are mixed.

In addition to providing a surrogate measure for Chla, the TSI score also provides a good measure of overall trophic condition of a given lake. Recognizing the connection between trophic status and nutrient enrichment, USEPA generally considers hypereutrohic conditions as measured by the TSI indicative of impairment (USEPA, 2000c). IDEM does not believe that the TSI score alone is sufficient information for making designated use assessments because it can be affected by a number of variables in addition to nutrient loading. However, in cases where the Chla results are mixed, IDEM used the most recent TSI score to determine impairment. If the TSI score indicates eutrophic or hypereutrophic conditions, the lake was assessed as impaired. It should be noted that TSI scores were not used in absence of Chla results. TSI scores were only reviewed in cases where there were sufficient TP and Chla data but where those data showed conflicting results.

The benchmarks from the LTI study were used to make assessments for recreational uses (as opposed to other designated uses), specifically within the context of aesthetics. Because IDEM does not have sufficient information regarding the response of aquatic communities to nutrient enrichment, these criteria are used to make recreational use support determinations only. These assessments are made within the context of aesthetics as opposed to health risk. Recreational use support assessments for human health are based on pathogen data and are made in the same manner as for rivers and streams when adequate data are available. All impairments identified based on this methodology were assessed as impaired for phosphorus as opposed to nutrients because the LTI study did not include analyses of other nutrient-related parameters.

Figure 3 provides a simplified model of how the median values calculated for a given total phosphorus threshold are used to determine recreational use support. A more detailed discussion is provided in following section.

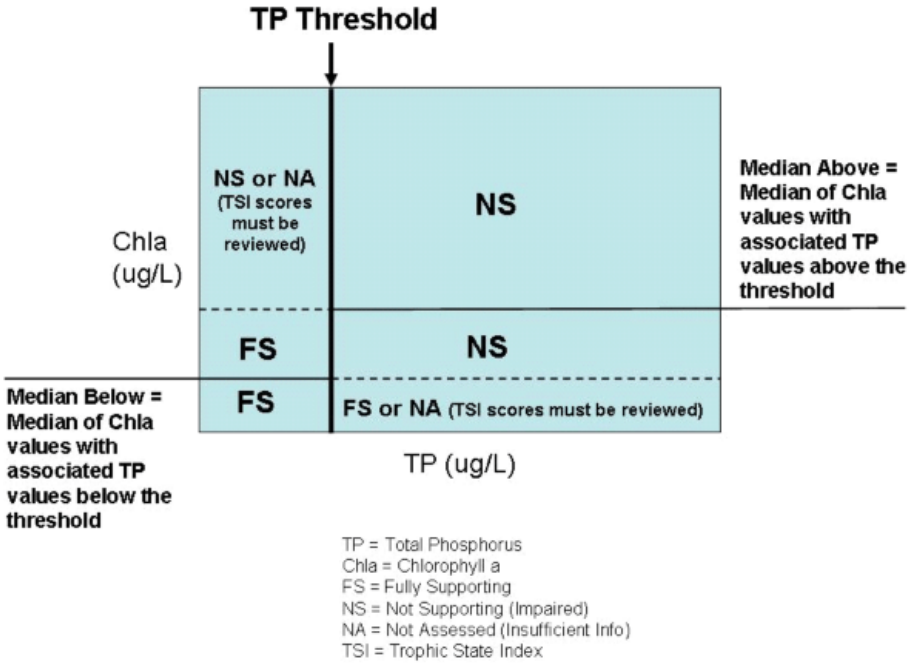

Figure 3: Simplified model of IDEM's assessment methodology using TP data in conjunction with Chla data.

IDEM's assessment methodology using the total phosphorus thresholds

Step 1. Determine the available data to be used for assessment

Indiana's CLP samples 70-80 lakes each year in accordance with a rotating sampling

strategy similar to the rotating basin strategy employed by IDEM for monitoring streams. However, the basin rotation IDEM employs for Indiana's rivers and streams does not work well for lakes given their unequal distribution across the Indiana landscape. While some basins contain very few lakes, others contain more than can feasibly be sampled in a given year. Instead, the Indiana's CLP monitoring rotation for lakes is designed to analyze all public access lakes once every five years. Through this rotation, a given lake is monitored approximately once every five years in July and August with approximately 80 lakes sampled each year. About 400 lakes are thus monitored in a given five-year rotation. In general, only public lakes having an accessible boat launching area were sampled. The July-August period is used because this is the time of year when worst-case scenario and stable conditions (warm temperatures, thermal stratification, hypolimnetic anoxia, and algal blooms are expected).

All available data for a given lake were used for assessment purposes. USEPA guidance suggests that, while all readily available data should be reviewed, 305(b) assessment decisions should be based on data five years old or less. The use of historical data is necessary because the sampling conducted by IDEM's CLP program is designed specifically to support CWA Section 314 assessments of trophic state and lake trends, not to make designated use assessments. As a result, while IDEM's CLP sampling strategy ensures sufficient samples for determining trophic state and trends, a given CLP sampling rotation does not guarantee sufficient data for making designated use assessments. IDEM's benchmark criteria were developed using data from 1989 forward. USEPA recommends that, in general, the method of data gathering for determining compliance (in this case, designated use support) for lakes and reservoirs should be similar to that used to establish the criteria (USEPA, 2000c). CLP data used for designated use assessments includes results from:

- One-time samples collected from public access lakes by SPEA students and analyzed in the CLP laboratory, and
- Monthly TP and Chla samples collected from public and private lakes by trained volunteers and sent to the CLP laboratory for analysis.

Step 2. Determine adequate data for assessment

For purposes of determining recreational use support within the context of aesthetics, the following general rules were applied:

- Only TP and chla data, including volunteer-collected data, analyzed in the CLP laboratory in accordance with the CLP QAPP were used for assessment purposes.
- A minimum of three years' worth of data was considered sufficient for assessment purposes, provided each TP value had a corresponding Chla value.
- Multiple results within a given year for each parameter (TP and Chla) were averaged to provide a single value for that year.
- For consistency in assessments, all samples used in attainment decisions must have been collected during the summer season.

Step 3: Apply benchmark criteria to determine use support

The thresholds shown in Table 4 were applied to all natural lakes and reservoirs for which sufficient data were available. IDEM's methods for applying these criteria are summarized in Table 6 and are illustrated in Figure 6. All waters found to be not supporting of recreational use (aesthetics) were categorized as impaired and placed in Category 5A of Indiana's 303(d) list.

Table 6: Summary of IDEM's assessment methodology for recreational use support within the context of aesthetics.

Recreational Use Support (Aesthetics) – Lakes and Reservoirs		
	Fully Supporting	**Not Supporting**
Natural Lakes	No more than 10% of all TP values >54 ug/L and their associated Chla values are <20ug/L	Less than 10% of all TP values are <54 ug/L but their associated Chla values are >20ug/L, and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values <4ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values >4ug/L
	Fully Supporting	**Not Supporting**
Reservoirs	No more than 10% of all TP values >51 ug/L and their associated Chla values are <25ug/L	Less than 10% of all TP values are <51 ug/L but their associated Chla values are >25 ug/L and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values <2ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values >2ug/L

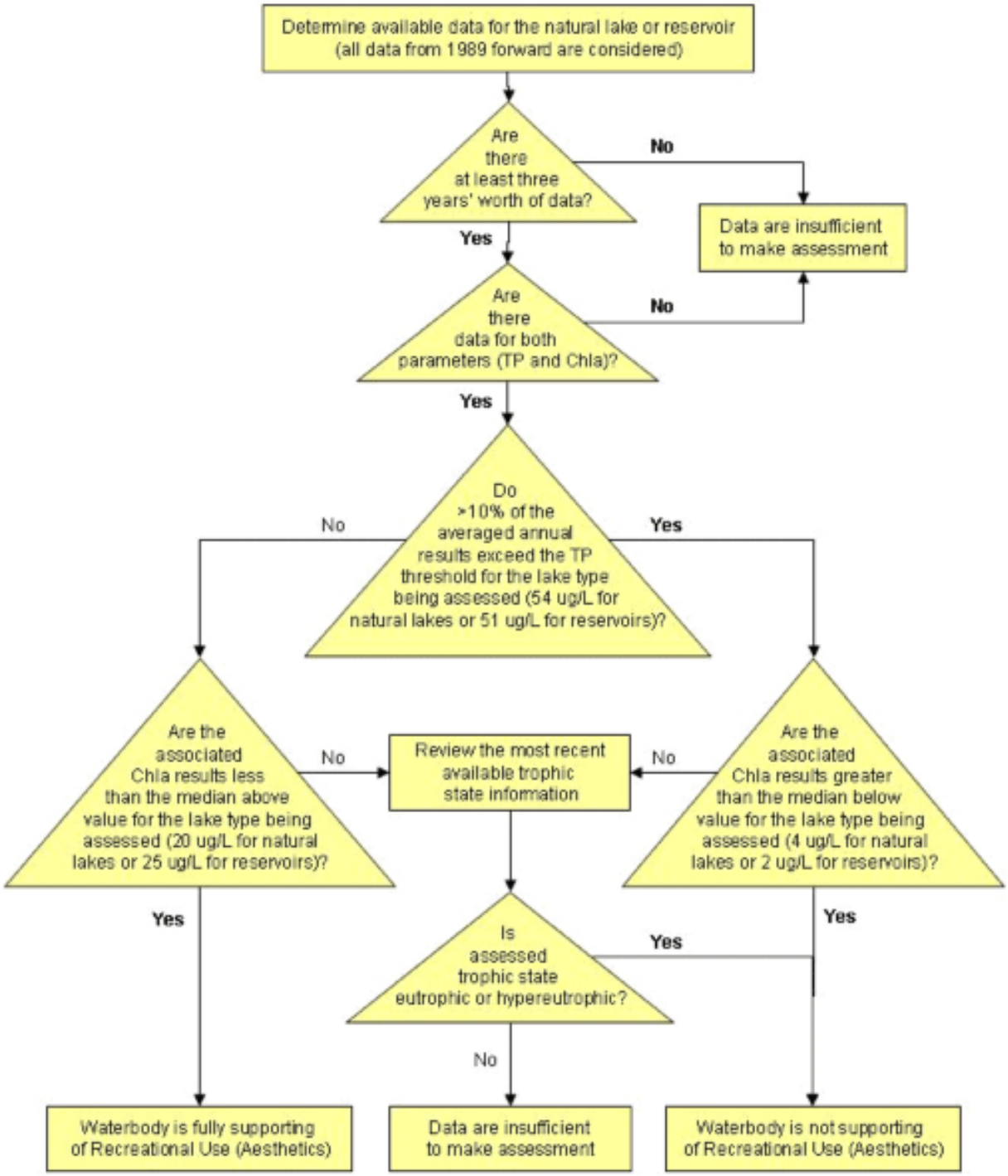

Figure 4: IDEM's assessment process for determining recreational use support for lakes within the context of aesthetics.

Implementation of the new criteria

Of the approximately 1,504 lakes and reservoirs IDEM has in its ADB, the agency has identified approximately 150 for which there appears to be sufficient data to make an assessment (36 reservoirs and 114 natural lakes). For the 2008 cycle, IDEM's new recreational use assessments for lakes have been completed for natural lakes. Reservoir assessments will be completed by the end of 2007 with any resulting impairments added to Indiana's finalized 303(d) list to be submitted by April 1, 2008. Given the robust, Indiana-specific dataset upon which the thresholds recommended in the LTI study were developed, IDEM believes they are appropriate for making designated use assessments and will likely provide the basis for rulemaking to establish nutrient criteria for Indiana's lakes in the future. When IDEM finalizes its nutrient criteria and incorporates them into the state's WQS, IDEM will review all lakes assessments made with the present methodology to determine their consistency with the revised WQS.

Changes to Indiana's Assessment Methodology for Fish Consumption

USEPA "generally believes that fish and shellfish consumption advisories…based on segment specific information demonstrate impairment of CWA section 101(s) 'fishable' uses" and continues to require that IDEM make water quality assessments for fish consumption and place waters with fish consumption advisories on its 303(d) list of impaired waters (USEPA, 2000a). However, Indiana's WQS (WQS) do not contain numeric criteria for the concentration of mercury or polychlorinated biphenyls (PCBs) in fish tissue. IDEM's past and present fish consumption use assessments are a translation of the narrative portion of Indiana's WQS, which states that surface waters "…shall be free from substances in concentrations that on the basis of available scientific data are believed to be sufficient to injure, be chronically toxic to, or be carcinogenic…to humans, animals, aquatic life or plants." (327 IAC 2-1-6 (a)(2)).

Until now, in the absence of numeric criteria for mercury and PCBs in fish tissue, Indiana's 305(b) assessment and 303(d) listing methodology has relied primarily on the state's Fish Consumption Advisory (FCA) published by the Indiana State Department of Health (ISDH). This new methodology results in criteria that are more readily applicable to Indiana's Integrated Report (Sections 305(b) and 303(d)) water quality assessments and will resolve the following issues:

- Indiana's FCA is developed by an interagency workgroup consisting of representatives from the ISDH, Indiana Department of Natural Resources (IDNR), and IDEM. IDEM's role in the development of the FCA is to collect and manage the contaminants data, present the results to the FCA workgroup, and to assist the workgroup in the interpretation of the data. However, final publication of the FCA is the responsibility of the ISDH. Should its publication ever be discontinued IDEM would necessarily have to revise its methodology in order to continue identifying waters that are impaired for their fishable uses pursuant to USEPA's 305(b) and 303(d) policy. Thus, IDEM believes that this change is proactive in nature and ensures a methodology independent of our sister agency's potentially changing mandates.
- Concentrations for assigning FCA groupings, as well as other variables for calculating these concentrations, can change with new scientific information. The advisory groupings shown in the FCA do not include the contaminant concentrations associated with them making it very difficult to determine whether a previous assessment is still valid when such changes occur. Using fish tissue concentration data is more straightforward, making it easier to reevaluate previous assessments as new information becomes available.
- Indiana's FCA was never intended to be used to make designated use assessments under CWA Sections 305(b) and 303(d). There is nothing mandatory or regulatory

about the advice itself. Rather, the FCA is intended to provide the public with important public health information. In contrast, the 303(d) list is a list of waterbodies that do not meet WQS, and for which a Total Maximum Daily Load (TMDL) is required. The groupings shown in the advisory are not designed to and do not translate into WQS. In the interest of achieving greater consistency with goals of CWA Sections 305(b) and 303(d), IDEM believes this change in its methodology for making water quality assessments for fish consumption is in order.

IDEM's 2008 Assessment Criteria for Mercury and PCB Concentrations in Fish Tissue

Mercury

In 2001, USEPA issued a revised human health-based water quality criterion for methylmercury (USEPA 2001). The new criterion is unique among all USEPA (Clean Water Act 304(a)) water quality criteria in that it identifies an acceptable mercury concentration in fish tissue rather than water. A fish tissue criterion is logical because it is fish that are the main source of methylmercury exposure to both humans and wildlife. Also, a tissue-based criterion eliminates the need for a bioaccumulation factor in the criterion calculation, which can be a significant source of uncertainty. The USEPA criterion (USEPA 2001) is 0.3 mg/kg methylmercury in fish muscle tissue. Since nearly 100 percent of the mercury in fish muscle is methylmercury, the criterion can reasonably be considered a total mercury criterion.

Polychlorinated Biphenyls (PCBs)

USEPA has not issued a human health-based criterion for PCBs in fish tissue nor do Indiana's WQS contain a numeric concentration criterion for PCBs in the edible portion of fish tissue. However, Indiana has adopted human health WQS to protect the public from adverse impacts due to 1) exposure through public drinking water supplies withdrawn from surface waters and 2) nondrinking water exposures such as consumption of fish caught in Indiana lakes, rivers, and streams. Although human consumption of sport fish is not explicitly described in Indiana's WQS, criteria for fish consumption are included as part of the calculation of the human health criteria IDEM plans to propose. The fish consumption values in the human health criteria calculation are intended to ensure that the levels of a carcinogenic chemical in fish are not at levels harmful to people who consume them.

Absent a USEPA criterion derived specifically for fish tissue concentration of PCBs, using USEPA's methodology for deriving ambient water quality criteria for the protection of human health (USEPA 2006a) to calculate a concentration value for PCBs is a reasonable alternative that results in a criterion that is more readily applicable to Sections 305(b) and 303(d) water quality assessments than using FCA grouping levels.

Assessment Criteria for Mercury and PCBs Concentrations in Fish Tissue

IDEM's Assessment Criteria for Mercury and PCBs in Fish Tissue

IDEM's revised benchmark criterio for mercury and PCBs in fish tissue is shown in Table 7.

Table 7: WQS-based assessment thresholds for mercury and PCBs.

Mercury (Hg)		
Concentration in Fish Tissue	Fully Supporting	Not Supporting
	≤ 0.3 mg/kg	> 0.3 mg/kg
Polychlorinated Biphenyls (PCBs)		
Concentration in Fish Tissue	Fully Supporting	Not Supporting
	≤ 0.02 mg/kg	> 0.02 mg/kg

Relationship of IDEM's WQS-Based Criteria to the FCA

A fish consumption advisory is determined based on the quantity of a chemical in fish, such as milligrams of chemical per kilogram of the edible portion of fish tissue (mg/kg), which is commonly expressed as parts per million (ppm). WQS, on the other hand, are expressed as the quantity of the chemical in water, such as micrograms of a chemical per liter of water (ug/L). The exposure assumptions upon which the human health criteria are based can be used to calculate a maximum safe fish concentration. That fish concentration value can then be directly compared to the values used to issue fish consumption advisories to determine whether the advisory is less or more protective than the WQS.

The levels of fish tissue contaminants that trigger a FCA have little relation to the levels of fish tissue contaminants on which the WQS criteria are based. This discrepancy exists because different assumptions about fish consumption rates and body weight are made in calculating water quality criteria than in issuing FCA. FCAs are intended to provide for protection of human health over a lifetime of exposure, maximizing benefits of eating fish while minimizing the risk. The calculations used to determine if an FCA should be issued are based on contaminant concentration found in fish, which is treated as a constant while consumption rates are allowed to vary. Allowing for different consumption rates makes it possible to safely consume fish that have different levels of contamination. The recommended consumption rate is reduced as fish tissue concentrations increase. To determine a Group 2 advisory, the FCA uses a higher consumption rate (32 g/day) and a lower body mass (22 kg) than the WQS-based criteria calculation (Appendix A), which results in a higher effective exposure in terms of contaminant concentration per unit body mass. These values for consumption and body mass differ because FCA is intended to advise at-risk populations (women who are pregnant or breastfeeding, women who plan to have children, and children under 15 years of age) about how much fish they can safely eat.

In contrast, WQS criteria calculations start with an assumed level of fish consumption and derive a criterion for a safe level given the exposure. Because the consumption rate is held constant, the resulting criterion can be applied consistently to all waters. FCAs are expressed for a given waterbody in terms of certain species within certain size ranges, very few FCAs apply to all fish in a given waterbody, which limits their utility for water quality assessment purposes.

IDEM's new assessment methodology, applicable to all waters, uses the revised human health-based water quality criterion for methylmercury (USEPA 2001) and a criterion for PCBs derived from USEPA's (2000b) human health methodology.

While mindful of the differences in purpose and function of the FCA and the 303(d) list, IDEM's new methodology maintains as much consistency as possible between the protocols ISDH uses to assess data for the FCA and the protocols IDEM uses to assess data for the determination of impairment. For PCBs, the WQS-based threshold is consistent with the one meal per week advice in the FCA, which is equivalent to a Group 2 advisory. However, the threshold for mercury is higher than that which would trigger a Group 2 advisory (Table 8). For mercury, given the existing exposure assumptions upon which the water quality criteria are based, issuance of a FCA does not necessarily indicate an exceedance of WQS.

Table 8: Fish tissue concentrations for levels of consumption advice established by ISDH for mercury and total PCBs and its correspondence to an impairment condition as determine by the WQS-criteria.

Mercury	Fish Tissue Concentration (mg/kg)				
	<0.05	<0.05 – 0.2	0.2 – 1.0	1.0 – 1.9	>1.9
FCA Groups	Group 1	Group 2	Group 3	Group 4	Group 5
Consumption Advice (FCA)	unlimited	1 meal/ week	1 meal/ month	1 meal/ 2 months	No consumption
PCBs	**Fish Tissue Concentration (mg/kg)**				
	<0.05	<0.05 – 0.2	0.2 – 1.0	1.0 – 1.9	>1.9
FCA Groups	Group 1	Group 2	Group 3	Group 4	Group 5
Consumption Advice (FCA)	unlimited	1 meal/ week	1 meal/ month	1 meal/ 2 months	No consumption

*Shaded cells indicate consumption advice that corresponds to nonsupport and an impaired condition using the WQS-based criteria.

IDEM's benchmark criteria do not reflect any determination by IDEM of what an appropriate fish consumption rate should be. The consumption rates expressed in Indiana's WQS for human health are 15.0 g/day for waters in the Great Lakes basin (327 IAC 2-1.5-14) and 6.5 g/day for downstate waters (327 IAC 2-1-8.6).

For mercury, IDEM defaulted to the USEPA water quality criterion for water quality criterion for mercury in fish tissue (USEPA, 2001), which corresponds to one meal per month, or a Group 3 advisory.

For calculating the criterion for PCB in fish tissue, IDEM used the same consumption rate USEPA used to calculate its criterion for mercury in fish tissue for the general population, which is 17.5 g/day national consumption rate. The use of a higher consumption rate in the PCB calculation is consistent with that used by USEPA and results in a more protective criterion than applying the consumption rate expressed for either the Great Lakes basin or downstate waters. The same holds true for mercury. IDEM's decision to use USEPA's criterion value for mercury in fish tissue was a policy decision based on the fact that USEPA's criterion is more protective. Calculations for both criteria are provided at the end of this appendix.

Assessment method using the WQS-based criteria

IDEM's new assessment methodology reflects a conservative approach intended to both identify waters in which fish tissue data indicate impairment for mercury and/or PCBs and to provide for the protection of human health. Using this approach, all samples from a given sampling reach must have results below the benchmarks for mercury and PCBs in order to be assessed as fully supporting, and all waters with a sample result exceeding the benchmark for either mercury and/or PCBs are classified as impaired.

Table 9: Methods for determining fish consumption use support in Indiana waters.

Determining Use Support		
	Fully Supporting	**Not Supporting**
Mercury in Fish Tissue	Actual concentration values (including values above the method detection limits) ıples collected from sampling reach are ≤	One or more actual concentration values (including estimated values above the method detection limits) for samples collected from sampling reach are > 0.3 mg/kg
PCBs in Fish Tissue	Actual concentration values (including estimated values above the method detection limits) for all samples collected from sampling reach are ≤ 0.02 mg/kg	One or more actual concentration values (including estimated values above the method detection limits) for samples collected from sampling reach are > 0.02 mg/kg

The following describes in detail the steps in IDEM's assessment process for fish consumption, which are illustrated in Figure 5.

Step 1. Determine the available data to be used for assessment

Available fish tissue data for the most recent 12 years of data collection were evaluated for 305(b)/303(d) purposes for the 2008 cycle in order to encompass three monitoring cycles in Indiana's rotating basin monitoring strategy (IDEM, 2005). USEPA guidance suggests that, while all readily available data should be reviewed, 305(b) assessment decisions should be based on data five years old or less. The use of historical data is necessary because IDEM's fish tissue sampling program is designed specifically to support the development of the state's FCA, not to make designated use assessments. As a result, while IDEM's sampling strategy ensures sufficient fish tissue samples for developing the FCA, there are not enough samples collected from enough locations each year to conduct a thorough assessment of contaminant levels in fish tissue across the state. Also, most of IDEM's previous assessments for fish consumption were based on data which is now more than five years old. However, to ensure accuracy in Indiana's 303(d) list in 2008 and future cycles, it is necessary to reevaluate all of the data used in all previous assessments using the new methodology. IDEM emphasizes that in completing this reassessment, no waterbody impairment previously identified on Indiana's 303(d) list was proposed for delisting due to the age of the data available for assessment.

Step 2. Determine adequate data for assessment

For purposes of determining fish tissue contaminant concentrations for assessment, the following general rules were applied:

- In order to ensure the most representative data were used for assessment, only samples prepared from the edible portion of fish were utilized.
- One year of sampling was considered sufficient for assessment purposes.
- For waterbodies with data collected in multiple years, species size classes were determined for each year of sampling and treated as individual samples.
- Concentration values less than the analytical method detection limit were considered insufficient for assessment purposes due to the uncertainty associated with such results. It should be noted that for PCBs and mercury, values below the analytical method detection limits do not commonly occur because both contaminants are bioaccumulative in fish tissue.
- Estimated values that are lower than the required quantitation limit[4], which for PCBs

is greater than 0.02 mg/kg, were considered valid for assessment purposes.

- Waterbodies were assessed as fully supporting only if all samples have actual quantitations (i.e., values above the method detection limits) and all were equal to or less than 0.02 mg/kg for PCBs and 0.3 mg/kg for mercury.
- One sample exceeding either criterion with an actual reported concentration was sufficient for the purposes of assessing impairment. This conservative approach is intended to provide greater protection of human health.

Step 3: Apply WQS-based concentration thresholds to determine use support

The WQS-based assessment thresholds shown in Table 21 were applied to all lakes and streams for which sufficient fish tissue data were available. IDEM's methods for applying these criteria are summarized in Table 9. All waters found to be not supporting due to either mercury or PCBs or both were categorized as impaired and placed in Category 5B of Indiana's 303(d) list.

Step 4: Determine the appropriate geographical extent to which the assessment applies

In some cases fish can be very mobile and difficult to attribute to a discrete portion of a lake or river reach. For 305(b)/303(d) assessments, all fish tissue data for a given lake or reservoir were aggregated into a lakewide assessment unless there was evidence that fish from certain parts of a lake are isolated and may have been exposed to different levels of contamination. In determining the appropriate geographical extent to which results can be confidently applied to rivers and streams, a number of factors were considered in a weight-of-evidence approach to the decision making process, including:

- The size and complexity of watershed relative to the amount of data available for decision-making and differences in stream orders within a given watershed;
- The spatial continuity of sampling results across watershed boundaries for a larger streams and rivers;
- Contaminant concentrations and information regarding known sources;
- The types of species sampled (bottom-feeder versus predator) (considered in cases where the data were very limited;
- The relative amount and age of data (in cases where there were conflicting results from different sites along the same assessment unit).

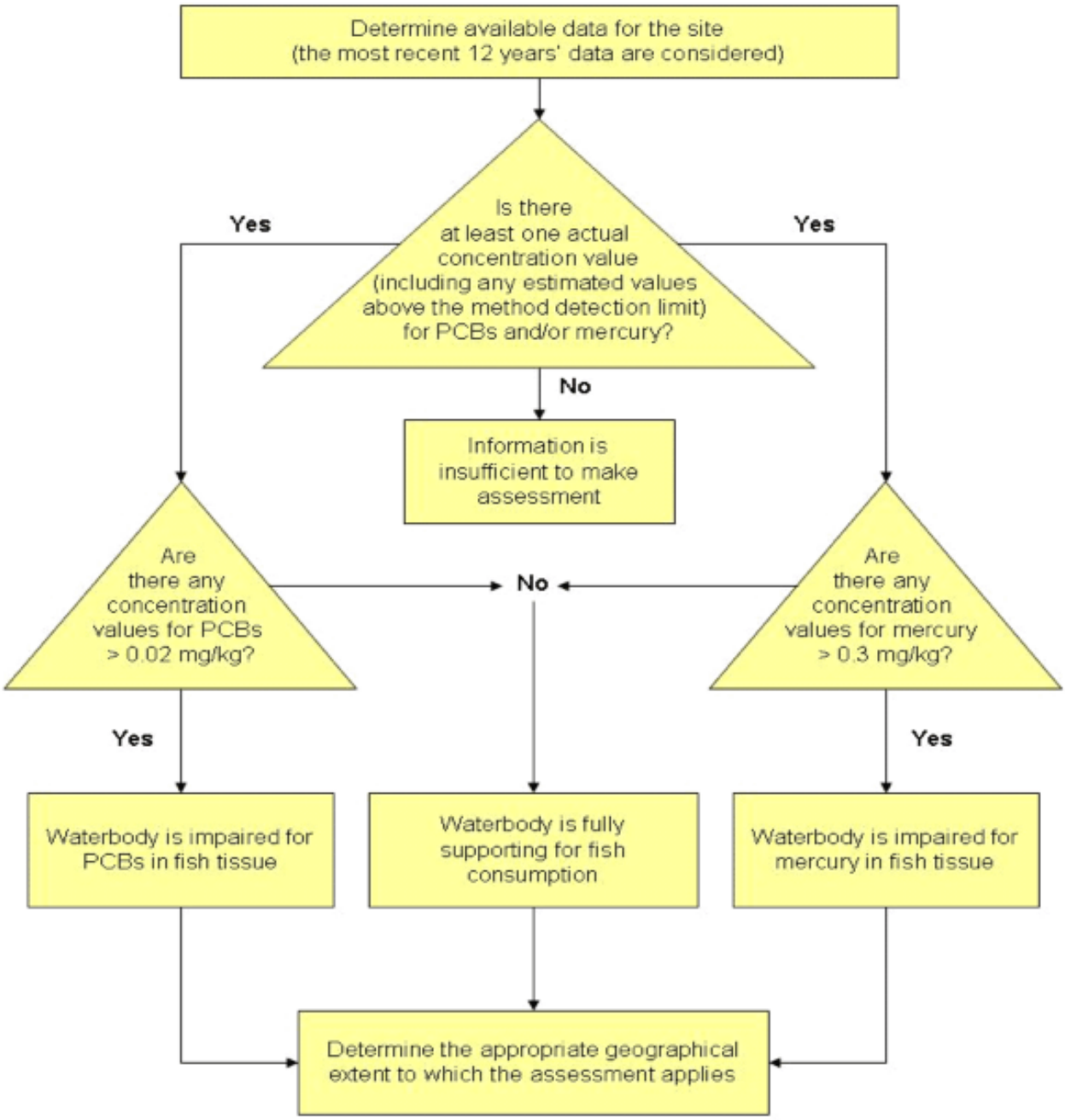

Figure 5: IDEM's assessment process for mercury and/or PCBs in fish tissue.

Implementation of IDEM's new methodology for fish consumption

IDEM implemented this methodology by conducting a statewide reassessment of all IDEM fish tissue data. The data set reviewed for reassessment was comprised of results from sampling conducted from 1994-2005 and is IDEM's longest ranging and most complete fish tissue data set to date. This reassessment was conducted in two phases:

Phase 1: Assessments were conducted using geospatial software (GIS) to distinguish between waters for which IDEM had sufficient fish tissue data to make an assessment and those for which there was little or no data to support decision-making. This approach provided the necessary starting point for the development of decision rules regarding how to determine the appropriate distance over which to apply results from a given site.

Phase 2: Assessments were finalized by applying the decision rules regarding extrapolations to each waterbody for which there was sufficient data with which to make an assessment.

For the 2008 303(d) list, all previously assessed impairments found to be valid using the new assessment methodology remain in Category 5B. However, the impairment for which each has been listed has been changed to more accurately reflect IDEM's new methodology and lend more precision to the meaning of the assessment (Table 10). Previously listed impairments for which the fish tissue data were not sufficient to make an assessment were moved to Category 3 of Indiana's consolidated list. A more complete description of each category and subcategory of Indiana's Consolidated List can be found in the following section of this document entitled "Listing of Waterbody Impairments by Category".

Table 10: Key to changes in how segments are listed for fish consumption impairments.

Fishable use impairment listed under previous methodology	Fishable use impairment listed under new methodology
FCA for Mercury	Mercury in Fish Tissue
FCA for PCBs	PCBs in Fish Tissue

Presently, IDEM assesses for mercury and PCBs in fish tissue. Because IDEM's revised methodology for fish tissue assessments is based on human health criteria, it allows for the calculation of additional criteria for other potentially harmful substances (e.g., dieldrin, DDT, chlordane, and other organochlorine pesticides) that might be found in fish tissue and can be used to identify waters in which fishable uses are impacted by such substances. IDEM has been collecting fish tissue data since the 1970s and has contaminant concentration information for a number of substances in addition to mercury and PCBs. However, because past assessments were based on the FCA, IDEM's ability to assess this information for 305(b)/303(d) purposes was limited to those constituents addressed in the advisory. In future 305(b)/303(d) cycles, IDEM expects to calculate criteria for the additional substances for which the agency has fish tissue data in order to more fully characterize the fishable uses in Indiana's waters and identify those waters that do not support fish consumption.

How to interpret impairments for fish consumption identified on Indiana's 303(d) List of Impaired Waters

IDEM emphasizes that the purpose of the 303(d) list is not to provide the public with a list of waters that they should or should not swim in, or catch and eat fish from. Section 303(d) of the CWA requires that states develop a list identifying impairments to water quality for which a TMDL is required. The 303(d) list is not and was never intended to be a public health advisory. IDEM continues to defer to the Indiana FCA on questions regarding the relative risks of consuming fish caught from Indiana waters and recommends that the public refer to the current

FCA and/or contact the Indiana State Department of Health with any specific questions or concerns in this respect. The current fish consumption advisory can be found online at: http://www.in.gov/isdh/dataandstats/fish/fish_adv_index.htm and contains more specific information than the 303(d) list does regarding the sizes and species of fish that can be safely consumed and how often.

Because IDEM uses the similar methods in determining unsafe levels of mercury and PCBs that ISDH uses in determining fish consumption advice, the concentrations of these contaminants used to determine impairment correspond closely to the meal frequency recommendations published in the FCA. However, it is important to emphasize that one cannot assume, because a particular waterbody does not appear on the 303(d) list for fish consumption that the fish in that waterbody are safe for consumption of more than one meal per week. Likewise, due to the statewide fish consumption advisory for carp, it should not be assumed that carp greater than 15" in length from waters assessed as fully supporting are safe for consumption of more than one meal per month for the general population or at all by at-risk populations. *The 303(d) list is not intended to communicate health risk information.*

At present, adequate translators do not exist for applying concentrations of mercury or PCBs in fish tissue to concentrations in the water column. Toxicants may be present in fish at levels that have no ill effects on aquatic life but due to bioaccumulation may make them unsafe to eat. The concentrations shown in Table 21 apply only to fish tissue, not water. *Therefore, it also should not be assumed that if a waterbody is impaired for fish consumption that mercury and/or PCBs are present in the water column in amounts harmful to human health.*

IDEM's fish consumption use assessments are required by USEPA and are a translation of the narrative portion of Indiana's water quality standard, which states that surface waters "…shall be free from substances in concentrations that on the basis of available scientific data are believed to be sufficient to injure, be chronically toxic to, or be carcinogenic…to humans, animals, aquatic life or plants." (327 IAC 2-1-6 (a)(2)). In addition to resolving the issues associated with using the FCA for assessments, IDEM believes this assessment methodology is consistent with this standard, achieves consistency with the decision making criteria used in developing the FCA, and is consistent with USEPA 305(b) and 303(d) policy guidance.

Changes to IDEM's Use Support Criteria for Biological Data

IDEM's use support criteria for fish community and macroinvertebrate community data have undergone significant changes since they was first adopted in 1996. Table 11 summarizes the evolution of IDEM's criteria for making assessments with biological data. The criteria developed in 2002 are calibrated to reference conditions in Indiana and remain in effect today. However, with the changes in 2002 and each change prior to that time, resulting criteria were applied only to the basins being assessed at the time. In 2007, IDEM completed its review of all aquatic life use support assessments made prior to 2002 to identify any waterbodies that may now be considered fully supporting.

Table 11: Evolution of the criteria used in making aquatic life use assessments with biological data.

Year	Criteria Development and Changes
Monitored: 1996 Assessed: 1997 Reported: 1998	IDEM used Karr's 1986 Index of Biotic Integrity (IBI) Classification and Attributes Table to establish criteria to apply to fish community (IBI) data for use support assessments: • IBI ≥ 44 = Fully supporting (Excellent/Good) • IBI < 44 and ≥ 22 = Partially supporting (Fair/Poor) • IBI < 22 = Not supporting (Very Poor/No Fish) IDEM's criteria for macroinvertebrate community (mIBI) data collected using kick methods: • mIBI ≥ 4 = Fully supporting • mIBI < 4 and ≥ 2 = Partially supporting • mIBI < 2 = Not supporting
Monitored: 1997 and 1998 Reported: 2000	IDEM reviewed fish community data from 1990-1995 (n=831) to determine new, more accurate limits reflective of Indiana fish communities by subtracting ½ standard deviation from the statewide mean to calculate the following criteria: • IBI > 34 = Fully supporting • IBI ≤ 34 and ≥ 32 = Partially supporting • IBI < 32 = Not supporting Criteria for macroinvertebrate community data were unchanged.
Monitored: 1999 and 2000 Assessed: 2000 and 2001 Reported: 2002	Based on IDEM's adoption of USEPA's integrated reporting format, the category for partially supporting was eliminated for both fish community data and macroinvertebrate community data: • IBI ≥ 32 = Fully supporting • IBI < 32 = Not supporting Criteria for macroinvertebrate community data were unchanged.
Monitored: 2001 and 2002 Assessed: 2002 and 2003 Reported: 2004	IDEM completes its first five-year basin monitoring rotation. After reviewing the narrative biological criteria [327 IAC 2-1-3(2)] and water quality standard definition [327 IAC 2-1-9(49)] of a well balanced aquatic community, IDEM determined that IBI values previously considered partially supporting are reflective of poorer conditions and should be classified as not supporting. The resulting criteria are now applied to all basins in Indiana: • IBI ≥ 36 = Fully supporting • IBI < 36 = Not supporting With a more robust set of macroinvertebrate community data, IDEM was also able to calibrate its criteria for this type of data, developing specific criteria applicable to all basins in the state. For samples collected with an artificial substrate sampler: • mIBI ≥ 1.8 = Fully supporting • mIBI < 1.8 = Not supporting For samples collected using kick methods: • mIBI ≥ 2.2 = Fully supporting • mIBI < 2.2 = Not supporting

Biological impairment classifications for streams were based on the sampling and evaluation of either the fish communities or benthic aquatic macroinvertebrate communities, or both. Indices of Biotic Integrity (IBI) for fish and macroinvertebrate IBI (mIBI) assessment scores, or both, were calculated and compared to regionally calibrated models. In evaluating fish communities, streams rating as "fair" or worse were classified as nonsupporting for aquatic life uses. For benthic aquatic macroinvertebrate communities, individual sites were compared to a statewide calibration at the family level of identification for Indiana. All sites at or above background for the calibration were considered to be supporting aquatic life uses. Those sites rated as moderately or severely impaired in the calibration were considered to be nonsupporting. Nonsupport for aquatic life use was considered an impairment of the biological community. Consideration was also given to the size of the stream being assessed. Habitat evaluations were considered in determining the potential for waters to support aquatic communities. If habitat was the primary reason for nonsupport, then the waterbody was not considered for inclusion on IDEM's 303(d) List of Impaired Waters (Category 5) (see Category 4C under "Consolidated Listing Methodology").

Consolidated Listing Methodology

For the development of the 2008 303(d) list, IDEM has followed, to the degree possible, the 305(b) and 303(d) reporting methods outlined in the USEPA's Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act (USEPA, 2005) and the additional guidance provided in the USEPA memorandum Information Concerning 2008 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions (USEPA, 2006). The 303(d) list was developed using the 305(b) Assessment Database. Interpretation of the data and listing decisions take into account IDEM's assessment methodologies, USEPA's guidance, and IDEM's 303(d) Listing Methodology. A copy of IDEM's current 303(d) Listing Methodology is included at the end of this document.

Waterbody AU were classified as monitored if surface water quality data used for assessments were not more than five years old or were still considered representative of current conditions. Data from a given monitoring site are considered representative of the waterbody for that distance upstream and downstream in which there are no significant influences to the waterbody that might cause a change in water quality. Using this same rationale, data may also be extrapolated to some distance into tributaries upstream of a given sampling location. Waterbody AU with monitoring site(s) upstream and downstream and those for which reliable assessments can be made based on extrapolation of representative data are classified as monitored. Waterbody AU were classified as evaluated if the primary data used for assessment was more than five years old and little was known concerning changes in the watershed, or the assessment was based on other monitored waterbody AU in the watershed. Only waterbody AU designated as monitored were considered for 303(d) listing purposes. All waterbody AU identified as "Not Supporting" in accordance with the criteria described in Table 18 were considered for 303(d) listing purposes.

Interpretation of the data and 303(d) listing decisions are made in accordance with IDEM's assessment methodologies for the 305(b) report and USEPA guidance. One aspect of USEPA's guidance calls for a comprehensive listing of all monitored or assessed waterbodies in the state, based on the state's assessment and listing methodology. Each waterbody is to be placed in one or more of five categories depending on the degree to which it supports designated uses. Prior to 2006, USEPA required that states place each waterbody into only one category. The draft guidance issued by USEPA in 2005 encourages states to place waterbody AU in

additional categories as appropriate in order to more clearly illustrate where progress has been made in TMDL development and other restoration efforts.

Delineation of these waterbody AU will be based on the National Hydrography Dataset (NHD). The NHD is a database created by USEPA and the USGS that provides a comprehensive coverage of hydrographic data for the United States. It uniquely identifies and interconnects the stream segments that comprise the nation's surface water drainage system. It also contains information for other common surface waterbodies such as lakes, reservoirs, estuaries, and coastlines. States may use spatial resolution on a finer scale than the NHD, and USEPA will translate that resolution into the NHD system. An explanation of the five categories is given below. Indiana's 303(d) List of Impaired Waters will consist of waterbody AU listed in Category 5.

Listing of Waterbody Impairments by Category

Category 1 **Attaining the water quality standard for all designated uses and no use is threatened.** Waters should be listed in this category if there are data and information that meet the requirements of the state's assessment and listing methodology and support a determination that all WQS are attained and no designated use is threatened.

Category 2 **Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened.** Waters should be listed in this category if there are data and information that meet the requirements of the state's assessment and listing methodology to support a determination that some, but not all, designated uses are attained and none are threatened.

Category 3 **Insufficient data and information to determine if any designated use is attained.** Little or no information is available with which to make an assessment. Waters should be listed in this category where the data or information to support an attainment determination for any designated use are not available or are not consistent with the requirements of the state's assessment and listing methodology. States should schedule monitoring on a priority basis to obtain data and information necessary to classify these waters as Category 1, Category 2, Category 4, or Category 5.

Category 4 **Impaired or threatened for one or more designated uses but does not require the development of a TMDL.**

A. A TMDL has been completed that results in attainment of all applicable WQS, and has been approved by USEPA. Monitoring should be scheduled for these waters to verify that the WQS are met when the water quality management actions needed to achieve all TMDLs are implemented.
B. Other pollution control requirements are reasonably expected to result in the attainment of the WQS a reasonable period of time. Consistent with the regulation under 130.7(b)(i),(ii), and (iii), waters should be listed in this subcategory where other pollution control requirements required by local, state, or federal authority are stringent enough to achieve any water quality standard (WQS) applicable to such waters. Monitoring should be scheduled for these waters to verify that the WQS are attained as expected.
C. Impairment is not caused by a pollutant. Waters should be listed in this subcategory if the impairment is not caused by a pollutant but is attributed to other types of pollution for which a total maximum daily load cannot be calculated.

Category 5 The water quality standard is not attained. Waters may be listed in both 5A and 5B depending on the parameters causing the impairment.

A. The waters are impaired or threatened for one or more designated uses by a pollutant(s) and require a TMDL. This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDL(s) are needed. Waters should be listed in this category if 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 impairment. Where more than one pollutant is associated with the impairment of a single AU, the AU will remain in Category 5 until TMDLs for all pollutants have been completed and approved by USEPA.

B. The waterbody AU are impaired due to the presence of mercury and/or PCBs in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants. This category also composes a portion of the Section 303(d) list of impaired waters, but the state believes that a conventional TMDL is not the appropriate approach. The state will continue to work with the general public and USEPA on actual steps needed ultimately to address these impairments.

Because each situation is unique, resources, and data sets are sometimes limited, the 2008 listing process may at times require IDEM staff to apply rational professional discretion. Any waterbody AU assessed differently than indicated in the water quality assessment methodology outlined above will be accompanied by written justification, so that stakeholders will understand how each decision was made.

The 2008 303(d) list includes impairments from the 2006 303(d) list that still require TMDL development. For an AU to be listed, it must have been assessed using representative data, and the data must support listing. Any data, both internal or from outside sources, that is used for listing decisions must meet IDEM's quality assurance and quality control (QAQC) requirements as outlined in IDEM's surface water quality monitoring Quality Assurance Project Plan.

Delisting of Impairments

The USEPA's new guidance does not change existing rules for listing and delisting. The existing regulations require states, at the request of the USEPA's Regional Administrator, to demonstrate good cause for not including impairments on the 303(d) list that were included on previous 303(d) lists (pursuant to 40 CFR 130.7(b)(6)(iv)). In general IDEM will only consider delisting an AU one of the following is true:

1. New data indicates that WQS are now being met for the AU under consideration. This would typically occur during IDEM's scheduled assessments when reviewing data collected through our 5-year basin rotation.
2. The assessment and/or listing methodology has changed, and the AU under consideration would not be considered impaired under the new methodology.
3. An error is discovered in the sampling, testing, or reporting of data that led to an inappropriate listing. IDEM will review previous assessments and 303(d) listings when there is there is reason to believe that the original assessment was not valid. Reassessment (review of previous assessment and/or 303(d) listing) typically occurs as a result of ongoing QA/QC of IDEM's Assessment Database (ADB) or through inquiry by IDEM staff or external parties. Under these circumstances, the 305(b)/303(d) coordinator works with the IDEM staff initiating the question or receiving it from the external party

to gather the necessary information and consult with other staff as needed to resolve the question. During reassessment, several types of information are considered, including data quality issues, past assessment methodologies, land use data, historical information from the public, etc. Regardless of the situation, no assessment is dismissed as invalid based solely on the age of the data.

4. If it is determined that another program, besides the TMDL program, is better suited to address the water quality problem, or the problem is determined not to be caused by a pollutant (see Categories 4B[6] and 4C above).

5. A TMDL has been completed, and the waterbody AU is expected to meet WQS after implementation of the TMDL (see Category 4A above).

TMDL Development Schedule and Prioritization

In 2004, IDEM refined its methods of prioritizing waters for TMDL development in order to meet its TMDL goals. IDEM's basin-rotation water quality monitoring schedule continues to be a factor in determining where TMDL development will occur to the extent that it provides data for use in the TMDL. For example, if IDEM is monitoring in a given basin in one year, the data collected will usually be available the following year for incorporation into a TMDL. To take advantage of all available resources for TMDL development, the following additional factors are considered when determining when impairments on the 303(d) list (Category 5) will be scheduled for TMDL development:

1. The quantity and age of available data –AU for which the most current and robust data available will receive greater priority than AU for which data are scarce or nonexistent.

2. The nature of impairment – The three leading causes of impairment to Indiana's waters are impairments due to the presence of mercury and/or PCBs in fish tissue, E. coli, and impaired biotic communities (IBC). To date, states have received little guidance from USEPA regarding how to develop a TMDL to restore a waterbody with elevated levels of mercury and/or PCBs in fish tissue. IDEM has placed all fish tissue impairments in a separate category of the list (5B) because it does not believe that, at this point in time, a conventional TMDL is the appropriate approach for addressing these impairments. Until adequate guidance is available, IDEM believes it to be more prudent to focus its limited resources on developing TMDLs on impairments for which appropriate methods have been established.

3. Other activities occurring in the watershed which may improve water quality if given sufficient time – TMDL development for impairments to waterbody AU where other interested parties, such as local watershed groups, may be working to alleviate the water quality problem may be delayed to give these other actions time to have a positive impact on the waterbody. If WQS still are not met, then the TMDL process will be initiated.

In keeping with the need to make the best possible use of limited resources, IDEM's primary focus in the short term is on E. coli. IDEM has established an effective method for developing E. coli TMDLs and will continue to use this method to address the second leading cause of impairment to Indiana's surface waters. IBC, which is the third leading cause of impairment of surface waters is more difficult to address because IBC are actually a symptom of other unidentified stressors in the environment, which may include a combination of pollution, for which no TMDL would be required, and one/more pollutants. IDEM continues to explore different methods of source identification through its second-year studies program and has plans to complete additional TMDLs over the next two years for a number of IBCs and other impairments, including nutrients, sulfates, total dissolved solids, dissolved oxygen, pH, nickel, zinc, and copper.

Waterbodies on the 2008 303(d) list are scheduled to complete the TMDL development

process within 15 years. Since the CWA does not clearly define the timeline for TMDL development, USEPA, in response to the Federal Advisory Committee Act (FACA) Committee's recommendations, issued guidance for states to develop expeditious schedules of not more than eight to 15 years. 40 CFR section 130.7 also dictates that the 303(d) list specifically include the identification of waters targeted for TMDL development in the next two years. This list is currently being developed and will be submitted to USEPA with Indiana's finalized 303(d) List of Impaired Waters by April 1, 2008.

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[1] IDEM staff from the following program areas were involved in the evaluation of Indiana's waterbodies: the TMDL Group, Biological Studies Section, Water Quality Surveys Section, and Water Quality Standards Section. Staff from other program areas were consulted where appropriate.
[2] Agency data used included those collected by Indiana Department of Environmental Management (IDEM), U.S. Environmental Protection Agency (USEPA), and the Army Corps of Engineers (ACOE).
[3] A fact sheet providing more detailed information on Indiana's Clean Lakes Program (CLP) can be found online at: http://www.in.gov/idem/programs/water/quality/biostud/index.html.
[4] The required quantitation limit depends on the specific contract laboratory conducting the analyses and methods used. All methods and their associated quantitation limits are specified in IDEM's Quality Assurance Project Plan

for Indiana Surface Water Quality Monitoring and Total Maximum Daily Load (TMDL) Program (IDEM, 2004).

[5] IDEM's fish tissue monitoring methods are described in detail in the agency's Biological Studies Section Standard Operating Procedures (IDEM, 1992).

[6] A decision to list a water in Category 4B using §130.7(b)(1)(i) must be supported by the issuance of technology-based effluent limitations required by Sections 301(b), 306, 307 or other sections of the CWA. A decision to list in Category 4B using §130.7(b)(1)(ii) must be supported by the issuance of more stringent effluent limitations required by federal, state or local authority. EPA expects that the state will provide a rationale for why they believe that these effluent limits will achieve WQS within a reasonable period of time. Placement of waters in Category 4B based on §130.7(b)(iii) must be supported by the existence of "other pollution control requirements (for example, best management practices) required by local, state, or federal authority" that are stringent enough to implement WQS. EPA expects that the state will demonstrate that these control requirements will achieve WQS within a reasonable period of time.

DERIVATION OF CRITERIA VALUES FOR CONCENTRATIONS OF MERCURY AND PCBS IN FISH TISSUE

USEPA stipulates that the risk assessment parameters used to categorize fish tissue contaminant data must be at least as protective as those used in the WQS-based fish concentrations. The equation for calculating a fish tissue criterion for PCBs utilizes the guidance provided by USEPA for calculating screening values for target analytes (http://www.epa.gov/waterscience/fishadvice/volume1/v1ch5.pdf). EPA's Office of Water recommends the use of this calculation method because it is the basis for developing current water quality criteria for the protection of human health. The general equation used for calculating Screening Values (SVs) for carcinogens in fish tissue is derived from this guidance and is as follows:

$$SV_c = [(RL / CSF) \bullet BW] / CR \qquad \text{Equation 1}$$

where:

SV_c = Screening value for a carcinogen (mg/kg; ppm)
RL = Maximum acceptable risk level (dimensionless)
CSF = Oral cancer slope factor $(mg/kg\text{-}d)^{-1}$
BW = Mean body weight of the general population (kg)
CR = Mean daily consumption rate of species of interest (kg/d)

In determining a screening value or fish tissue criterion for PCBs, the same assumptions and parameters used for calculating human health water quality criteria were applied. These parameters include a BW of 70 kg, CSF (of 2.0 $(mg/kg\text{-}d)^{-1}$, RL of 10^{-5}, and CR of 17.5 (g/d).

The general equation for calculating a fish tissue screening value for PCBs is:

$$Fish\ Tissue\ ScreeningValue\left(mg/kg\right) = \frac{\left[\frac{Cancer\ Risk\ Level}{q1^{*}\left(\left(mg/kg/d\right)^{-1}\right)}\right] \times Body\ Weight\ \left(kg\right)}{Fish\ Consumption\ \left(kg/d\right)} \qquad \text{Equation 2}$$

Therefore,
Cancer risk level (the RL value from equation 1) = 10^{-5}
$q1$ (the CSF from equation 1) = of 2.0 $(mg/kg\text{-}d)^{-1}$
BW (same in both equations) = 70 kg
Fish Consumption (CR in equation 1) = 17.5 (g/d) or 0.0175 (kg/d)

$$PCB\ Fish\ Tissue\ ScreeningValue\left(mg/kg\right) = \frac{\left[\frac{1E-05}{2.0\ \left(mg/kg/d\right)^{-1}}\right] \times 70\ \left(kg\right)}{0.0175\ \left(kg/d\right)} = 0.02\ \left(mg/kg\right)$$

A tissue-based criterion eliminates the need for a bioaccumulation factor in the criterion calculation while PCB exposure from drinking water is negligible (http://www.great-lakes.net/humanhealth/lake/superior.html).