2008 Guidance for Assessing and Reporting Surface Water Quality in Texas

(March 19, 2008)

In Compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act

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List of Abbreviations Used in the Guidance

AU	assessment unit
AVS	acid volatile sulfide
BPJ	best professional judgement
°C	degrees celcius
CFR	Code of Federal Regulation
CFS or ft^3/s	cubic feet per second
Chl *a*	chlorophyll *a*
CRP	Clean Rivers Program
CWA	Clean Water Act
DO	dissolved oxygen
DQO	data quality objectives
DSHS	Texas Department of State Health Services
EPA	United States Environmental Protection Agency
°F	degrees Fahrenheit
IBI	index of biotic integrity
IP	implementation plan
m	meter
MCL	maximum contaminant level
μg/L	micrograms per liter
mg/L	milligrams per liter
mL	milliliter
MPN	most probable number (bacteria)
MTBE	methyl tert butyl ether
NH_3-N	ammonia-nitrogen
NO_2-N + NO_3-N	nitrite-nitrogen + nitrate-nitrogen
OP	orthophosphorus
PECs	probable effects concentrations
PELs	probable effects limits

List of Abbreviations Used in the Guidance

QA	quality assurance
QC	quality control
7Q2	seven-day, two-year low flow
RBA	rapid bioassessment protocol
RWA	receiving water assessment
SWQM	surface water quality monitoring
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TMDL	total maximum daily load
TOC	total organic carbon
TP	total phosphorus
TPWD	Texas Parks and Wildlife Department
TRACS	TCEQ Regulatory Activities and Compliance System
TDWS	Texas Drinking Water Standards
TSWQS	Texas Surface Water Quality Standards
USGS	United States Geological Survey
UAA	use attainability analysis

CHAPTER 1
SUMMARY OF THE REPORTING APPROACH

Introduction

In compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act (CWA), the Texas Commission on Environmental Quality (TCEQ) evaluates water bodies in the state and identifies those that do not meet uses and criteria defined in the *Texas Surface Water Quality Standards* (TSWQS). Guidance developed by the Environmental Protection Agency (EPA) directs each state to document and submit the results of its evaluation to the EPA biennially, in even-numbered years. The TCEQ also publishes the results on its Web site as the *Texas Water Quality Inventory and 303(d) List* (hereafter called "Report") prepared by the TCEQ and submitted biennially to the EPA. The report is also published on the TCEQ Web site.

The Report describes the status of water quality in all surface water bodies of the state that were evaluated for a given assessment period. The TCEQ uses data collected during the most recent seven-year period in making its assessment. The data are gathered by many different organizations that all operate according to approved quality control guidelines and sample collection procedures. The quality of waters described in the Report represents a snapshot of conditions during the specific time period considered in the assessment. In most circumstances, the period of record for water quality data and information used in preparing the Report is the most recent seven years.

Assessment Guidance

Water quality is evaluated according to assessment guidance. The guidance is developed by expert staff of the TCEQ through a stakeholder process. Individuals representing diverse organizations and interests are invited to participate in the revision of current guidance and to develop, review, and comment on new draft guidance every few years. The stakeholder group includes but is not limited to, state agencies, environmental consultants, river authorities, environmental groups, industry, agricultural interests, and municipalities. The TCEQ's guidance for assessing water bodies is documented in Chapter *2—General Assessment Methodology* and *Chapter 3—Assessment of Beneficial Uses*.

After the evaluation is complete, EPA guidance requires that all water bodies be placed into one of five categories. See Chapter 5—*Categorizing Water Quality Conditions for Management Action* for details on the categories and the management strategies the state employs for each.

The categories indicate the status of water quality in the segment. Category 5 constitutes the 303(d) List of Impaired Waters, for which total maximum daily loads (TMDLs) may be required. The TCEQ holds a public comment period to solicit input from the public and stakeholders on the Report, and then prepares a schedule that identifies the TMDLs the TCEQ expects to develop and

submit to the EPA within the next two years. The TMDL schedule is submitted to the EPA along with the Report.

Development of the Inventory and List

Development of the Report includes the following basic steps:

- Active solicitation and selection of acceptable data and information to develop the Inventory.
- Assessing these data and information to determine which water bodies are not meeting TSWQS (See Chapters 2 and 3).
- Preparing and categorizing the draft Report.
- Receiving public comment on the draft Report.
- Revising and finalizing the assessment and list based on new information and comments from the EPA and the public.
- Propose the draft Report at Commissioner's Work Session to seek approval for submission to EPA.
- Developing a schedule for TMDLs for Category 5 water bodies.

Data and Information Used

As required by CWA Section 303(d) and CFR Section 130.7(b)(5), the TCEQ considers "all existing and readily available water quality-related data and information" during the development of the Report. The TCEQ solicits data and information primarily through the established public outreach mechanisms of the Texas Clean Rivers Program (CRP), including steering committee meetings, public meetings, and publications, and by posting drafts of the Report on the TCEQ Web site.

The TCEQ and the EPA recognize that there are some boundaries that must be established for the data and information ultimately used for listing. These boundaries are:

- **Time limitations**. In most circumstances, data collected prior to the most recent seven-year assessment period do not adequately reflect current conditions.

- **Data quality**. Given the regulatory implications associated with the use of water quality data, the TCEQ requires the highest quality data feasible. Data collected using consistent and scientifically rigorous water quality sampling methods ensures a valid outcome.

Data must therefore meet minimum quality assurance and quality control requirements established by the TCEQ. Data that are not collected under a TCEQ-approved quality assurance plan, if submitted, must be accompanied by documentation of quality assurance for evaluation by TCEQ water quality staff. Data without appropriate quality assurance documentation will be considered as anecdotal evidence to support or refute assessment results, but will not be used in statistical evaluations.

- **Data format**. All data must be in a form that does not require extensive data format manipulation to be useable for assessment. TCEQ provides guidance and support to monitoring entities that allow them to submit data in an appropriate and consistent format.

In order to increase the data available to the TCEQ for water quality assessment purposes, TCEQ staff work closely with local and regional agencies and other interest groups to develop and implement data collection procedures under an established quality assurance and quality control program.

Readily Available Data and Information

Readily available data are defined for the purposes of the assessment as :

- **Routine surface water quality data stored in the TCEQ integrated database**. These data are used to conduct the assessment and to compile the draft Report. This database consists of water quality data collected by the TCEQ, the U.S. Geological Survey (USGS), the Texas Department of State Health Services (DSHS), the Texas Parks and Wildlife (TPWD), Texas State Soil and Water Conservation Board (TSSWCB), and Clean Rivers Program (CRP) planning agencies and their associated partners.

- **Routine data and information obtained from other sources**.
  - Fish consumption advisories, aquatic life closures, and oyster waters closures issued by the DSHS.

  - The Chemical Monitoring System database of the TCEQ Water Utilities Division, which includes data on finished drinking water quality for pollutants related to surface water quality. Drinking water system samples are collected under quality assurance project plans in compliance with regulations passed in support of the federal Safe Drinking Water Act.

Other Data and Information

To refine the draft Report, the TCEQ relies on formal public comment to solicit additional data and information that support the listing process. These additional data and information can be used to support or refute results of the initial data assessment and to revise the category of water bodies. These data and information may also be used to direct future water quality monitoring activities. In all cases, the value and accuracy of these data are determined by TCEQ water quality staff.

Categorizing Water Bodies

Chapter 5 provides an in depth discussion of categories assigned to segments and the management strategies associated with each category. To summarize, one of five categories is assigned to each impairment parameter in each segment that affects the use of the water body as

defined in the TSWQS. When a segment falls into more that one category because of different impairments, its overall category is the highest numbered category assigned to any one use.

- **Category 1**. Attaining all water quality standards and no use is threatened.
- **Category 2**. Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
- **Category 3**. Insufficient data and information are available to determine if any water quality standard is attained.
- **Category 4**. Water quality standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.
  - **Category 4a**. TMDL has been completed and approved by EPA.
  - **Category 4b**. Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.
  - **Category 4c**. Nonsupport of the water quality standard is not caused by a pollutant.
- **Category 5**. The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
  - **Category 5a**. A TMDL is underway, scheduled, or will be scheduled.
  - **Category 5b**. A review of the water quality standards for the water body will be conducted before a TMDL is scheduled.
  - **Category 5c**. Additional data and information will be collected before a TMDL is scheduled.

Removing a Water Body from the 303(d) List

Water bodies are removed from the 303(d) List for any one on the following seven reasons:

- **Standards are met**. Additional monitoring data demonstrate that a water body meets applicable water quality standards.
- **Errors in listing**. Errors in the data or procedures used to list the water body invalidate the original basis for listing.
- **New procedures used**. Procedures used by the state to assess water quality monitoring data are routinely improved and revised. In the absence of recent data, the original data set for a listed water body may be reassessed with more accurate procedures and be found to attain the standard or criteria. The strength of the data set and quality of the water must also meet the requirement for delisting using revised methods. Note that the current 303(d) list includes historical listings established with instantaneous measurements of dissolved oxygen (DO) screened against the 24-hour average criterion. These have been reviewed in the current and past assessments. Where both the original listing would not have been made and current DO data are available to show no indication of impairment, the listings have been removed based on the judgement of the assessor. Where there are indications from recent data of poor water quality, 24-hour DO monitoring is being conducted to determine attainment.

- **New standards**. Water quality standards and criteria have been revised, and a listed water body attains the new standards or criteria.
- **TMDL approval**. The EPA approves a TMDL designed to attain water quality standards for a water body—Category 4a.
- **Water body expected to meet**. Based on water quality controls in place, attainment of the water quality standards is expected in the near future—Category 4b.
- **Impairments not caused by a pollutant**. New information demonstrates that the impairment is not caused by a pollutant, and that water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process.—Category 4c.

Note that for Category 4 impairments, because there are water quality controls in place, or the non-support is not amenable to TMDL processes, impairments are removed from this category when water quality standards are attained.

Public Participation

The draft Report, including the 303(d) List, is posted on the TCEQ Web site. Stakeholders and the public are alerted of opportunities to comment through a notice of publication in the Texas Register. The CRP has contracted with the river authority or other local water quality management entity in each major river basin to engage a diverse stake holder group. TCEQ distributes notification of opportunities to comment through the stakeholder process.

Comments, data, and information must be submitted during the formal public comment period in written form, via letter, facsimile transmission, or e-mail, to ensure an accurate record of the concerns of the person or group submitting them. Comments received during the comment period are considered in the development of the final Report. Those who comment will not be notified that their comments were received.

A summary of all comments received during the formal public comment period, along with the TCEQ's response to those comments, will be published with the draft Report on the TCEQ Web site.

Preparation of the Schedule for TMDL Development

In compliance with CFR 130.7(b)(4), the TCEQ prepares a schedule for the TMDLs that TCEQ expects to develop and submit to the EPA within the next two years. The TMDL schedule is submitted to the EPA along with the Report. The TMDL schedule is a plan. Additional factors, not known at the time of the schedule development, may alter the time required to complete the TMDL and hence the date of submission to EPA. The two most significant factors are a change in funding availability, and a change in the degree of complexity of a TMDL.

Preparation of the Final 303(d) List

During the comment period on the draft Report, TCEQ staff evaluate the data and information received and respond to requests for information. TCEQ staff modify the Report (including the 303(d) List) as appropriate, considering sound science and legal requirements. This may result in:

- Removal of a water body or a parameter from the 303(d) List.
- Addition to the 303(d) List of water bodies or parameters not on the draft list.
- Changes in category.

At the direction of the Commission in public worksession, the final 303(d) List, the TMDL Schedule, and supporting materials and summary documents are submitted to EPA. The supporting materials include, but are not limited to:

- The most recent *Guidance for Assessing and Reporting Surface Water Quality in Texas*
- A list of water bodies or pollutants removed from the previous list, along with reasons for delisting.
- A summary of public comments on the draft 303(d) List , and the TCEQ's response to the comments.
- A summary fact sheet for each water body describing the status of use support.
- The a summary of assessment data and information used.

The final submission is also available for public review on the TCEQ Web site, **http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/305_303.html** and by mail upon request by telephone, mail, or e-mail.

CHAPTER 2
GENERAL ASSESSMENT METHODOLOGY

Introduction

The TCEQ administers water quality management programs with the goal of protecting, maintaining, and restoring Texas water resources including the support of aquatic life, recreation, fishing, and drinking water supplies. The Texas Surface Water Quality Standards (TSWQS), TCEQ Rules Chapter 30, recognize the regional and geologic diversity of the state by dividing major river basins, bays, and estuaries into defined segments (referred to as classified segments). Appropriate water uses—such as aquatic life, contact recreation, or oyster waters—are designated for each of the classified segments. Site-specific criteria developed for classified segments to evaluate general uses—water temperature, pH, chloride, sulfate, and total dissolved solids (TDS)—apply to all classified segments but not to unclassified water bodies. The TSWQS most recently approved by the EPA will be used for the assessment.

Numerical criteria (water quality parameter concentrations) established in the TSWQS provide a quantitative basis for evaluating use support and for managing point and nonpoint loadings in Texas surface waters. These criteria are used as maximum or minimum instream concentrations that may result from permitted discharges and nonpoint sources. The procedure for assessing instream water quality against numerical criteria is specified in the TSWQS. The development of this guidance and each assessment decision involves judgement in application of the water quality standards. Best professional judgement comprises the use of expert opinion and judgement based on available data and site-specific conditions.

The TSWQS also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions, such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor-producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated by using screening levels, if they are available, as well as other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Narrative criteria, a form of general criteria, are applied to all classified and unclassified waters. The assessment methods for determining compliance with the narrative criteria are not based on adopted numeric criteria by rather an assessment practice prescribed in this guidance. In the absence of adopted numeric criteria, all available lines of evidence must be considered when making listing decisions, including professional judgement.

Texas Drinking Water Standards (TDWS), Texas Administrative Code, Chapter 30, Sections 290.101-121, and revised in September 2000, ensure the safety of public water supplies. Numerical criteria established in the TDWS for *finished water* (after treatment) provide a quantitative basis for evaluating support of the public water supply use.

Instream concentrations of nutrients and chlorophyll *a,* toxic substances in sediment, and toxic substances in fish tissue are useful in identifying water quality concerns and in evaluating the causes of nonsupport of the narrative standards. Numerical criteria for these constituents have not been established in the TSWQS. The screening levels (instream concentrations) for these parameters establish targets that can be directly compared to monitoring data. The screening levels are statistically derived from longterm monitoring data for this guidance or are based on published levels of concern. Recent monitoring data are compared to the screening levels to identify areas where elevated concentrations are causes of concern.

Summary of Changes in Methods Implemented for 2008

Changes in Requirements for Data and Information

- The 2008 assessment will consider all available water quality data and will focus on several specific groups of water bodies. In an effort to ensure that all readily available data and information are considered, TCEQ will assess data collected from all classified segments, other segments with a pending regulatory reason for evaluation or the need to initiate or revise planning activities such as a TMDL or standards revision, and some DO listings that are carried forward from previous listings. TCEQ will rely on cooperators, such as local, state, or federal agencies, members of the general public, or academic institutions to identify data or information that indicates water quality problems that may change the standards attainment status of other segments [as described in 40 CFR 130.7(b)(5)(iii)]. The 2008 Texas Quality Inventory and 303(d) List will report a support status for all water bodies and a category for all impaired parameters. The following water bodies will be a specific focus for assessment and others will have their current support status carried forward from 2006:

  - Classified segments (374 water bodies identified in TSWQS Appendix A).
  - Water bodies with a compelling need to initiate or revise planning activities such as a TMDL or standards review.
  - Water bodies where a regulatory decision is pending or will be made in the near term, before the next list is approved.
  - Carry forward DO listings from the 2000 303(d) List or earlier, based on grab samples compared to the average criterion.
  - Carry forward bacteria listings based on fecal coliform that now have adequate E. coli samples for assessment.

- The period of record for the 2008 assessment is seven years (rather than five) for parameters with adequate datasets, and up to ten years if needed to attain a minimum data set of ten samples (as we did for 2006). This change to seven years from the current five years of data for assessment will increase sample sizes and make the dataset less influenced by one or two

years of atypical climatic conditions. The assessor will use judgment in the use of older data if it is apparent that water quality has improved or deteriorated recently and that this change is likely permanent (e.g., rather than a short-term drought condition).

Changes in Assessment Method and Calculations

- The use of a Confidence Interval around a Percentile (CIP) was discussed as a statistical method for some parameters by the stakeholder advisory group. The CIP method evaluates confidence intervals around a specific percentile of the dataset and considers both the frequency and magnitude of exceedances. When applied to environmental data which may be highly variable this may result in a wider range of values than is appropriate for determining concern or support status. The CIP method is complex and would be difficult for stakeholders to reproduce without specialized computer programs or to communicate to the public. The adoption of new statistical methods will be delayed and the current binomial method will be employed for the 2008 assessment. A Statistics subgroup has been formed for the 2010 assessment guidance. This group will continue to explore statistical methods that consider both the frequency and magnitude of exceedances.

- The stated requirement for attainment is that 90% or more of the samples meet the criteria for conventional parameters. Previous methods for delisting, two less exceedances than required to list, occasionally allowed delisting when more than 10% of the samples exceeded. For 2008, exceedances rates will be applied as simple percent exceedances, not to exceed 10%, 25% and 8% for conventionals, bacteria, and toxics respectively. Some judgment may be used by the assessor if the percentage and magnitude of the exceedances are marginal.

- The discussion of spatial and temporal representativeness has been expanded.

- DO conditions are important to aquatic life in all seasons and TCEQ recommends evaluation of 24-hr DO data collected year-round. To allow seasonal representation, the requirements will be changed to require that no less than one-half and no more than two-thirds of the samples be in the index period, and no less than one fourth and no more than one-third be in critical period (months within the index period that are characterized by lowest flow and highest temperatures). The remainder of the samples can be collected outside the index period. These new requirements will require several years to phase in. The objective in making this change is to allow the assessment of data collected throughout the year. Because most existing data sets are from the index period, in 2008 we can require only that at least half of the samples be from index period, which will allow the use of existing samples outside the index period.

- Some of the older DO carryforward listings were developed solely from evaluating grab DO data with the 24-hr DO average criterion. This is not consistent with the TSWQS because this criterion is to be evaluated with the average of a 24-hr dataset. DO grab data are, however, evaluated with the DO minimum criterion. The appropriate method of evaluating DO data was adopted in 2002 assessment guidance, but some of the older listings may have been made

with the obsolete method, comparing grab DO data to the average criterion. In order to resolve this issue a step-wise procedure for evaluating the older DO carryforward listings will be made in 2008:

1) If there are enough 24-hour data to assess for DO, then the current data will be evaluated. Many of the water bodies listed years ago will now have an adequate 24-hour dataset in 2008 since DO listings have been targeted for this type of monitoring for several years.

2) If there is not enough 24-hour data to assess for DO, then re-evaluate the original dataset that listed the water body will be re-evaluated using the current binomial assessment method for grab DO data which compares measurements to the minima. If the water body was not impaired at that time, then the impairment will be delisted provided that these are recent grab data that indicate good water quality.

- Habitat datasets that indicate the habitat condition is not supporting (using the habitat index) will be reported as Concerns rather than Not Supporting.

- Samples generated by EPA Region 6 TOXNET Program will be evaluated as Concerns when consistent (> 50% and based on the judgment of the assessor) sublethal effects are identified. Where such concerns for sublethal effects are identified with TOXNET samples, subsequent testing using conventional water toxicity testing methods will be initiated to confirm sublethal effects. The water body may be listed based on lethal effects demonstrated with TOXNET samples, and with conventional water toxicity testing methods exhibiting lethal or sublethal effects.

- Hardness for use in determining aquatic life criteria will be calculated in the following manner based on approximately 30 hardness samples. Note that although these hardness values are used for calculating criteria for assessment, the target criteria (based on hardness) for TMDLs must be conservative, unchanging, and meet these criteria for assessment:

  - **Classified segments**. The 15th percentile of hardness will be assigned to the segment. These are published in the implementation procedures, RG-194.
  - **Unclassified segments**. The available data will be used to determine and assign the 15th percentile of hardness to the segment. When there are insufficient data to develop this default hardness, use the values published in RG-194 for the classified segment will be used.
  - **Assessment Unit (AU) for classified and unclassified water bodies**. The available data from the AU will be used to determine and assign the 15th percentile of hardness to the AU. The assessor can develop a rationale for using an alternate percentile, perhaps the 50th, when it is more appropriate for the AU.

- **Station**. The available data from the AU will be used to determine and assign the 15th percentile of hardness to the station. The assessor can develop a rationale for using an alternate percentile, perhaps the 50th, when it is more appropriate for the station.

- When most of the reported values for a parameter are nondetects, and the reporting (detection) limit is significantly greater than the criterion, the samples are not used for calculation of averages or percent exceedances (in terms of significantly greater… note that a margin of safety of about two for aquatic life and five to ten is incorporated into criteria). A status of Not Assessed may be identified, rather than Fully Supporting or No Concern. The assessor will use judgment when identifying parameters as fully supporting or delisting when the dataset includes nondetects.

- For sediment toxicity assessment, all available lines of evidence and their weight will be considered within hydrologically similar (in terms of sediment conditions) assessment areas, in contrast to previous assessments where each station was independently evaluated. Although sample data from the entire assessment area are considered together, assessors must be aware of hot spots that pose significant environmental risks which may be of smaller scale than the assessment area.

- Where the Agency determines methods proposed for a sediment toxicity evaluation project to be acceptable, the methods may be used for evaluating the health of biological communities as a Line of Evidence. Scientifically valid methods to evaluate the health of biological communities should be considered, for example those using least-impacted reference conditions.

- Assessments based on fecal coliform are being phased out. Note, when only fecal coliform data are available, fecal coliform will be used to determine use support and listing. Bacteria impairments based on fecal coliform will be delisted with either fecal coliform or the new indicators. Bacteria listed with the new indicators will only be delisted with the new indicators.

- For oyster water assessment, when waters which are administratively closed without actual data indicating poor water quality, the status will be identified as Not Assessed. Areas that are administratively closed <u>and</u> that exhibit water quality that is not good enough to allow shellfishing will be listed.

- The Surface Water Concern assessment method for Public Water Supply Use (for TDS, chlorides and sulfate) will be discontinued. The water quality standards include segment specific criteria for these parameters which consider PWS attainable uses. These are already assessed and reported for attainment of General Uses and this assessment method is duplicative.

Spatially Representative Data

Geographic Areas for Assessment

The term "water body" is used in a non-specific way to refer to a stream, reservoir, or estuary. A water body is generally divided into one or more segments. The Brazos River, for example, is divided into 48 segments. Classified segments are "water bodies" defined in Appendix A of the TSWQS. These segments have designated uses and water quality criteria. Each segment is given a number which identifies the river basin and segment. For example, the Brazos River Tidal segment number (SEG_ID) is 1201. The next upstream most Segment is 1202.

Water bodies not defined in Appendix A of the TSWQS are considered unclassified segments. For the purpose of the assessment, unclassified segments not in the TSWQS will be referenced to the classified segments described in the Appendix A. Each unclassified water body is given a number which ties it to the classified segment with a letter designation. For example, 1201A, is a small stream which flows into Segment 1201 of the Brazos River.

Certain unclassified water bodies have been given site specific designations and are listed in Appendix D of the TSWQS. These water bodies will also be referenced to a classified segment with an alpha-subscript (for example, 1006D).

For the purpose of the assessment, use support is reported for both segments and subareas of segments. Subareas are known as *assessment units (AU)*. A segment may consist of one or more AUs. Support of criteria and uses are examined for each AU (smallest geographic area of use support reported in the assessment). Regulatory decisions apply to the entire AU.

Considering the Representativeness of Stations

Water quality standards and criteria are set to protect the attainable uses for each water body. Sample sites used for ambient water quality monitoring are located in areas determined to be reasonably characteristic of major hydrologic portions of the water body and where the criteria are expected to be attained. Representative sites for stream sample collection should be placed in areas of good flow or circulation. For reservoirs, sites should be located downstream of headwaters and away from shorelines and isolated coves. Arm sites should be chosen nearer the main body of the water body than the riverine tributary areas. For biological sampling, all habitat types are sampled for characteristics of the fish community, while optimal available habitat, for example cobble substrate riffles, are sampled for benthic macroinvertebrates. The assessor can use judgment in determining if sites are representative of an assessment area and if it is appropriate to apply criteria to the data. Note that the TSWQS 307.9(b) states, "Representative samples to determine standards attainment will be collected at locations approved by the Agency. Samples collected at non-approved locations may be accepted at the discretion of the Agency".

As an alternative to using more than one station, only the single, most representative site in an AU could be used to characterize standards attainment. The assessment at the other stations can be reported in the assessment, but based on the assessors judgement, not used to determine use support or concerns for the AU.

Assessment Units

Each area of assessment is known as an AU which is defined as the smallest geographic area of use support reported in the assessment. Each AU within a water body segment is given a number such as AU_01. A segment may consist of one or more AUs.

There are two general types of AUs:

- Primary segment AUs which are hydrologically defined: They can be the entire segment or parts of the segment, but the cumulative size of all the primary segment AUs must add up to the total size of the segment. Numbering convention 0101_01, 0101_02.
- Special purpose AUs which are defined by available information such as oyster water maps, fish advisories, or special assessment (such as sediment or fish surveys) and may each cover part of the segment but must also add up to the entire segment. Numbering convention for special purpose AUs are,

    - Oyster waters—2439_OW1, 2439_OW2
    - Fish advisory—2451_FA1
    - Special assessments (sediment, fish survey)—2422_SA1, 2422_SA2

All assessment methods and use attainment status are reported for each of the primary segment AUs. In some instances, the use and assessment method summary statistics will be calculated across the entire segment, for example, some general uses, and this same information will also be reported for each of the primary AUs.

More than one AU can describe the same parts of a segment. For example, the entire segment can be made up of two smaller AUs—AU_01 and AU_02. Or, 1403_SA1 can be a sediment survey that applies to the lower part of the segment and includes primary AU 1403_03 and 1403_04. The results of the sediment survey will be repeated for each of these primary AUs (_03 and _04).

AUs do not have to be contiguous; for example, the various marshy fringe areas of a lake can make up one of the primary AUs.

For fish consumption and oyster water assessments, the stream length or area defined as the AU should be determined by the information made available by the responsible regulatory entity rather than hydrology. Such information may include sediment surveys, areas in which the fish population was sampled, oyster water maps, or fish consumption advisories.

Defining Assessment Units

To address water quality regulatory activity such as permitting, standards development, and remediation, use support information is provided at the AU level. The 303(d) list is reported at the level of the AU for each segment.

An AU may have one station, several stations, or no stations if it is in an unmonitored part of the segment. Stations are assigned to only one AU within the same AU type, and do not have to be grouped the same way for other AU types.

An AU can be assessed using only one station that is selected as most representative, or using data combined from several stations. Even when several stations are used, the assessor may choose to assess an individual station and report the results for that station. That station specific assessment is descriptive of the station rather than a subarea of the AU.

Improvements will be made in successive assessments by redefining AUs to more closely represent hydrologically distinct areas of streams, reservoirs, and estuaries. To give consistency year to year, the numbering of AUs will be unchanged if boundaries are shifted a little, even if a station is reassigned to an adjacent AU. However, when AUs are combined (because they are not hydrologically distinct areas) or when AUs are split, the description and AU numbering will be changed to better represent the assessment area. The National Hydrography Dataset (NHD) will be used to georeference the assessment results. Often stream paths extend up into the upper watershed. Because we assess "water in the state", as defined in the TSWQS, when the TCEQ water programs identify a regulatory need to define the extent of "waters in the state", the assessment areas will conform to their delineation.

Stream AUs. The upstream boundary of the most upstream primary AU is based on yield of the upstream watershed or the flow, which may be calculated from watershed size and corrected for rainfall. Alternatively, the boundary may be the upstream boundary of a classified segment, or the upstream boundary of a water body identified in Appendix D of the TSWQS. For streams described in Appendix D, the entire length typically constitutes one AU (see Figure 2-1).

However, if it is evident that hydrology and water quality conditions are different within the area described in Appendix D, based on water quality sampling and flow information, the segment can be split into more than one AU, with the same criteria applied to all AUs (See Figure 2-2).

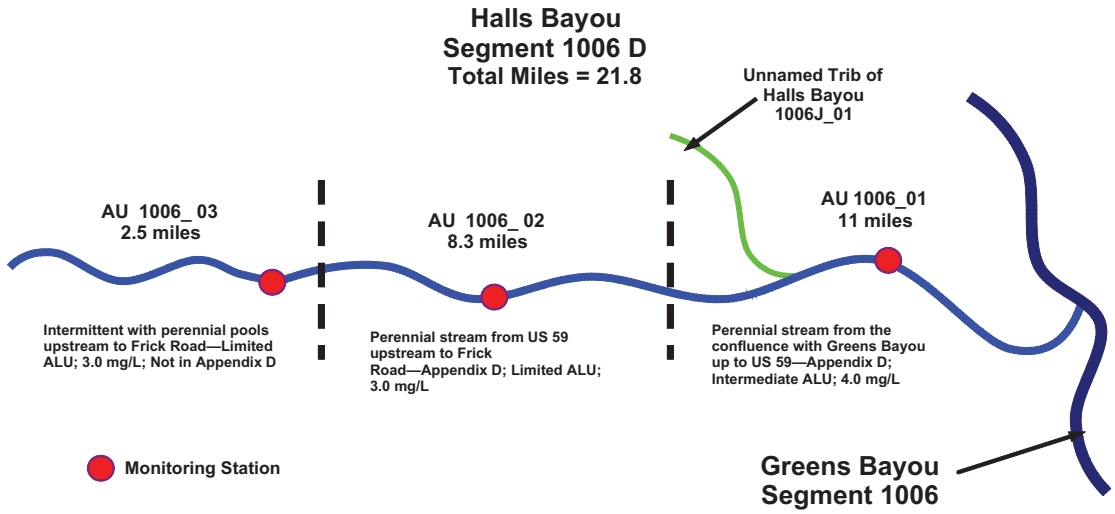

Figure 2-1. A water body divided into three AUs with two defined in Appendix D and one with a presumed ALU.

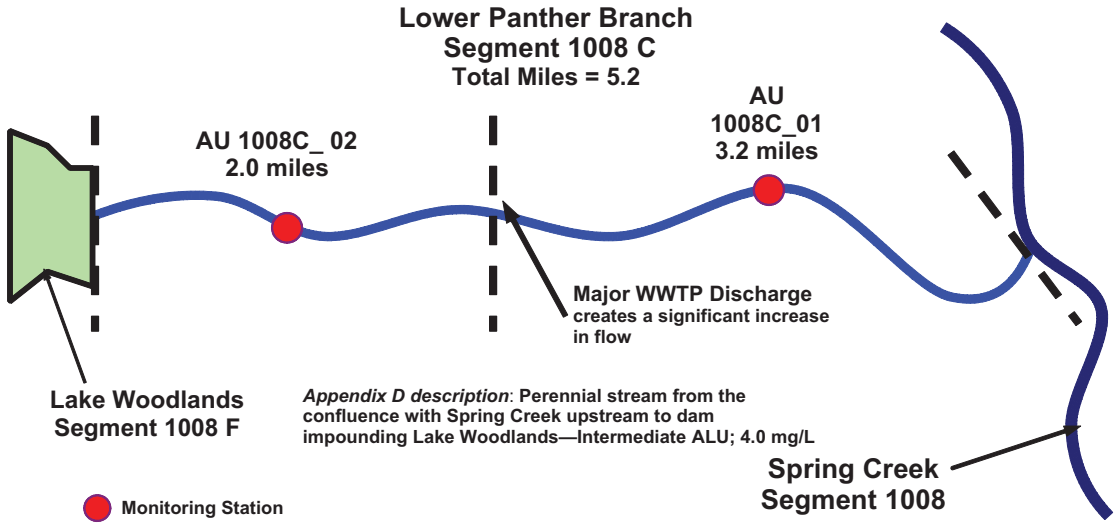

Figure 2-2. Appendix D defined water body divided into two AUs to reflect a significant change in flow.

As a rule of thumb, the downstream boundary and start of another AU is the point where the flow increases by 25% due to a confluence with a tributary or wastewater outfall since that can change water quality or the assimilative capacity of the AU. The high impervious cover of a city may also result in a significant increase in flow. AUs may also be based on tributary inflows that have the potential to influence water quality in the parent segment (see Figure 2-3).

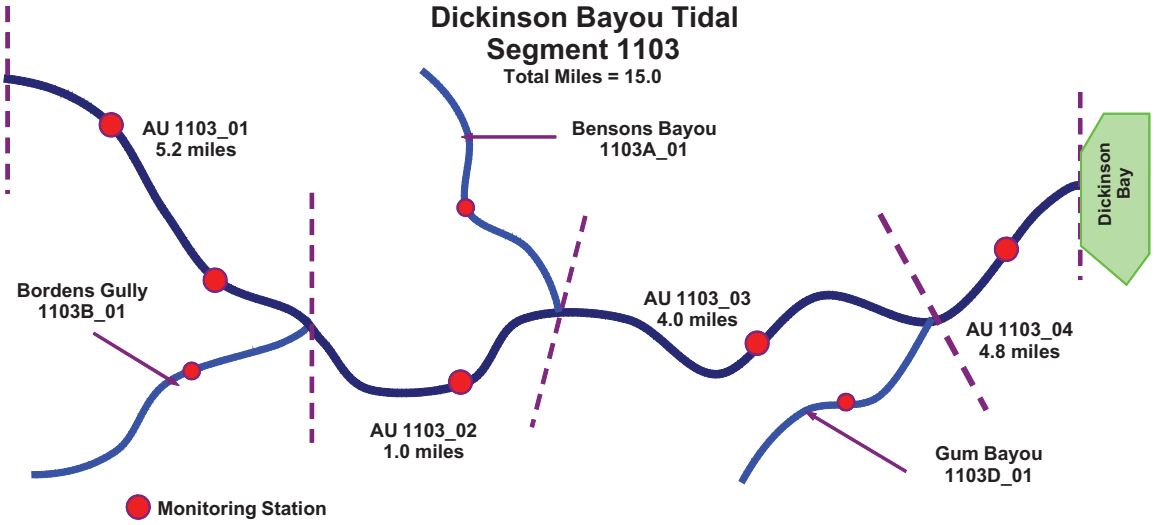

Figure 2-3. Water body divided into four AUs to reflect inflow from water bodies with the potential to influence water quality in the parent segment.

Note: The examples used in Figures 2-1 to 2-3 are based on actual water bodies included in the assessment but may have been modified to illustrate various AU selection scenarios.

As a rule of thumb, stream AUs are no more than 25 miles in length. Because the AU represents an area of similar hydrology, a station located anywhere in the AU ideally represents water quality conditions in the entire AU. Stream stations have a length of stream both upstream and downstream of the station, ideally half the length of the AU, that they characterize. This length is about 12.5 miles (half the 25 miles typically represented by an AU), and the distance covered by all of the stations in the AU should be 70% of the AU length.

Reservoir and Estuary AUs. Primary AUs are defined as hydrologically distinct arms or areas of the reservoir. The rule of thumb for most reservoirs is an AU representing the main body near the dam, and in each major arm or the upper part of the reservoir.

To meet the goals of the monitoring program, a reservoir or estuary with more than one AU has at least one AU representing the central area of the water body and one AU for each major tributary arm that receives drainage from more than 40% of the contributing watershed. The reservoir or estuary can also be divided into AUs at hydrologic constrictions that form distinct embayments.

Ideally, each station is at the center of a concentric assessment area and an AU is not assessed if the overlapping assessment areas from the stations describe less than 70% of the area of the AU. Tables 2-1 and 2-2 describe the assessment by stations on reservoirs and estuaries derived from historical practices. Linear distances describe for stations may be less if there are other stations representing hydrologically distinct areas.

Table 2-1. Assessment Units for Reservoirs

Size (acres)*	Number of AUs	Typical Linear distance described by station (miles)**
3000 or less	1 or more	1
3000 - 6000	2 or more	2
6000 - 10000	3 or more	3
10000 or greater	4 or more	3

* 3000 acres/640 equals 4.7 sq mi; ** radius of the assessment area

Table 2-2. Assessment Units for Estuaries

Size (square miles)	Number of AUs	Typical Linear distance described by station (miles)**
< 3	1 or more	1
3- 10	2 or more	2
10 - 50	4 or more	3
> 50	5 or more	3

** radius of the assessment area

Depth of Water Quality Measurements

Surface measurements—typically collected at a depth of one foot (0.3 meters) from the water surface—are generally used for assessing the following: water temperature, chloride, sulfate, TDS (or specific conductance), nutrients, chlorophyll *a*, fecal coliform, *E. coli*, and Enterococci. Samples collected by the USGS that are *composited* over depth (using equal-discharge-increment or equal-width-increment methods) may also be utilized in an assessment. In deep streams, reservoirs, estuaries, and the Gulf of Mexico, dissolved oxygen (DO) and pH measurements made in profile over the entire *mixed surface layer* are evaluated. For toxic substances in water, *individual surface grab samples are evaluated. If samples are available for the same day at multiple depths, criteria expressed as averages are evaluated as surface-to-bottom composite samples*.

Determination of the Surface Sample and Mixed Surface Layer

Surface sample results are used to evaluate temperature, sulfate, chloride, TDS (or specific conductance), nutrients, and chlorophyll. Samples collected at any depth are used to evaluate toxicity, although only surface samples are routinely available. *The surface sample is typically collected at 0.3 meters, or is the shallowest sample, not deeper than 1.5 meters. The first sample or profile collected for the day is used for the assessment.*

A water column profile is done by taking measurements at consistent depth intervals (depth intervals determined by the total water depth). The profile measurements should be made within one hour of the collection time of the surface water sample. Procedures for measuring depth or vertical profiles in reservoirs, deep rivers, bays, and barge and ship channels greater than 1.5 meters (5 ft) in depth are outlined in the most recent version of Chapter 3 of the *SWQM Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue*.

For reservoirs, the *mixed surface layer* in a water column profile is defined as the portion of the water column from the surface to the depth at which water temperature decreases more than 0.5 degrees Celsius. DO (mean of measurements) and pH (median of measurements) criteria apply to the entire mixed water column when a profile of measurements is reported and the water column is not stratified, or only to measurements made in the mixed surface layer if the water column is stratified. In rare instances, large declines in DO or pH may occur with depth within the mixed surface layer defined by water temperature, or a superheated layer at the surface may constrict the mixed surface layer by this definition. Best professional judgment may then be used to determine which DO and/or pH measurements are assessed from the mixed surface layer. The information considered for this decision will be recorded and made available in the assessment files.

The mixed surface layer for tidally influenced water bodies is defined as the portion of the water column from the surface to the depth at which the specific conductance is 6,000 µmhos/cm greater than the conductance at the surface. DO and pH criteria apply to the entire mixed water column when the water column is not stratified, or only to measurements made in the mixed surface layer if the water column is stratified. On occasion tidal areas may temporarily have fresh water, and the mixed surface layer is determined by considering temperature.

Monitoring personnel often make vertical field measurement profiles in deep freshwater and tidal streams. In these cases, the surface sample and profile are determined using the same method described above for reservoirs and estuaries.

An alternate method for determining the mixed surface layer that may be more useful, especially in the transition from fresh to saltwater, is the use of the density profile, calculated from TDS (specific conductance) and temperature. This approach will be considered for future assessments.

Determining the Extent of Tidal Influence

In most cases, the extent of tidal influence in freshwater streams that drain to tidal streams, estuaries, or the Gulf of Mexico, is determined by making field measurements (specific conductance and salinity), collecting water samples (TDS and chloride), and observing level recorders sequentially upstream from the streams' mouth over several complete tidal cycles. A water body is considered *tidally influenced* when there is observed tidal activity, TDS is greater than or equal to 2,000 mg/L, salinity is greater than or equal to 2 parts per thousand, or specific conductance is greater than or equal to 3,077 µmhos/cm. In the absence of monitoring data, the

tidal limit in a freshwater stream is approximated as the point where the 5-foot contour line (5 feet above average sea level) on a USGS topographic map crosses the stream. Marine criteria developed in the TSWQS apply to all tidally influenced streams (classified and unclassified), estuaries, and the Gulf of Mexico.

Temporally Representative Data

Frequency and Duration of Sampling

The assessment must use a sample set that is temporally representative of conditions in the assessment area. Optimally, sampling should be routinely scheduled over several years and at a minimum of two years, with approximately the same intervals of time between sampling events. This routine sampling plan results in monthly or quarterly sample data sets which are considered temporally representative of long-term conditions.

In some instances where water quality has dramatically improved or declined recently and there is good cause to believe the change will be persistent, the assessor may determine it is appropriate to use only the more recent and representative data set for assessing specific parameters likely to be affected by the changed conditions. These changes in water quality could be due to identified permanent changes in pollutant loadings, such as a new treatment facility, implementation of best management practices, or hydrologic changes.

Sediment and fish tissue samples generally do not vary greatly over time and are considered useful integrators of water quality over time and space. Fish and sediment samples collected as part of a one-time special monitoring event may be used in the assessment. For example, ten fish samples collected on the same day from a water body would meet the minimum sample requirement, as would ten sediment samples collected within a hydrologically-related area of a water body.

The most recent advisory or closure issued by the DSHS is used to determine support of the fish consumption use; although, sometimes these may have been issued in years prior to the period of record for the assessment.

Considering the Representativeness of Sample Events

To provide a temporally balanced data set, water sampling events should be collected on a routine frequency, for example each week, month, or quarter. Such a sampling regime will assess a range of flow and temperature conditions. An exception is sediment and tissue samples which have no such temporal requirements.

Samples from monitoring projects that are determined to bias the data set will be excluded. These may include data collected as part of a complaint investigation, equipment test, or a focused short term special study targeting specific conditions. Sampling projects targeted to high or low flow conditions may generate biased datasets. Such data can be used to add to a narrative for the water body assessment and may be useful for planning follow-up monitoring, but, in general, should not be used in the calculation for determining use support, listing, or delisting. Routine data may be collected during high flows or storm events and will be considered as part of the assessment dataset. Special study data that is determined to be ambient by design, e.g., monthly TMDL monitoring, may be used in assessment.

Other sources of data and information, for example volunteer monitoring, compliance monitoring and complaint investigations can be used to plan future monitoring and develop adequate datasets to characterize water quality conditions and document sources of pollutants.

Samples from the same day or month will be used from different stations, or from different routine programs at the same station, if they comprise a routine data set or were collected at a consistent frequency that independently meets temporal requirements for number of years and seasonality.

When samples that temporally bias the data set must be removed, samples in the remaining temporally representative data set will be those collected earliest, provided that they are collected after 8:00 am. The samples that are not used, however, may be considered by the assessor to determine if they, in fact, identify a water quality concern.

For criteria expressed as a 24-hour average, a time-weighted average will be calculated (see SWQM Volume 1 Manual for the method). This calculated value will be available as a parameter value (assigned to a reported STORET code).

As an alternative to using more than one station, only the single, most representative site in an AU could be used to characterize standards attainment. The assessment at the other stations can be reported in the assessment, but based on the assessors judgement, not used to determine use support or concerns for the AU.

Seasonal Requirements

- Samples must be collected over a minimum of two years (though not necessarily consecutive).

- No more than two thirds of the samples can be collected in any one year (defined as approximately 12 consecutive months).

- No more than one-third of the samples should be from any one of the four seasons

- If most of the samples are collected twice yearly, samples must represent the warm half of the year (approximately March 15 thru October 15) and cool half of the year (approximately October 16 thru March 14) of both years. No more than two-thirds of the samples should be from one of these two distinct parts of the year.

- If more samples are collected than needed for any particular time period, samples from the routine monitoring program or those with the earliest collection date (for each week, month, or half year, dependent on routine sampling frequency) will be used as a systematic and unbiased method to select a representative data set for assessment. The samples that are not used, however, may be considered the assessor to determine if they, in fact, identify a water quality concern.

- There are a specific seasonal requirements for biological (see "Determining Overall Aquatic Life Use" in Chapter 3) and 24-hour DO measurements (see "Dissolved Oxygen" in Chapter 3).

- Sample events should be separated by approximately equal time intervals.

- Samples using more accurate methods or indicators may be used preferentially over older data.

- More recent data that meet the requirements for a representative data set may be used, and older data excluded, if the water quality is known to have changed, and there is evidence that these changes will persist.

Period of Record

The 2008 assessment period of record for the last seven years is December 1, 1999 through November 30, 2006. Samples from these seven years are evaluated when available, and if necessary, the most recent samples collected in the preceding three years (December 1, 1996 through November 30, 1999) can also be included to meet the requirements for minimum sample number.

Minimum Number of Samples

At least 10 samples over the seven-year period of record are required for assessment of use attainment (listing and delisting). However, less than the required number of samples can be used to identify nonsupport for use attainment parameters if the threshold number of exceedances for these parameters is met when using the binomial method (See "Small data sets indicating nonsupport below"). Use attainment and concern assessment parameters are identified in Table 2-3. Concerns can be identified with as few as four samples. This count of samples *does not include those measurements or samples that are excluded for use in calculations*, for example events when flow is below the 7Q2 on perennial streams. Samples collected from multiple monitoring

stations in an assessment area may be aggregated to meet the minimum sample requirement. All assessment methods based on the *average* will require 10 samples for listing and delisting, although in rare instances the assessor will make the use attainment decision with fewer samples and indicate this by reporting a data set qualifier of JQ (based on judgement of the assessor).

Each assessment method (parameter) is evaluated independently for minimum sample number. These minimum sample numbers were chosen to allow confidence in the assessment, while making the best use of limited monitoring resources. All stations with four or more temporally representative samples are assessed, although it may not be possible to establish use support with so few samples. Water bodies recently monitored, but with small data sets that are not temporally representative, will be listed in the narrative for the classified segment watershed.

Extending the period of record and minimum number of samples to increase confidence in listing and delisting. In order to ensure that minimum sample size requirements can be met for determining use support, the period of record will be extended back in time, up to ten years, until the minimum number of samples are identified. At least half of the samples (five samples) must come from the most recent seven-year sample period. This will establish use support for more water bodies and parameters, and will report more recent water quality conditions than our previous practice of carrying forward the assessment information from only the last period that had a complete data set.

Table 2-3. Sample Size Requirements for Assessment Methods

Use	Assessment Method	Use Attainment or Concern Assessment	Minimum Sample Sizes and Levels of Parameter Support for Data Qualifier (see Table 2-4 for definitions of levels of support and data qualifier)		
			ID Inadequate Data	LD Limited Data	AD Adequate Data
Aquatic Life Use	Dissolved oxygen 24-hr average	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Dissolved oxygen 24-hr minimum	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Dissolved oxygen grab minimum	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Dissolved oxygen grab screening level	C	<4 NA	4-9 CS, NC	10 CS, NC
	Acute toxic substances in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Chronic toxic substances in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Acute ambient toxicity tests in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Chronic ambient toxicity tests in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	TOXNET ambient toxicity tests in water - lethality	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	TOXNET ambient toxicity tests in water - sublethality	C	<4 NA	4-9 CS, NC	10 CS, NC

Table 2-3. Sample Size Requirements for Assessment Methods

Use	Assessment Method	Use Attainment or Concern Assessment	Minimum Sample Sizes and Levels of Parameter Support for Data Qualifier (see Table 2-4 for definitions of levels of support and data qualifier)		
			ID Inadequate Data	LD Limited Data	AD Adequate Data
Aquatic Life Use (continued)	Acute toxicity tests in whole sediment	N/A	<4 NA	4-9 Report tests only	10 Report tests only
	Chronic toxicity tests in whole sediment	N/A	<4 NA	4-9 Report tests only	10 Report tests only
	Elutriate toxicity tests in sediment	N/A	<4 NA	4-9 Report tests only	10 Report tests only
	Toxic substances in sediment	C	<4 NA	4-9 CS, NC	10 CS, NC
	LOE toxic sediment condition	U	<4 (LOE is not reported if less than four samples are available)	4-9 CN, NC, NS (data set qualifier must be JQ rather than LD)	10 NS, CN, FS, TH (data set qualifier must be JQ rather than AD)
	Habitat		0 NA	1 CS, NC	2 CS, NC
	Macrobenthic community	U	0 NA	1 CN, NC	2 NS, CN, FS, TH
	Fish community	U	0 NA	1 CN, NC	2 NS, CN, FS, TH
Recreation Use	Bacteria single sample	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Bacteria geomean	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
General Use	Water temperature	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	High pH	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Low pH	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Dissolved solids	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Enterococcus (1006, 1007) single sample	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Enterococcus (1006, 1007) geometric mean	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Nutrient screening levels	C	<4 NA	4-9 CS, NC	10 CS, NC
	Nutrient enrichment	U	see text, NA, CN, NC, NS, TH (data set qualifier OE)		
	Altered color	U	see text, NA, CN, NC, NS, TH (data set qualifier OE)		
	Fish kill reports	U	see text, NA, CN, NC, NS, TH (data set qualifier OE)		
Fish Consumption Use	DSHS advisories, closures, and risk assessments	U	see text, NA, NC, NS, FS, TH (data set qualifier OE)		

Table 2-3. Sample Size Requirements for Assessment Methods

Use	Assessment Method	Use Attainment or Concern Assessment	Minimum Sample Sizes and Levels of Parameter Support for Data Qualifier (see Table 2-4 for definitions of levels of support and data qualifier)		
			ID Inadequate Data	LD Limited Data	AD Adequate Data
Fish Consumption Use (continued)	HH bioaccumulative toxics in water average	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Bioaccumulative toxics in fish tissue	C	<4 NA	4-9 CS, NC	10 CS, NC
Public Water Supply Use	HH criteria for PWS average	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS, TH
	Surface water toxic substances average concern	C	<4 NA	4-9 CS, NC	10 CS, NC
	Finished drinking water dissolved solids average	C	see text, NA, CS, NC (data set qualifier OE)		
	Finished drinking water MCLs and toxic substances running average	U	see text, NA, NS, FS, TH (data set qualifier OE)		
	Finished drinking water MCLs concern	C	see text, NA, CS, NC (data set qualifier OE)		
	Increased cost for treatment	C	see text, NA, CS, NC (data set qualifier OE)		
Oyster Waters Use	DSHS shellfish harvesting maps	U	see text, NA, NS, FS, TH (data set qualifier OE)		

A minimum of 10 samples from the last seven years *or* the most recently collected 10 samples for up to ten years are used to determine use support. Concerns will be identified with as few as four samples if they are within the last seven years. The sample set must be temporally representative and it may be useful to include recent samples from the previous seven-year period to establish concern status.

Small data sets indicating nonsupport. Water bodies with small data sets (< 10) will be identified as not supporting designated uses for methods using a percent exceedance without regard for sample size, provided they meet the threshold number of exceedances that would be required for the minimum sample size and are otherwise representative—routine data collected over at least a two-year period. For these water bodies there is certainty that small data sets with a threshold number of exceedances that would be required for the minimum sample size will demonstrate nonsupport of uses should more samples be collected to reach a total sample size of 10. All assessment methods based on average will require 10 samples for listing and delisting.

Public water supply use. For some assessment methods to determine support of the public water supply (PWS) use are based on annual running averages (as "samples") reported by water utilities in the last three years. A minimum of one sample for finished drinking water in each of four consecutive quarters is required to calculate an annual average. For finished drinking water, an

average calculated from at least four temporally representative samples reported by water utilities is required for comparison to the primary and secondary drinking water standards.

Use of Continuous Water Quality Data for the Assessment

Continuous water quality sampling may be conducted for a variety of reasons, but to be used in the assessment, specific requirements must be met. For field parameters, summary statistics evaluated for use attainment are considered for each day the data are available:

- 24-hour average and minimum for DO
- 24-hour minimum and maximum for pH
- 24-hour maximum for temperature
- 24-hour average for specific conductance

Site location and instrument placement at the station must be representative of the water body or assessment unit if the data are to be used for determining compliance with the water quality standards. Samples near the surface are considered representative of a mixed surface layer. In reservoirs and estuaries, automated multiprobe instruments used to monitor field measurements over complete 24-hour periods are generally positioned between one foot from the water surface and one-half the depth of the mixed surface layer. If profile data are available in a continuous record, these measurements can also be used. Average, maxima, and minima for each profile are compiled to produce the 24-hour statistics described above.

Data from continuous monitoring sites must meet requirements for temporal representation, including a period of at least two years of sampling; no more than two-thirds of the samples collected in any one year; and no more than one-third of the samples from any one of the four seasons. If it appears the data are considerably biased toward any given time period during the period of record due to data gaps, steps may be taken to minimize the bias such as removing some samples from the over-represented period. If, for example, there are only twenty valid days in August that meet the requirements, only the first twenty valid days from the remainder of the months may be used.

One summary statistic or “sample” is reported for field parameters for each day of sampling. To report valid samples, statistics should be developed for days that have at least 90% data return from midnight to midnight with intervals of one hour or less. The summary statistics for continuous monitoring data are assigned to specific parameter codes. For other parameters, such as nutrients, which are collected less frequently, each of the individual measurements can be evaluated over the entire period of record (rather than daily statistics).

Continuous monitoring stations report raw measurements in near real-time. Data are validated by post-calibration after a period of days or several weeks of deployment. Only data with post-

calibration category requirements consistent with SWQM DQOs for field data will be used in the assessment. When both continuous and grab data are available, the assessor will consider both in determining the support status.

Flow Conditions

Water quality criteria and screening levels generally apply to perennially flowing streams when flow exceeds critical, low flow conditions. Many small, unclassified streams in Texas develop intermittent stream flow in summer months and eventually become completely dry, while others maintain perennial pools when flow is interrupted. The decision matrixes illustrated in Tables 3-2, 3-5, 3-8, 3-9, 3-12, and 3-14 were developed for this guidance to explain which DO, toxic substances in water, bacteria, general use, human health, and surface water criteria respectively, apply under different flow conditions. These tables summarize the when site-specific and general criteria are applicable, consistent with the Texas Surface Water Quality Standards.

Eliminating Low Flow Events on Perennial Streams

The first step is to assess a water body using data from all flow conditions and determine if there are any concerns or nonsupport for use attainment, for *any* of the assessment methods or parameters. Samples are reviewed to determine if any need to be removed due to low flow, only if nonsupport or concerns are identified. Low flow is defined as the *seven-day, two-year low-flow* (7Q2)—the lowest stream flow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data.

Removing measurements made at low flow is a way to avoid inappropriately listing a water body based on data that do not support the TSWQS when strictly applied. Samples from low flow events are not excluded when the samples support the water quality standards and would not result in a listing or concern. Only the individual sample values for the assessment parameter not meeting the criterion for an assessment method during the low flow event will be removed. For example, if the grab DO is less than the grab screening level of 5 mg/L the data value will be removed if < 7Q2. However, if this same measurement is greater than the grab screening level, it will be included for that assessment method. The number of samples assessed for the data set are counted and reported after low flow samples are removed. General criteria are assessed at all flows according to 30 TAC Section 307.8 (a) (7).

Because the 7Q2 flow condition occurs rarely, and the accepted exceedance rate (percent of time the criterion is not attained) is already as large as 10% (25% for bacteria) the removal of low flow events from the data set may be an unnecessary practice that contributes bias (disproportionally toward higher than actual flow on the segment) and introduces the possibility of errors (the 7Q2 applied to the sample location may not be accurate and flow measurements for events may not be available or accurate). The assessor will use judgement when evaluating samples to be removed.

Classified stream segments. For classified segments, when,

- measured flow is below the 7Q2 or 0.1 cfs, regardless of flow severity

  or
- a flow severity of 1 (no flow), but with no measured flow reported

The following parameters are removed if the initial assessment using all of the samples indicates nonsupport,

- DO
- pH
- temperature
- bacteria
- chronic toxic criteria
- human health criteria (harmonic mean flow)
- chronic ambient toxicity tests

If there is no available flow information for classified perennial streams, flow will be presumed to be above the 7Q2. Note that perennial streams are only rarely below the 7Q2, so it is unlikely that samples were collected during this condition.

The following still apply at all flows on classified stream segments and are not removed below 7Q2,

- TDS
- chloride
- sulfate
- acute toxic criteria
- acute ambient toxicity tests

For Human Health criteria, use the Harmonic Mean rather than the 7Q2.

Unclassified perennial streams. For unclassified perennial streams when,

- a measured flow is below the 7Q2 or 0.1 cfs, regardless of flow severity.

  or
- a flow severity of 1 (no flow) is reported, but with no measured flow.

The following parameters are removed if the initial assessment using all of the samples indicates nonsupport,

- DO
- bacteria (for perennial streams, remove the bacteria below the 7Q2, see 307.8 (a) (1) (F) in TSWQS).
- chronic toxic criteria
- human health criteria (harmonic mean flow)
- chronic ambient toxicity tests

If there is neither measured flow nor flow severity for unclassified perennial streams, presume that the flow is above the 7Q2 and use the sample results.

Unclassified intermittent streams. For unclassified intermittent streams and intermittent streams with pools, do not evaluate the flow (cfs or flow severity) or eliminate data below the 7Q2 because the 7Q2 is zero cfs.

Toxicity: The following apply at all flows above a quarter of the 7Q2 (see 307.8 (a)(2) in the TSWQS) on perennial and intermittent unclassified streams,

- Acute toxic criteria.
- Acute ambient water toxicity test (the river authorities and EPA Houston have been running only acute tests).

The chronic criteria and chronic ambient water toxicity tests also apply to intermittent streams that support significant aquatic life, including streams identified as intermittent with pools. This includes,

- Pools large enough to support significant aquatic life (greater than 20% stream bed, greater than 1 m deep).
- Perennial streams, and small pools downstream of wastewater discharges on streams that would otherwise be intermittent, but outside the area where the criteria may not apply as established in the TCEQ permitting process.

Note: Chronic criteria don't apply to intermittent streams with no pools, only acute apply to streams with these conditions.

Methodology for Determining Standards Attainment

Levels of Support

A range of water quality conditions and assessment status is expressed by a level of support established for each parameter, and for the use in each assessment unit and in some instances for each station. Support status reflects (1) that data are not sufficient to allow assessment, (2) when only a concern can be established from limited data, and (3) when the assessment can confidently establish the level of support.

Assessment methods for use attainment (based on numeric and narrative TSWQS) apply to the parameters, the use, the AU and the segment. Assessment methods are discussed in Chapter 3 (also see Table 3-1). When current support status can not be assessed because the data set is not adequate, the support status from the previous assessment is reported if it was a concern or impairment. Impairments identified in previous years may be removed (delisted) when the degree of support is adequate.

For all parameters and uses, a water body may be considered Threatened for nonattainment based on documented information (such as trend analysis) and judgement of the assessor. A use will be identified as Threatened if a water body is currently supporting the water quality standards, but based on trends demonstrated with instream data or anticipated pollution loads, that within seven years that standard will no longer be attained. An improving trend away from impairment or increasing pollution loads, demonstrated with the most recent two to seven years of data or information, will be evidence that the water body is no longer Threatened. These threatened water bodies are placed on the 303(d) List so that water quality management actions can be taken in the interim before the next list.

Support status is expressed with a letter or several letters with the following definitions. A support code and data set qualifier from the columns in Table 2-4 are reported for each assessment method and parameter.

Values Below Reporting Levels

Many individual values in the SWQM water quality database are reported as less than the laboratory reporting limits (*nondetects*) for the day's sample batch. There is no generalized way to determine the true value for an individual result in the range between zero and the reporting limit. For assessments, half of an analytical reporting limit may be used in calculations. This is done to include as many individual data points in the analysis as possible and to indicate the level of monitoring effort.

Values reported as nondetects with a reporting limit that exceeds criteria or screening levels, are not counted as exceedances.

For criteria that are expressed as averages, including chronic toxicants (aquatic life use), bacterial indicators geometric mean (recreation use), human health criteria for water (fish consumption use), and primary organic substances (public water supply use), which ever of the following measurements is smaller is used in calculating the average—half of the reporting limit or half of the criterion. For values expressed as greater than the reporting limit, the whole value is used.

When most of the reported values for a parameter are nondetects, and the reporting (detection) limit is significantly greater than the criterion (note that a margin of safety of about two for aquatic life and five to ten is incorporated into criteria), the samples are not used for calculation of averages or percent exceedances. A status of Not Assessed may be identified, rather than Fully Supporting or No Concern. The assessor will use judgment when identifying parameters as fully supporting or delisting when the dataset includes nondetects.

Rounding Values

For managing measurement values, the *EPA Standard Methods Rule of Rounding* is used. Digits that are not significant are dropped. If the digit 6, 7, 8, or 9 is dropped, the preceding digit is

Table 2-4. Support Codes and Data Set Qualifiers

Resulting Support Code for Use	Support Code Assigned to Parameter	Level of Use Support	Use Standard or Screening Level Concern
FS	FS	standard for use fully supported—however may not meet delisting requirements; Note: Fish consumption rolls up to NA when advisories/risk assessment method is not available	Use
NS	NS	standard not supported	Use
TH	TH	threatened for non attainment of use in the next two years	Use
FS	CN	concern—near non attainment for parameter with adequate data	Use
NA	CN	concern—near non attainment for parameter with limited data	Use
NA	NC	no concern for parameter with limited data	Use
NA	NA	not assessed	Use
NA	CS	concern—**screening levels** indicate marginal water quality for parameter by **concern assessment methods**	Concern
NA	NC	no concern—**for screening level parameters**	Concern
NA	NA	not assessed	Concern

Data Set Qualifier Code	Data Set Qualifier for Parameters
AD	adequate data—meets minimum sample number and other requirements
LD	limited data (less than minimum sample size of 10)
TR	not temporally representative, used with NA
SR	not spatially representative, used with NA
JQ	based on judgement of the assessor
SM	this assessment method is superceded by another method
ID	inadequate data (<4 samples), used with NA
OS	assessment area outside state boundaries
OE	other information than ambient samples evaluated

Notes:
A support code is assigned to the segment, AU, use, and parameters. Both the support code and dataset qualifier are required to describe attainment for parameters. The assessment method is not assigned a support code or a data set qualifier.

Assessment methods based on averages (including median and geometric mean) are reported as FS when criteria are attained.

increased by one unit. For example, 2.89 becomes 2.9. If the digit 0, 1, 2, 3, or 4 is dropped, do not alter the preceding digit. For example, 2.53 becomes 2.5. If the digit is dropped, round off the preceding digit to the nearest *even* number. For example, 2.25 becomes 2.2 and 2.35 becomes 2.4.

Trend Analysis

The TCEQ has identified trend analysis as a tool to determine if a water body is not expected to meet applicable water quality standards, or is threatened as defined in *40 Code of Federal Regulations Section 130.2(j) and EPA guidance*. In general, trend analysis provides information which contributes to a quantitative, objective assessment of whether or not the values for a random variable such as chloride concentration, or biological integrity (the dependent variable) are increasing or decreasing over time, as a function of an independent variable such as time. Trend analysis also provides an estimate of the rate of change. In most cases the explanatory (independent) variable will be time. The TCEQ may also look at trend analyses to evaluate improvement in impaired water bodies as well as where there are no trends. However, trend analyses will most likely be prioritized to evaluate water bodies which appear to be threatened. For purposes of generating a statistical trend, 20 to 60 samples collected over a period of five to 20 years are required. The TCEQ has some long-term stations as part of the routine monitoring network. One of the purposes of these monitoring stations is to assess long-term water quality trends.

Trend Analysis Method

For details relating to the trend analysis method refer to the Clean Rivers Program Guidance, Task 5—Data Analysis and Reporting, Exhibit 5B—Steps and Criteria for Trend Analysis. This guidance can be found on the Web at:
http://www.tceq.state.tx.us/compliance/monitoring/crp/guidance/index.html

Use of the Binomial Method for Establishing Required Number of Exceedances for Nonsupport of Designated Uses

A primary objective of water quality assessment is to draw conclusions about a water body based on a group of measurements for a particular water quality parameter of interest. The universe of existing values for a variable in the AU of interest is referred to as the *population*. In general, it is impossible to obtain all of the measurements for a population. Then it becomes necessary to describe the population, as reliably as possible, by collecting a set of samples from that population. There is always uncertainty and a potential for error in this process. For the 303(d) listing process, there are essentially two categories of such errors:

Type 1 Error. We would make a Type 1 error if we identified a water body as not supporting, when that water body is actually fully supporting.

Type 2 Error. We would make a Type 2 error if we identified a water body as fully supporting, when that water body is actually not supporting.
The *binomial method* is a useful tool for estimating the probability of committing Type 1 and/or Type 2 errors for situations when the analysis is based on a given variable that falls into one of two categories. Placing measurements of water quality variables in two categories—either equal to or less than a criterion, or greater than the criterion—is an example of such a situation.

Note: Some criteria are expressed as averages, such as TDS, geometric mean for bacteria indicators, and chronic toxic criteria, where the binomial method cannot be used.

In general, when the binomial method is used, the proportion of the population that belongs to one of the two categories—in this case the proportion of the population that exceeds the criterion—is denoted as p. The proportion of the population that belongs to the second category (in this case the proportion of the population that meets the criterion) is denoted as q, which is equal to $1-p$. For example, for a fully supporting water body, p is equal to or less than 10% (0.1), and q is greater than or equal to 89.9% (0.899). In this case, p and q, respectively, represent the probabilities, for a single sample event, of collecting a sample that exceeds or a sample that meets the criterion. During the assessment of water quality, multiple samples are collected and the cumulative probabilities are determined in order to estimate the probability of committing Type 1 and Type 2 errors.

The binomial method can be used to calculate the probability of collecting more than 10% exceedances from a water body that actually contains less than 10% (0.10) exceedances—that is, erroneously classifying a water body as not supporting for each combination of number of samples (n) and number of exceedances (e). For example, this method can be used to determine the cumulative probability of error when two or more exceedances out of 10 samples are collected and when the actual exceedance rate in a water body is 10%. This cumulative probability represents the Type 1 error probability. By calculating these cumulative probabilities for each combination of n and e, it becomes possible to select the combination which provides an acceptable probability of committing a Type 1 error and to identify the Type 2 error.

Error rates for delisting decisions can be described in a similar, but reversed, manner for each combination of number of samples and exceedances. We would make a Type 1 error if we delisted a water body when that water body is actually not supporting. We would make a Type 2 error if we did not delist a water body that is actually fully supporting.

For each number of samples available for a parameter (sample size), a minimum threshold number of exceedances must be identified for listing, considering Type 1 and II error rates (see Table 2-5). Appendices A and B provide examples of the number of samples and exceedances that result in various levels of use and concern attainment.

The specified maximum acceptable Type 1 error rate for identifying impairments and concerns for conventional parameters and bacteria is less than 20% near the threshold frequency of exceedances (10% actual exceedances for conventionals and 25% for bacteria). For toxics, in order to be more protective, a larger Type 1 error probability, 40%, is accepted. Specifying a maximum Type 1 error rate results in corresponding Type 2 error rates.

Table 2-5. Compliance with Water Quality Criteria and Acceptable Error for Listing Delisting, and Concerns with at Least Ten Samples.

Use and Concerns Attainment	Error Type	List		Concern		Delist	
		Maximum Accepted Sample Error Rate (%)	Exceedance Rate for Parameter (%)	Maximum Accepted Sample Error Rate (%)	Exceedance Rate for Parameter (%)	Resulting Sample Error Rate* (%) Range for 10 to 20 samples	Exceedance Rate for Parameter (%)
Conventional Use Attainment	Type 1	20	10	20	8	**37 to 70**	**11**
	Type 2	91	11	62	20	**8 to 25**	**5**
		38	30				
Dissolved Oxygen Concerns	Type 1	n/a	n/a	20	8	n/a	n/a
	Type 2	n/a	n/a	62	20		
Toxic Use Attainment	Type 1	40	10	40	8	**35 to 71**	**9**
	Type 2	81	11	38	20	**12 to 43**	**5**
		16	30				
Bacteria Use Attainment	Type 1	20	25	20	20	**36 to 39**	**26**
	Type 2	91	26	44	40	**4 to 20**	**13**
		38	50				
Screening Level Concerns	Type 1	n/a	n/a	20	20	n/a	n/a
	Type 2	n/a	n/a	44	40		

* The methodology for delisting is not based in target error rates. See discussion on delisting below.

The resulting Type 2 error rate at the threshold exceedance of 11% for conventional parameters is 91% and for toxics it is 81%. Because criteria are conservative and set to protect for the best water quality conditions when developing permits, exceedance rates of two to three times the threshold frequency can occur without the need for listing and additional water quality controls through the TMDL process. At these higher exceedance rates, the resulting Type 2 error rate is 38% for

conventional parameters and bacteria, and about 16% for toxics. Note that at the sample sizes less than 10, the Type 2 error rate cannot be controlled in a useful way.

Delisting parameters for the 303(d) list. Water bodies will be delisted from Category 5 when the rate of exceedances is not greater than 10% for conventional parameters (and/or the mean is not exceeded for criteria evaluated as a mean), 25% for bacteria, and 8% for toxic substances. This change in delisting methodology, now based on a simple percentage, is approximately equivalent to the previous method which was based on the binomial method (delisting with two fewer exceedances than the threshold for listing). The use of a simple percentage increases confidence that previously impaired waters are attaining their use before they are delisted.

An exception is when new standards and criteria have been adopted. Use attainment is determined by the statistical method and the additional level of assurance (requirement that the criteria are not exceeded more than 10% of the time) is not required for delisting. Similarly, for Category 4 impairments, because there are water quality controls in place, or the non-support is not caused by a pollutant, impairments are removed from this category when water quality standards are attained without this additional level of assurance.

For delisting impairments, this methodology results in a Type 1 error rate of 37 to 70% when the rate of criteria exceedance is just above the threshold of 10% for conventional parameters, and 8 to 38% when the exceedance rate is 20%. The Type 2 error rate is less than 8 to 25% for conventional parameters when water quality is good (exceedance rate of only 5%). Error rates when delisting toxic parameters are more protective.

CHAPTER 3
ASSESSMENT OF BENEFICIAL USES

Introduction

Assessment of each beneficial use is accomplished by applying several assessment methods. These methods often have several criteria or screening levels that are used to evaluate assessment parameters (see Table 3-1). Use attainment assessment methods are used to determine use support and concerns for near-nonattainment for uses; concern assessment methods are used to identify concerns with screening levels.

Table 3-1. Use Assessment Methods, Parameters, and Impairments

Use	Assessment Method	Use Attainment or Concern Assessment	Assessment Parameter	Impairment
Aquatic Life Use	Dissolved oxygen 24hr average	U	Dissolved oxygen 24hr average	Depressed dissolved oxygen
	Dissolved oxygen 24hr minimum	U	Dissolved oxygen 24hr average	Depressed dissolved oxygen
	Dissolved oxygen grab minimum	U	Dissolved oxygen grab	Depressed dissolved oxygen
	Dissolved oxygen grab screening level	C	Dissolved oxygen grab	Depressed dissolved oxygen
	Continuous dissolved oxygen daily 24-hour average	U	Continuous dissolved oxygen 24-hr	Depressed dissolved oxygen
	Continuous dissolved oxygen daily 24-hour minimum	U	Continuous dissolved oxygen 24-hr	Depressed dissolved oxygen
	Acute toxic substances in water	U	Metals, organics	Lead in water, etc.
	Chronic toxic substances in water	U	Metals, organics	Lead in water, etc.
	Acute ambient toxicity tests in water	U	Water acute toxicity	Water toxicity
	Chronic ambient toxicity tests in water	U	Water chronic toxicity	Water toxicity
	TOXNET ambient toxicity tests in water - lethality	U	Water acute toxicity	Water toxicity
	TOXNET ambient toxicity tests in water - sublethality	C	Water chronic toxicity	Water toxicity
	Acute toxicity tests in whole sediment	N/A	Sediment acute toxicity	Report test results only
	Chronic toxicity tests in whole sediment	N/A	Sediment chronic toxicity	Report test results only

Table 3-1. Use Assessment Methods, Parameters, and Impairments

Use	Assessment Method	Use Attainment or Concern Assessment	Assessment Parameter	Impairment
Aquatic Life Use (continued)	Elutriate toxicity tests in sediment	N/A	Sediment elutriate toxicity	Report test results only
	Toxic substances in sediment	C	Lead, etc.	Lead in sediment, etc.
	LOE toxic sediment condition	U	Sediment Toxicity (LOE)	Toxic Sediment (LOE)
	Habitat	C	Habitat	Habitat
	Macrobenthic community	U	Macrobenthic community	Impaired macrobenthic community
	Fish community	U	Fish community	Impaired fish community
Recreation Use	Bacteria single sample	U	*E. coli*, fecal coliform, or Enterococcus	Bacteria
	Bacteria geomean	U	*E. coli*, fecal coliform, or Enterococcus	Bacteria
General Use	Water temperature	U	Temperature	Temperature
	Continuous temperature daily maximum	U	Continuous temperature	Temperature
	High pH	U	pH	pH
	Low pH	U	pH	pH
	Continuous pH daily maximum	U	Continuous pH	pH
	Continuous pH daily minimum	U	Continuous pH	pH
	Dissolved solids	U	Total dissolved solids, chloride, or sulfate	Total dissolved solids, chloride, or sulfate
	Continuous total dissolved solids daily average	U	Continuous total dissolved solids	Total dissolved solids
	Enterococcus (1006, 1007) single sample	U	Enterococcus	Bacteria
	Enterococcus (1006, 1007) geometric mean	U	Enterococcus	Bacteria
	Nutrient screening levels	C	Orthophosphorus, ammonia, total phosphorus, nitrate, chlorophyll *a*	Orthophosphorus, ammonia, total phosphorus, nitrate, chlorophyll *a*
	Nutrient enrichment	U	Algae, macrophytes, or DO grab, DO 24hr	Excessive algal growth, excessive macrophyte growth, or DO swings
	Altered color	U	Color	Color
	Fish kill reports	U	Golden alga	Harmful algal blooms/golden alga

Table 3-1. Use Assessment Methods, Parameters, and Impairments

Use	Assessment Method	Use Attainment or Concern Assessment	Assessment Parameter	Impairment
Fish Consumption Use	DSHS advisories, closures and Risk Assessments	U	PCBs, etc.	PCB's in large mouth bass (as specified in advisory)
	HH bioaccumulative toxics in water	U	Acrylonitrile, etc.	Acrylonitrile in water, etc.
	Bioaccumulative toxics in fish tissue	C	Arsenic, etc.	Arsenic in fish tissue, etc
Public Water Supply Use	Surface water HH criteria for PWS average	U	Arsenic, nitrate, etc.	Arsenic in water, etc.
	Surface water toxic substances average concern	C	Alachlor, atrazine, MTBE, and perchlorate	Alachlor, atrazine, MTBE, and perchlorate in water
	Finished drinking water dissolved solids average	C	Chloride, sulfate, or total dissolved solids	Chloride, sulfate, or total dissolved solids in finished drinking water
	Finished drinking water MCLs and toxic substances running average	U	Arsenic in water, etc.	Arsenic in finished drinking water, etc.
	Finished drinking water MCLs concern	C	Atrazine, etc.	Atrazine in finished drinking water, etc.
	Increased cost for treatment	C	Demineralization or treatment costs	Demineralization costs, or taste and odor treatment costs
Oyster Waters Use	DSHS shellfish harvesting maps	U	Bacteria, zinc, etc.	Bacteria (oyster waters)

Aquatic Life Use

Each classified segment in the TSWQS is assigned one of the following aquatic life uses, based on physical, chemical, and biological characteristics of the water body: *exceptional*, *high*, *intermediate, limited,* or *minimal* (no significant) *aquatic life use*.

Support of the aquatic life use is based on assessment of dissolved oxygen criteria, toxic substances in water criteria, ambient water and sediment toxicity test results, and indices for habitat, benthic macroinvertebrate and fish community, provided that the minimum number of samples are available. Each set of criteria is generally evaluated independently of the others, and impairment of the aquatic life use results when any of the individual criteria are not attained.

For freshwater streams not classified in the TSWQS, the aquatic life use and criteria are presumed based on the stream flow type. Stream flow-type—perennial, intermittent with pools, or intermittent—is established from flow data associated with samples, information provided by local monitoring staff, previous assessments, or recent RWAs. Flow types, assigned aquatic life uses,

and criteria, when established in Appendix D of the TSWQS or in support of TCEQ permit decisions will be used when available.

Dissolved Oxygen

Classified Water Bodies

Aquatic life uses are protected by an average DO criterion (measured over 24-hours) and absolute minimum criterion. The criteria are not supported when these criteria are not attained more than 10 percent of the time using the binomial method.

24-hour average criteria. DO criteria (24-hour averages) to protect these aquatic life uses for freshwater range from 2.0 to 6.0 mg/L, respectively (see Table 3-2).

In tidally influenced water bodies the dissolved oxygen criteria are 1 mg/L lower than freshwater for exceptional, high, and intermediate aquatic life uses due to differences between oxygen solubility in fresh and salt water. A minimal aquatic life use and dissolved oxygen screening level of 2.0/1.5 mg/L (average/minima) is used in this guidance where the TSWQS designate no significant aquatic life use.

DO average criteria are compared to the measurement taken at the surface or to the average of measurements in the mixed surface layer when a profile of measurements is reported.

Minimum criteria. In addition, the TSWQS designates *minimum criteria* to protect the range of aquatic life uses. In freshwater, these minimum criteria range form 2.0 to 4.0 mg/L and the minimum screening level for minimal use is 1.5 mg/L. Minimum in tidal waters are the same, except the criterion for the intermediate use is 2.0 mg/L, and there is no limited use or criterion (see Table 3-2).

DO minimum criteria are compared to the measurement taken at the surface or to the average of measurements in the mixed surface layer when a profile of measurements is reported.

Dissolved oxygen grab screening level. Grab dissolved oxygen measurements are made at the majority of sampling events. These measurements are compared to the average DO criterion value and a concern is identified when this screening level is exceeded more than eight percent of the time using the binomial method.

The DO grab screening level is compared to the measurement taken at the surface or to the average of measurements in the mixed surface layer when a profile of measurements is reported.

Table 3-2. Aquatic Life Use—Dissolved Oxygen Criteria

Water Body/ Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A and Water Bodies Identified in Appendix D of the TSWQS				Unclassified Water Bodies			
		Most Typically Designated Aquatic Life Use	**Typically Designated Criteria ⑨ 24-hour average/ minimum (mg/L) ⑩**	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2—if not published or no information to contrary**	**Presumed ALU ①**	**Presumed Criteria 24-hour average/ minimum (mg/L)**	**Eliminate samples below 7Q2 ③**	**Presumed 7Q2— if not published or no information to contrary ⑨**
Freshwater Stream	***Freshwater Perennial Stream*** ④	Exceptional	6.0/4.0	Yes	0.1 cfs	High	5.0/3.0	Yes	0.1 cfs
		High	5.0/3.0						
		Intermediate	4.0/3.0						
		Limited	3.0/2.0						
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑥	Limited	3.0/2.0	n/a	0.0 cfs	Limited	3.0/2.0	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	Minimal	2.0/1.5	n/a	0.0 cfs	Minimal	2.0/1.5	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream***, but within the area of influence of a permitted wastewater load ⑦ the observed flow-type is altered (intermittent to perennial, or intermittent to intermittent with perennial pools) as a result of the discharge ⑧	Established by TCEQ permit process		n/a	0.0 cfs	Established by TCEQ permit process		No 7Q2 is 0.0 cfs	0.0 cfs
Reservoir	***Reservoir***	Exceptional	6.0/4.0	n/a	n/a	High	5.0/3.0	n/a	n/a
		High	5.0/3.0						
		Limited	3.0/2.0						
Tidal Stream	***Tidal Stream***	Exceptional	5.0/4.0	n/a	n/a	High	4.0/3.0	n/a	n/a
		High	4.0/3.0						
		Intermediate	3.0/2.0						

Table 3-2. Aquatic Life Use—Dissolved Oxygen Criteria

Water Body/ Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A and Water Bodies Identified in Appendix D of the TSWQS				Unclassified Water Bodies			
		Most Typically Designated Aquatic Life Use	**Typically Designated Criteria ⑨ 24-hour average/ minimum (mg/L) ⑩**	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2—if not published or no information to contrary**	**Presumed ALU ①**	**Presumed Criteria 24-hour average/ minimum (mg/L)**	**Eliminate samples below 7Q2 ③**	**Presumed 7Q2— if not published or no information to contrary ⑨**
Estuary	*Estuary*	Exceptional	5.0/4.0	n/a	n/a	High	4.0/3.0	n/a	n/a
		High	4.0/3.0						
		Intermediate	3.0/2.0						
Ocean	*Ocean*	Exceptional	5.0/4.0	n/a	n/a	n/a	n/a	n/a	n/a
Freshwater Wetland	*Freshwater Wetland*	Aquatic life use is derived from contiguous/adjoining segments. Criteria are not specified, but criteria of 2.0/1.5 must be attained.		n/a	n/a	Aquatic life use is derived from contiguous/adjoining segments. Criteria are not specified, but criteria of 2.0/1.5 must be attained.		n/a	n/a
Saltwater Wetland	*Saltwater Wetland*								

① Presumed ALU and criteria are used for unclassified water bodies except for perennial streams listed in Appendix D of the Texas Surface Water Quality Standards (TSWQS).
② Presume event was above the 7Q2 for classified perennial stream segments when no flow information is available for the event a flow severity of “1" is reported, indicating no flow.
③ Presume event was above the 7Q2 for unclassified perennial stream if no flow information is available (either severity code or measurement).
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
⑥ Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. Generally, an “adequate pool” to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ The area of influence is established in the TCEQ permitting process.
⑧ In the stretch of steam upstream and downstream, and outside of the area of influence from wastewater flow, the observed flow-type is used to the establish the flow-type, ALU, and criteria for assessment.
⑨ For East Texas—see TSWQS Table 5 for low flow criteria. The 7Q2 is published however if a more recent TCEQ permit action alters the 7Q2 at the site, a more accurate 7Q2 may be calculated and used.
⑩ Springtime criteria, up to 1.5 mg/L higher than shown, to protect fish spawning periods are applied during that portion of the first half of the year when water temperatures are 63.0 to 73.0 degrees Fahrenheit (see Table 4 in the TSWQS).

Seasonal Requirements for 24-hour Dissolved Oxygen Data Sets. Twenty-four hour dissolved oxygen sampling is resource intensive, so only samples from an index period were required in past assessments. Requirements for the period of record, balance between years, are the same as those for other methods. At least one half of the 24-hour DO monitoring events must be spaced over an index period representing warm-weather seasons of the year (March 15-October 15). One-fourth to one-third of the measurements must be made during the critical period (July 1-September 30). Approximately one month must separate each 24-hour sampling event. Although samples over the entire year are not required at this time, future assessment guidance may require that at least a third of the samples come from outside the index period. Current monitoring guidance encourages year-round sampling.

Hierarchy of assessment methods for determining use support for dissolved oxygen. When both 24-hour measurements (average and minima) and grab DO measurements (evaluated against the DO minimum criterion and DO screening level) are adequate for assessment, the assessment results for 24-hour DO data set are used to determine both use support and concerns. When this is the case the data set qualifier for the assessment methods using grab samples is reported as SM (superceded by another method). The assessor must consider grab exceedances of the DO minimum criterion and use judgement to determine if these exceedances indicate nonsupport of the criterion and use. When this is the case, the data set qualifier for the 24-hour minimum is reported as JQ (based on judgement of the assessor).

Unclassified Streams

Establishing aquatic life use based on stream flow-type. In contrast to other criteria, dissolved oxygen criteria are derived from aquatic life use categories. The aquatic life use is assigned to unclassified segments for assessment, based on the flow-type for the segment.

Unclassified perennial streams are presumed to have a high aquatic life use and corresponding DO criterion of 5.0 mg/L for average DO. Unclassified intermittent streams with significant aquatic life use created by perennial pools are presumed to have limited aquatic life uses (protected by a 3.0 mg/L criterion for average dissolved oxygen). Intermittent streams without perennial pools are presumed to have minimal aquatic life uses (protected by a 2.0 mg/L average criterion).

Site specific standards. Site-specific aquatic life use and associated dissolved oxygen criteria have been assigned to unclassified water bodies through receiving water assessments (see Appendix D of the TSWQS). For other unclassified water bodies, the aquatic life use and associated DO criteria are presumed, based on the flow-type or other information developed by the TCEQ water programs. The aquatic life use and criteria for unclassified water bodies most recently used for assessment will be provided with assessment results. Another exception is perennial streams located in the eastern and southern areas of the state—as described in the TSWQS, 307.7(b) (3)(a)(ii)—where a strong dependent relationship exists among summertime dissolved oxygen concentration, stream flow, and channel bed slope. Streams with significant aquatic life use in these areas of the state are evaluated for 24-hour dissolved oxygen

concentrations using criteria that are dependent on flow and stream bed slope. If a water body or AU does not support the DO criteria, that impairment must be verified. The following section outlines the steps necessary to verify the impairment.

Confirming apparent DO impairments in the eastern or southern portions of the state. If a water body or subsegment in the eastern or southern portions of the state (as defined on page 10 of the *Implementation Procedures*) does not support the DO criteria, only then are the following steps used, for each individual sample not attaining the assigned 24-hour average criterion, to further assess attainment of the sample.

This procedure applies to both classified and unclassified water bodies, and is performed only for sample measurements made when the flow equals or exceeds the 7Q2. Using the guidelines in the *Procedures to Implement the Texas Surface Water Quality Standards* (Implementation Procedures, RG-194, revised January 2003) adopted by the TCEQ on November 15, 2000,

1. Calculate the bedslope for the subject stream reach (as outlined on page 11 of the *Implementation Procedures*), and go to the step 2.

2. Calculate the critical low flow for applying the DO criteria using bedslope, flow, and Table 2 of the *Implementation Procedures*, page 155. The critical low-flow values in Table 2 (same as Table 5 in the TSWQS) may be used to evaluate summertime DO criteria (see Table 1 of the *Implementation Procedures*, page 154) for presumed, designated, or assigned aquatic life uses.

   An example for a stream with a bedslope of 0.4 m/km,
   - If the DO criterion is 6.0 mg/L, the appropriate critical low flow is 20.0 cfs
   - If the DO criterion is 5.0 mg/L, the appropriate critical low flow is 3.3 cfs
   - If the DO criterion is 4.0 mg/L, the appropriate critical low flow is 0.5 cfs
   - If the DO criterion is 3.0 mg/L, the appropriate critical low flow is 0.1 cfs

3. If the flow at the of DO measurement is above the critical low from the table, then the violation indicated in the initial screening for this sample is correct.

4. If the flow at the time of DO measurement is below the critical low flow from the table, then the sample event is not considered in the assessment.

5. Reassess the DO for the water body or AU with the appropriate sample events.

The *Implementation Procedures* document can be found on the Web at
www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-194.html

Toxic Substances in Water

Support of the aquatic life use, based on toxic chemicals in water, includes an evaluation of those metals and organic substances for which criteria have been developed. The TCEQ has developed water quality criteria in the TSWQS for 12 metals and 26 organic substances (see Tables 3-3 and 3-4, respectively). *Acute criteria* apply to all waters of the state and at all flows above one-fourth the 7Q2 except in small zones of initial dilution near wastewater discharge points. *Chronic criteria* apply outside of mixing zones in water bodies with aquatic life uses designated in Appendixes A and D of the TSWQS, in unclassified perennial streams when the stream flow is greater than the 7Q2, and in intermittent streams that support significant aquatic life.

For evaluation of acute toxicity, individual measurements of 12 metals and 26 organic substances are compared against acute criteria established in the TSWQS (Table 1 in the TSWQS). Selection of which set of criteria (freshwater or tidal water) to use in the comparison is based on the location of the station; for example, for a station located in tidally influenced water, the marine criteria are applicable (see Table 3-5).

Support of the aquatic life use is also based on *toxic substance chronic criteria* for either freshwater or saltwater. Marine criteria are used at stations in segments classifed as tidal or where tidal activity is indicated by specific conductance measurements that routinely exceed 3,000 µS/cm, or where the stream is below five feet in elevation and tidal activity is presumed. For each parameter at each site, the average of all values is compared against the chronic criterion to determine aquatic life use support. If the average exceeds the criterion, the use is not supported.

Should the average be exceeded over the period of record, the data set is subsequently evaluated to ensure the criterion is also exceeded more than one time. If the average exceeds, and this is the result of only an occasional high value, the assessor will use judgement in the evaluation of the data set and a concern rather than impairment, is identified. Additional monitoring is initiated when a concern for toxic contaminants is identified.

Assessing Compliance with an Acute Toxic Criterion at a Percent of Samples Exceeding the Criterion of Up to 10 Percent

The acute criteria have additional statistical safeguards and safety factors incorporated into them. So even a moderate rate of exceedance for acute criteria do not constitute an ecological disruption. In order to assess compliance from limited data sets, even the use of a 10 percent exceedance rate will cause a water body to be considered impaired with a very small number of measured exceedances when the possibility of statistical and measurement error is only marginally acceptable. So to consider a smaller frequency of exceedance would be impractical. The relevant narrative provisions in the EPA-approved Texas Surface Water Quality Standards [30 TAC §307.4(d), §307.6(b), §307.6(c)] do not suggest that a single measured exceedance of an acute (or chronic) toxic criterion should be considered a violation of the standards. TCEQ added the following clarification in §307.9(a) of the 2000 Texas Surface Water Quality Standards: "Unless otherwise stated in this chapter, additional details concerning how sampling data are

evaluated to assess standards compliance are provided in the latest approved version of the TNRCC [now TCEQ] *Guidance for Screening and Assessing Texas Surface and Finished Drinking Water Quality Data*."

Using the Average of Samples to Compare to a Chronic Toxic Criterion Instead of Assessing Compliance as a Percentage of Samples Exceeding the Criterion

The definition of chronic toxicity in the 2000 Texas Water Quality Standards is as follows: "Toxicity which continues for a long-term period after exposure to toxic substances. Chronic exposure produces sub-lethal effects, such as growth impairment and reduced reproductive success, but it may also produce lethality. The duration of exposure applicable to the most common chronic toxicity test is seven days or more."

The standards also indicate that "specific numerical chronic aquatic life criteria are applied as seven-day averages." The purposes of the seven-day average are (1) to establish a low-flow "cut-off" for applicability of the criterion as defined by 7Q2 stream flows, (2) to tie the criteria to a typical seven-day duration of chronic lab tests, and (3) to indicate that assessment of instream compliance is based on an average condition—not on a single "grab" sample.

For purposes of monitoring instream compliance with standards, it is not appropriate to compare single samples against the chronic criteria because that approach doesn't allow for any averaging of instream measurement at all.

It has been suggested in some EPA guidance that exceedances of chronic criteria should only occur every three years. That suggestion is based on the observation that three years might be needed between substantial ecological disruptions in order to allow time for aquatic biota to recover. However, moderate exceedances of the adopted chronic criteria do not in any way constitute an ecological disruption. The criteria, which are in fact an attempt to develop an acceptable concentration for average exposure (albeit over somewhat limited time periods in testing), have a variety of safety factors and statistical safeguards incorporated into them.

Hardness and pH-based Criteria

Default values for segment specific hardness or pH are used in the screening program to calculate an allowable instream concentration of toxicants. Hardness or pH values, published in the *Implementation Procedures*, were developed in order to calculate a conservative threshold concentration for permitting, above which the instream conditions would exceed the criterion. When a permitted discharge is modeled using the computed criteria, instream concentrations are expected to exceed the criterion about 15 percent of the time if the facility is discharging at the permitted limit and when a stream is near critical low flow conditions. The published segment specific hardness or pH values are used in the calculation of both acute and chronic criteria for a classified segment and its unclassifed tributaries. See Table 5 of the *Implementation Procedures*, page 161 for segment specific hardness and pH values.

Using pH and hardness values. To apply more accurate local acute and chronic criteria to instream conditions, assessors can use the 15th percentile of a minimum of 30 values for hardness or pH collected over approximately the same time period as the metal or organics samples. This can apply to a specific station or an assessment unit. These are stored in default tables in the assessment data base and the site-specific percentiles are only generated when needed. When data are available, the hierarchy of preferred hardness or pH values for calculation criteria is as follows:

- **Classified segments**. The 15th percentile of hardness will be assigned to the segment. These are published in the implementation procedures, RG-194.

- **Unclassified segments**. The available data will be used to determine and assign the 15th percentile of hardness to the segment. When there are insufficient data to develop this default hardness, use the values published in RG-194 for the classified segment will be used.

- **Assessment Area (AU) for classified and unclassified water bodies**. The available data from the AU will be used to determine and assign the 15th percentile of hardness to the AU. The assessor can develop a rationale for using an alternate percentile, perhaps the 50th, when it is more appropriate for the AU.

- **Station**. The available data from the AU will be used to determine and assign the 15th percentile of hardness to the station. The assessor can develop a rationale for using an alternate percentile, perhaps the 50th, when it is more appropriate for the station.

Use of the 15th percentile of hardness is conservative when applied to all of the samples in a dataset and, on occasion, may incorrectly identify nonsupport of acute criteria for the segment. To get the most accurate determination of instream conditions for *acute* toxicity, the existence of toxicity is determined at the time of the sampling event by computing the threshold concentration of toxicant needed to cause toxicity at the time of collection, and then comparing this threshold concentration to the sample event toxicant concentration. To do this, use the event hardness or pH and the TSWQS equation to calculate a unique acute criterion for each event. Then, compare each calculated criterion to the corresponding measured concentration of toxicant in order to determine support of the criterion for that sample.

Note: Often hardness is not reported in the database, but calcium and magnesium are. Hardness can be computed from calcium and magnesium for a sample event using this equation:

$$\text{Hardness (mg/L CaCO3)} = 2.497\ (\text{calcium, mg/L}) + 4.118\ (\text{magnesium, mg/L})$$

Free Ionic Form of Silver

The TSWQS express the criterion for *silver* in the *free ionic form*. Silver data in the SWQM database are reported as the dissolved fraction. The percentage of dissolved silver that is present in the free ionic form is calculated and compared to the criterion.

The TCEQ developed a regression equation ($R^2 = 0.87$) that calculates the percentage of dissolved silver that is in the free ionic form. The following equation is used to determine what percentage of dissolved silver is in the free ionic form:

$$Y = \exp [\exp (1/(0.6559 + 0.0044 \times Cl))]$$

where

Y = percent of dissolved silver in the free ionic form

Cl = dissolved chloride (mg/L)

The percentage obtained from the above equation is converted to a proportion and then multiplied by the dissolved fraction to obtain the free ionic silver concentration. For this equation, chloride values are obtained from the *Implementation Procedures*, Table 5, page 161. When the range of chloride values exceeds 140 mg/L, the percentage of silver in the free ionic form will be 8.98 percent. The event-specific chloride or the 50th percentile value of the dissolved chloride concentration for each AU or station can be used, provided that 30 or more chloride measurements from ambient samples are available. For unclassified water bodies, the 50th percentile for the classified segment that receives the water can be used, or when the unclassified water body is freshwater and the segment is saltwater, the basin values can be used.

Table 3-3. Criteria for Specific Metals in Water for Protection of Aquatic Life

(All metals values listed or calculated are in µg/L. Hardness concentrations are input as mg/L)

Parameter Code	Parameter	Freshwater Acute	Freshwater Chronic	Tidal Water Acute	Tidal Water Chronic
01106	Aluminum (d)	991w	—	—	—
01000	Arsenic (d)	360w	190w	149w	78w
01025	Cadmium (d)	$0.973w_e^{(1.128(\ln(hardness))-1.6774)}$	$0.909\ w_e^{(0.7852(\ln(hardness))-3.490)}$	45.4w	10w
01030	Chromium (Tri)(d)	$0.316w_e^{(0.8190(\ln(hardness))+3.688)}$	$0.860w_e^{(0.8190(\ln(hardness))+1.561)}$	—	—
01040	Copper (d)	$0.960w_e^{(0.9422(\ln(hardness))-1.3844)}$	$0.960w_e^{(0.8545(\ln(hardness))-1.386)}$	13.5w	3.6w
00722	Cyanide (free)	45.8	10.7	5.6	5.6
01049	Lead (d)	$0.889w_e^{(1.273(\ln(hardness))-1.460)}$	$0.792w_e^{(1.273(\ln(hardness))-4.705)}$	133w	5.3w
71900	Mercury (t)	2.4	1.3	2.1	1.1
01065	Nickel (d)	$0.998w_e^{(0.8460(\ln(hardness))+3.3612)}$	$0.997w_e^{(0.8460(\ln(hardness))+1.1645)}$	118w	13.1w
01147	Selenium (t)	20	5	564	136
01523 (f)	Free Ionic Silver (d)	0.8w	—	2w	—
01090	Zinc (d)	$0.978w_e^{(0.8473(\ln(hardness))+0.8604)}$	$0.986w_e^{(0.8473(\ln(hardness))+0.7614)}$	92.7w	84.2w

(d) - dissolved fraction

(t) - total metal

(f) - free ionic silver values converted to free ionic form for individual samples

w - Indicates that a criterion is multiplied by a water-effects ratio in order to incorporate the effects of local water chemistry on toxicity. The water-effects ratio is equal to 1 except where a site-specific water-effects ratio has been established through a special study. Water-effects ratios for individual water bodies are added to Appendix E in the TSWQS when standards are revised. The number preceding the w in the freshwater criterion equation is an EPA conversion factor.

Table 3-4. Criteria in Water for Specific Organic Substances for Protection of Aquatic Life
(All values listed are in µg/L)

Parameter Code	Parameter	Freshwater Acute	Freshwater Chronic	Tidal Water Acute	Tidal Water Chronic
Pesticides					
39330	Aldrin	3.0	—	1.3	—
39350	Chlordane	2.4	0.004	0.09	0.004
81403	Chloropyrifos (Dursban)	0.083	0.041	0.011	0.006
39750	Carbaryl (Sevin)	2.0	—	613.0	—
39370[1]	4,4' - DDT	1.1	0.001	0.13	0.001
39560	Demeton	—	0.1	—	0.1
39780	Dicofol (Kelthane)	59.3	19.8	—	—
39380	Dieldrin	2.5	0.002	0.71	0.002
39650	Diuron	210.0	70.0	—	—
34361	Endosulfan I (alpha)	0.22	0.056	0.034	0.009
34356	Endosulfan II (beta)	0.22	0.056	0.034	0.009
34351	Endosulfan sulfate	0.22	0.056	0.034	0.009
39390	Endrin	0.18	0.002	0.037	0.002
39782	gamma-Hexachlorocyclohexane (lindane)	2.0	0.08	0.16	—
39580	Guthion	—	0.01	—	0.01
39410	Heptachlor	0.52	0.004	0.053	0.004
39530	Malathion	—	0.01	—	0.01
39480	Methoxychlor	—	0.03	—	0.03
39755	Mirex	—	0.001	—	0.001
39540	Parathion (ethyl)	0.065	0.013	—	—
39516	PCBs, total	2.0	0.014	10	0.03
39032	Pentachlorophenol	$e^{[1.005(pH) - 4.830]}$	$e^{[1.005(pH) - 5.290]}$	15.1	9.6
39400	Toxaphene	0.78	0.0002	0.21	0.0002
30340	Tributyltin (TBT)	0.13	0.024	0.24	0.043
77687	2,4,5 Trichlorophenol	136	64	259	12
Semivolatile Organic Substances					
34461	Phenanthrene	30	30	7.7	4.6

[1] DDT in whole water

Narrative Criteria Protecting Aquatic Life

Ambient Water Toxicity

Aquatic life is protected from toxic conditions in water by narrative criteria. Aquatic life use support is evaluated based on ambient water toxicity tests using sensitive test organisms. Sample toxicity can be established with tests using more than one species of test organism. If any of these tests exhibit toxicity, the sample is considered toxic. Support of the aquatic life use is determined with ambient acute and chronic toxicity tests in water. The narrative criteria protecting aquatic life

Table 3-5. Aquatic Life Use—Toxic Criteria

Water Body/ Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A and water bodies identified in Appendix D of the TSWQS			Unclassified Water Bodies ①		
		Aquatic Life Criteria see Tables 3-3 and 3-4 in the Guidance	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or no information to contrary**	**Aquatic Life Criteria** see Tables 3-3 and 3-4 in the Guidance	**Eliminate samples below 7Q2 ③**	**Presumed 7Q2 if not published or no information to contrary**
Freshwater Stream	***Freshwater Perennial Stream*** ④	FW Acute	No	0.1 cfs	FW Acute	No	0.1cfs
		FW Chronic	Yes	0.1 cfs	FW Chronic	Yes	0.1 cfs
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑥	FW Acute	n/a	0.0 cfs	FW Acute	No 7Q2 is 0.0 cfs	0.0 cfs
		FW Chronic	n/a	0.0 cfs	FW Chronic	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	FW Acute	n/a	0.0 cfs	FW Acute	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream***, but within the area of influence of a permitted wastewater load ⑦ the observed flow-type is altered (intermittent to perennial, or intermittent to intermittent with perennial pools) as a result of the discharge ⑧	FW Acute	n/a	0.0	FW Acute	No 7Q2 is 0.0 cfs	0.0
Reservoir	***Reservoir***	FW Acute	n/a	n/a	FW Acute	n/a	n/a
		FW Chronic	n/a	n/a	FW Chronic	n/a	n/a

Table 3-5. Aquatic Life Use—Toxic Criteria

Water Body/ Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A and water bodies identified in Appendix D of the TSWQS			Unclassified Water Bodies ①		
		Aquatic Life Criteria see Tables 3-3 and 3-4 in the Guidance	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or no information to contrary**	**Aquatic Life Criteria** see Tables 3-3 and 3-4 in the Guidance	**Eliminate samples below 7Q2 ③**	**Presumed 7Q2 if not published or no information to contrary**
Tidal Stream	***Tidal Stream***	SW Acute	n/a	n/a	SW Acute	n/a	n/a
		SW Chronic	n/a	n/a	SW Chronic	n/a	n/a
Estuary	***Estuary***	SW Acute	n/a	n/a	SW Acute	n/a	n/a
		SW Chronic	n/a	n/a	SW Chronic	n/a	n/a
Ocean	***Ocean***	SW Acute	n/a	n/a	n/a	n/a	n/a
		SW Chronic	n/a	n/a	n/a	n/a	n/a
Freshwater Wetland	***Freshwater Wetland***	SW Chronic	n/a	n/a	FW Acute	n/a	n/a
		SW Acute	n/a	n/a	FW Chronic	n/a	n/a
Saltwater Wetland	***Saltwater Wetland***	SW Acute	n/a	n/a	SW Acute	n/a	n/a
		SW Chronic	n/a	n/a	SW Chronic	n/a	n/a

① Presumed ALU and criteria are used for unclassified water bodies except for the site specific criteria listed in Appendix E, and perennial streams listed in Appendix D of the Texas Surface Water Quality Standards (TSWQS).
② Presume event was above the 7Q2 for classified perennial stream segments when no flow information is available for the event. Note that flow severity of 1 is no flow, and thus the event is below 7Q2. Flow severity of 2 through 5 is above the 7Q2.
③ Presume event was above the 7Q2 for unclassified perennial stream if no flow information is available (either severity code or measurement).
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
⑥ Definition of intermittent with perennial pools: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life (not just a refuge). Generally, an “adequate pool” to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ The area of influence is established in the TCEQ permitting process.
⑧ In the stretch of stream upstream and downstream, and outside of the area of influence from wastewater flow, the observed flow-type is used to the establish the flow-type, ALU, and criteria for assessment.

is not supported when samples are toxic more than ten percent of the time using the binomial method. Although a minimum of ten samples are required for full assessment when two or more ambient water (or sediment) samples are toxic in smaller data sets, the aquatic life use is not attained.

Samples generated by EPA Region 6 TOXNET Program will be evaluated as Concerns when persistent (> 50% and based on the judgment of the assessor) sublethal effects are identified. Where such concerns for sublethal effects are identified with TOXNET samples, subsequent testing using conventional water toxicity testing methods will be initiated to confirm sublethal effects. The water body may be listed based on lethal effects demonstrated with TOXNET samples, and with conventional water toxicity testing methods exhibiting lethal or sublethal effects. Persistent sublethal effects based on conventional water toxicity testing will be used to list the water body, with some judgement allowed to the assessor in cases where toxicity testing is highly episodic and occurrences of sublethal toxicity are observed at varying points in time and under a various water quality conditions (e.g. sublethal toxicity is observed under a condition of flow or temperature that confounds the attribution of toxicity to a given condition and all other indicators demonstrate support of a use).

Determination of ambient toxicity is subject to some judgement by the assessor. All available information must be evaluated, including the reliability of the toxicity tests, presence of toxic contaminants, health of the biological community and condition of fish sampled, and the proximity and route to known and potential sources of toxic contaminants. For future assessments the TCEQ may prepare a weight of evidence approach for evaluating ambient water toxicity, similar to the approach we have adopted for sediment toxicity.

Ambient Sediment Toxicity

Aquatic organisms are also protected against toxic conditions in sediment. Sediment toxicity in conjunction with other water quality information may be used to make determinations of water quality standards attainment. Sediment toxicity sample collection is to be conducted to examine specific water bodies where concerns have been identified. Ambient sediment toxicity assessments will examine the spatial and temporal relationship between contaminants, observed toxicity, and resident biological communities. All information will be integrated into a weight of evidence approach to best judge the condition of the area of investigation and to identify toxic sediment. The lines of evidence (LOE) process described in this guidance document is appropriate for defining use support and listing or delisting on the 303(d) List. Planning water quality restoration and decisions about implementation, will require additional sampling and information gathering.

The method for evaluating sediment toxicity is outlined in Appendix C. Ambient sediment toxicity status is reported only with the LOE assessment method and only when there are at least two of the following LOE available for consideration—ambient whole sediment or elutriate tests, sediment contaminant levels, or biological community data. However, use support of aquatic life using the LOE ambient sediment toxicity method is routinely reported only when ambient whole sediment or elutriate tests are available. Acute and chronic whole sediment and elutriate test

outcomes are reported as results for these assessment methods (number of samples and number of exceedances), but use attainment or concern status not reported for these methods.
When concerns for sediment toxicity are identified using elutriate samples, additional monitoring and evaluation of use attainment will be initiated within two years using whole sediment toxicity tests.

Metal and Organic Substances Sediment Contaminant Levels

Sediments are screened for metal and organic substances that have been demonstrated to have adverse ecological effects. Sample contaminant concentrations are compared to screening levels developed by TCEQ's Ecological Assessment Program outlined in Table 3-6. A concern for aquatic life is identified if more than 20 percent of the contaminant samples exceed the screening levels using the binomial method.

Table 3-6. Screening Levels for Sediment

CAS #	Constituent	Freshwater	Marine
	Inorganics (mg/kg dry wt)		
7440-36-0	Antimony	25[a]	
7440-38-2	Arsenic	33	70
7440-43-9	Cadmium	4.98	9.6
7440-47-3	Chromium	111	370
7440-50-8	Copper	149	270
7439-89-6	Iron	40,000[b]	-
7439-92-1	Lead	128	218
7439-96-5	Manganese	1,100[b]	-
7439-97-6	Mercury	1.06	0.71
7440-02-0	Nickel	48.6	51.6
7440-22-4	Silver	2.2[a]	3.7
7440-66-6	Zinc	459	410
	Polycyclic Aromatic Hydrocarbons (µg/kg dry wt) *Footnote (j) applies to all listed PAHs*		
83-32-9	Acenaphthene	89	500
208-96-8	Acenaphthylene	130	640
120-12-7	Anthracene	845	1,100
56-55-3	Benz(a)anthracene	1,050	1,600
50-32-8	Benzo(a)pyrene	1,450	1,600
218-01-9	Chrysene	1,290	2,800
53-70-3	Dibenz(a,h)anthracene	140[k]	260
206-44-0	Fluoranthene	2,230	5,100
86-73-7	Fluorene	536	540

Table 3-6. Screening Levels for Sediment			
CAS #	**Constituent**	**Freshwater**	**Marine**
Polycyclic Aromatic Hydrocarbons (µg/kg dry wt)			
91-57-6	2- Methyl naphthalene	-	670
91-20-3	Naphthalene	561	2,100
85-01-8	Phenanthrene	1,170	1,500
129-00-0	Pyrene	1,520	2,600
	Low Molecular Weight PAHs	-	3,160[e,i]
	High Molecular Weight PAHs	-	9,600[f, i]
	Total PAH	22,800[g, i, j]	44,790[g, i, j]
Chlorinated Pesticides/PCBs/Benzenes (µg/kg dry wt)			
309-00-2	Aldrin	80[b]	-
27323-18-8	Aroclor 1254	340[b]	-
12674-11-2	Aroclor 1016	530[b]	-
11096-82-5	Aroclor 1260	240[b]	-
12672-29-6	Aroclor 1248	1,500[b]	-
319-84-6	alpha-BHC	100[b]	-
319-85-7	beta-BHC	210[b]	-
Chlorinated Pesticides/PCBs/Benzenes (µg/kg dry wt) (continued)			
58-89-9	gamma-BHC (Lindane)	4.99	0.99[d]
608-73-1	BHC	120[b, i]	-
57-74-9	Chlordane (Total)	17.6	4.79[d]
60-57-1	Dieldrin	61.8	4.30[d]
72-20-8	Endrin	207	-
118-74-1	HCB (Hexachlorobenzene)	240[b]	-
1024-57-3	Heptachlor epoxide	16	-
2385-85-5	Mirex	1,300[b]	-
72-55-9	Sum DDE	31.3[i]	374[d, i]
72-54-8	Sum DDD	28[i]	7.81[d, i]
50-29-3	Sum DDT	62.9[i]	4.77[d, i]
	Total DDT	572[i]	46[i]
1336-36-3	Total PCBs	676[i]	180[i]
Other Pesticides (µg/kg dry wt)			
8001-35-2	Toxaphene	32[m]	-
Phthalates (µg/kg dry wt)			
117-81-7	Bis(2-ethyl-hexyl)phthalate	-	2,647[d]
	Di-n-butyl phthalate	43[l]	-

Table 3-6. Screening Levels for Sediment			
CAS #	**Constituent**	**Freshwater**	**Marine**
Volatiles (µg/kg dry wt) *Footnote (n) applies to all listed volatiles*			
67-64-1	Acetone	367,990	1,003,360
107-13-1	Acrylonitrile	1,360	1,040
71-43-2	Benzene [0]	45,010	45,010
104-51-8	N-butylbenzene	6,570	-
103-65-1	Propyl benzene	4,350	-
135-98-8	Sec-butylbenzene	5,280	-
98-06-6	Tert-butylbenzene	7,260	-
75-27-4	Bromodichloromethane	14,740	-
78-93-3	2-butanone	154,260	-
75-15-0	Carbon disulfide	780	-
56-23-5	Carbon tetrachloride [0]	37330	37,330
108-90-7	Chlorobenzene [0]	19,870	19,870
124-48-1	Chlorodibromomethane	940	-
67-66-3	Chloroform (trichloromethane)	5,630	25.8
74-87-3	Chloromethane	10,680	52,430
98-82-8	Cumen	53,950	-
99-87-6	p-Cymene	5,980	-
95-50-1	1,2-dichlorobenzene	4,950	4,440
541-73-1	1,3-dichlorobenzene	350	1,950
106-46-7	1,4-dichlorobenzene	4,650	4,210
75-71-8	Dichlorodifluoromethane	22,090	-
75-34-3	1,1-dichloroethane	13,890	-
107-06-2	1,2-dichloroethane	28,690	25,800
75-35-4	1,1-dichloroethene	11,220	92,470
156-60-5	1,2-dichloroethene (trans)	71,840	-
78-87-5	1,2-dichloropropane	13,170	-
542-75-6	1,3-dichloropropene	1,370	260
100-41-4	Ethylbenzene	17,180	3,930
87-68-3	Hexachlorobutadiene [0]	550[m]	12.76[n,o]
67-72-1	Hexachloroethane [0]	13,770	13,770
110-54-3	Hexane, n- [0]	12,770	-
591-78-6	2-hexanone	28,200	-
108-10-1	4-methyl-2-pentanone (MIBK)	116,590	272,060
74-83-9	Methyl bromide	460	2,490
22967-92-6	Methyl Mercury	N/A	-
80-62-6	Methyl methacrylate	56.98	-
75-09-2	Methylene chloride	46.52	22,910

Table 3-6. Screening Levels for Sediment			
CAS #	**Constituent**	**Freshwater**	**Marine**
Volatiles (µg/kg dry wt) (continued)			
98-95-3	Nitrobenzene [0]	161.06	161,060
71-41-0	1-Pentanol [0]	N/A	-
67-63-0	2-Propanol [0]	443.99	-
100-42-5	Styrene	61,420	22,310
79-34-5	1,1,2,2-tetrachloroethane	3,800	3,690
127-18-4	Tetrachloroethene	10,050	18,590
108-88-3	Toluene	17,290	5,660
75-25-2	Bromoform	1,310	10,670
120-82-1	1,2,4-trichlorobenzene	5,310	2,320
71-55-6	1,1,1-trichloroethane	24,800	15,830
79-00-5	1,1,2-trichloroethane	5,880	1,800
79-01-6	Trichloroethene	5,070	8,820
75-69-4	Trichlorofloromethane	10,120	-
76-13-1	1,1,2-trichlorotrifluoroethane	16,700	-
95-63-6	1,2,4-trimethylbenzene	4,580	12,950
108-67-8	1,3,5-trimethylbenzene	4,590	-
108-05-4	Vinyl acetate [0]	366,290	-
75-01-4	Vinyl chloride	11,780	-
108-38-3	m-Xylene [0]	2,080	-
1330-20-7	Xylenes	12,010	7,470

Table 3-6. Screening Levels for Sediment			
CAS #	**Constituent**	**Freshwater**	**Marine**

Freshwater - Unless otherwise noted, values are Probable Effect Concentration (PEC)(changed from TEC by SWQM awaiting new errata from Remediation) from: MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

Marine - Unless otherwise noted, values are Effects Range Median (ERM) from: Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environ. Manage. 19(1):81-97.

a Effects Range Median (ERM) from: Long, E.R. and L.G. Morgan. 1990. The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, March 1990.

b Severe Effects Level (SEL) from: Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Water Resources Branch. Ontario Ministry of the Environment and Energy. August.

c Probable Effect Levels (PEL) from: Environment Canada. 1997. Canadian Sediment Quality Guidelines for DDTs. Environment Canada, Guidelines and Standards Division. January, 1998 Draft.

d Probable Effect Level (PEL) from: Smith, S.L., D.D. MacDonald, K.A. Keenleyside, and C.L. Gaudet. 1996b. The Development and Implementation of Canadian Sediment Quality Guidelines. In: Development and Progress in Sediment Quality Assessment: Rationale, Challenges, Techniques & Strategies. Ecovision World Monograph Series. Munawar & Dave (Eds.). Academic Publishing, Amsterdam, The Netherlands.

e The sum of the concentrations of the following compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, and 2-methyl napthalene.

f The sum of the concentrations of the following compounds: fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, and dibenzo [a,h]anthracene.

g The sum of the concentrations of each of low and high molecular weight PAHs listed above and any other PAH compounds that are COCs.

h Values in the original reference were based on percent total organic carbon. These values were converted to bulk sediment values by assuming 1% TOC (SEL x 0.01).

i When benchmarks represent the sum of individual compounds, isomers, or groups of congeners, and the chemical analysis indicates an undetected value, the proxy value specified at §350.51 (n) shall be used for calculating the sum of the respective compounds, isomers, or congeners. This assumes that the particular COC has not been eliminated in accordance with the criteria at §350.71 (k).

j The benchmarks for total PAHs are the most relevant in evaluating risk in an ERA as PAHs almost always occur as mixtures. Values for individual, low molecular weight, and high molecular weight PAHs are provided as guidelines to aid in the determination of disproportionate concentrations within the mixture that may be masked by the total. See discussion in Section 3.5.4.

k CCME (Canadian Council of Ministers of the Environment). 1999. Canadian environmental quality guidelines. Winnipeg, Manitoba.

l Cubbage, J., D. Batts, and S. Briedenbach. 1997. Creation and analysis of freshwater sediment quality values in Washington State. Environmental Investigations and Laboratory Services Program. Washington Department of Ecology. Olympia, Washington.

m NYSDEC (New York State Department of Environmental Conservation). 1999. Technical guidance for screening contaminated sediments. Division of Fish , Wildlife, and Marine Resources. Albany, New York. 36 pp.

n Benchmarks derived using formula in: Fuchsman, P.C. 2003. Modification of the Equilibrium Partitioning Approach for Volatile Organic Compounds in Sediment. Environ Toxicol Chem. 22:1532-1534. TCEQ's LC50 database used for water quality values, except where noted. TRRP-24 default values of 1% fraction organic carbon (f_{oc}) and 0.37 porosity were used. The person should adjust these values if sufficient site-specific data indicate they are not representative.

o Acute water quality values were used as input for these COCs and were derived from DiToro, D.M., J.A. McGrath, and D.J. Hansen. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and tissue. Environ. Toxicol. Chem. 19: pp 1951-1970.

Fish and Benthic Community Assessment

In the TSWQS, an exceptional, high, intermediate, or limited aquatic life use is assigned to each classified water body, and to some unclassified water bodies, based on physical, chemical, and biological characteristics (see Appendixes A and D of the TSWQS). Biological characteristics that describe each aquatic life use category are assessed, based on fish and/or benthic macroinvertebrate data. For water bodies where aquatic life use categories have been designated or presumed, use attainment can be assessed. Determination of attainment of biological characteristics deemed appropriate for each aquatic life use category is based on the use of

multimetric indices of biological integrity which integrate structural and functional attributes of biotic assembleges.

Fish and benthic community data are collected according to field methods specified in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (RG-416). These data are used to evaluate the integrity of the fish community based on the *index of biotic integrity* (IBI). The IBI cannot be used to assess fish community samples collected from reservoirs or tidal streams. Please refer to the Volume 2 document for guidance on the use of IBIs. Regional IBIs must be used where available.

If benthic macroinvertebrates are collected according to *quantitative protocols* using a Surber sampler, the integrity of the benthic macroinvertebrate community should be evaluated based on the benthic index of biotic integrity. If benthic macroinvertebrates are collected according to *rapid bioassessment* (RBA) *protocols* (5-minute kicknet, RBA snags), then the integrity of the benthic macroinvertebrate community should be evaluated based on the metric set for evaluation of benthic macroinvertebrate data outlined in the Volume 2 of the SWQM Procedures (RG-416).

Aquatic Habitat

An evaluation of habitat quality is critical to any assessment of ecological integrity. Habitat protocols have been developed primarily for wadeable streams. A habitat quality evaluation is accomplished by measurement of physical habitat parameters at evenly-spaced transects over a defined stream reach according to established TCEQ protocols (*SWQM Procedures*, Vol 2, RG-416). These habitat measurements should be conducted at the same time as biological field work. Measurements are made instream, along the stream channel and banks, and in the riparian zone to provide a holistic habitat assessment. The actual habitat process involves rating nine parameters across four categories through use of a *multimetric habitat quality index*. The total score obtained from the stream reach is compared to categorical ranges that relate to exceptional, high, intermediate, and limited aquatic life uses. When the habitat index indicates nonsupport, the habitat attainment status is reported as a Concern.

Determining Overall Aquatic Life Use

When available, the determination of fish and/or benthic macroinvertebrate integrity should be used in conjunction with physical and chemical data to provide an integrated assessment of support of the aquatic life use for water bodies identified in the TSWQS (Appendixes A and D). Support for a given water body should be assessed according to the decision matrix specified in Table 3-7. Determination of attainment for bioassessment data is based on the average of the total scores. Scores are derived for each of two or more bioassessment events as described in *Volume 2 of the SWQM Procedures* (RG-416)

Two bioassessment events. If only two bioassessment events are considered, both should be conducted during the index period March 15 to October 15, with only one of the two events occurring between July 1 and September 30. An effort should be made to collect both samples

from the same index period. This reduces the probability of missing effects of perturbation(s) that occurred in the latter portion of the index period.

More than two bioassessment events. If more than two bioassessment events are considered, then the period of study should be two or more years, with two events or more samples per year. More than two samples collected during the same year may be considered as long as sample dates are consistent with temporal guidelines below.

All events should occur between March 15 and October 15 with one-half to two-thirds of the events occurring between July 1 and September 30.

Sample events are conducted at about one month apart and during periods of moderate to low flow but above the 7Q2.

The average score is compared to the aquatic life use point score ranges for fish, and for benthic macroinvertebrates, depending on what field protocols were followed. If sample results from multiple events are very different, the reasons will be determined, if possible, and it will be determined if the samples are appropriate for use. An aquatic life concern is identified when only one sample event is available for assessment and nonsupport of the use is indicated.

Threatened and Endangered Species

When water quality conditions do not support a healthy aquatic community or individual populations, including threatened and endangered species, that aquatic life use is not attained. A link to the most up-to-date information for threatened and endangered species will be provided on the TCEQ website. This information can be used to identify the presence of these species for use in assigning categories for TMDL development and planning the basin cooperative monitoring schedule.

Table 3-7. Decision Matrix for Integrated Assessments of Aquatic Life Use (ALU) Support

Overall Aquatic Life Use Support based on Bioassessment, Dissolved Oxygen, Toxics in Water, and Ambient Toxicity in Water. For three or more lines of evidence, unless otherwise illustrated here, nonattainment of any line of evidence discussed here results in nonsupport of the ALU.

Bioassessment Data	Aquatic Life Use Support Attainment					
	Dissolved Oxygen Data Meets Screening Criteria**	Toxics in Water, Toxicity Testing All Meet Screening Criteria	Dissolved Oxygen Data DO Not Meet Screening Criteria	Toxics in Water, Toxicity Testing Do Not Meet Screening Criteria	Habitat Assessment Meets Screening Criteria	Habitat Assessment Does Not Meet Screening Criteria (reported as a Concern)
Benthic macroinvertebrate and fish bioassessments done and both attain designated ALU	Fully Supported	Fully Supported	Fully Supported*	Not Supported	Fully Supported	Fully Supported *
Benthic macroinvertebrate and fish bioassessments done and one of the two does not attain designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supporting
Both benthic macroinvertebrate and fish bioassessment done and both indicate non-attainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only fish bioassessment done and indicates nonattainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only benthic macroinvertebrate bioassessment done and indicates nonattainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only fish bioassessment done and indicates attainment of designated ALU	Fully Supported	Fully Supported	Not Supported*	Not Supported	Fully Supported	Fully Supported *
Only benthic macroinvertebrate bioassessment done and indicates attainment of designated ALU	Fully Supported	Fully Supported	Not Supported*	Not Supported	Fully Supported	Fully Supported *
Bioassessment data not available	Fully Supported	Fully Supported	Not Supported	Not Supported	Fully Supported	Not Supported**

Both fish and macroinvertebrate samples are required to make an aquatic life use (ALU) attainment determination for 305(b)/303(d) assessment purposes. In certain cases where it is only possible to collect one or the other, the ALU determination may be made based on only fish or benthic macroinvertebrates according to the framework presented in this table. Proper justification is required for why only one type of community was sampled.

* Long-term bioassessment monitoring will be conducted to determine if adverse effects to the fish and/or benthic macroinvertebrates are detected.

** Listing when only habitat data is available, or when only habitat is impaired, will be done to protect the seagrass habitat only. When the habitat index indicates nonsupport, the habitat attainment status is reported as a Concern.

*** The average IBI and HBI scores are compared to the aquatic life use point score ranges for fish, and for benthic macroinvertebrates, depending on what field protocols were followed. If sample results from multiple events are very different, the reasons will be determined, if possible, and it will be determined if the samples are appropriate for use.

Recreation Use

Contact recreation is assigned to all water bodies, except for a few discussed below (non contact recreation.) Full support of the contact recreation use is not a guarantee that the water is completely safe of disease-causing organisms. Three organisms are analyzed in water samples collected to determine support of the contact recreation use: fecal coliform and *Escherichia coli* (*E. coli*) in freshwater, and fecal coliform and Enterococci in tidal water (see Table 3-8).

A *noncontact recreation* designation is assigned to some water bodies where ship and barge traffic makes contact recreation unsafe or a waterfowl refuge results in naturally high levels of bacteria. The recreation use for these water bodies is protected by the same criteria and indicators assigned to contact recreation waters—fecal coliform, *E. coli,* and Enterococci.

Bacteria densities are elevated and recurrent in Segment 2308 of the Rio Grande near El Paso, and they are caused by pollution that cannot be reasonably controlled under Texas law. A fecal coliform geometric average of 2,000 colonies/100 mL or an *E.coli* geometric average of 605 colonies/100 are assigned to protect the recreation use in this segment. A fecal coliform criterion of 4,000 colonies/100mL applies to individual samples. There is no single sample criterion for *E. coli*.

Some water bodies (for example, Segments 1006 and 1007 of the Houston Ship Channel) are not assigned recreation use due to local statutes that preclude any recreational uses for safety reasons.

Bacterial Indicators

For routinely monitored bacteria data, the following longterm geometric averages have been established as criteria: fecal coliform, 200 colonies/100 mL; *E. coli*, 126 colonies/100 mL; and Enterococci, 35 colonies/100mL. A fecal coliform criterion of 400 colonies/100 mL, an *E. coli* criterion of 394 colonies/100 mL, and an Enterococci criterion of 89 colonies/mL also apply to individual samples. The recreation use is not supported if the geometric average of the samples collected over the assessment period (two to five years) exceeds the criterion or if the criteria for individual samples are exceeded greater than 25 percent of the time using the binomial method.

Hierarchy of bacteria assessment parameters. The preferred indicators are *E. coli* (for freshwater) and Enterococci (for tidal waters), and these indicators are used if there are adequate data, even if fecal coliform data are also available. In these cases the data set qualifier for assessment methods using fecal coliform is reported as SM (superceded by another assessment method). In freshwater streams and reservoirs that have high concentrations of dissolved solids and specific conductance exceeding 10,000 microsiemens, the high salt concentration makes *E. coli* detection unreliable and fecal coliform will be used.

Assessments based on fecal coliform are being phased out. Note, when only fecal coliform data are available, fecal coliform will be used to determine use support and list. Bacteria impairments based on fecal coliform will be delisted with either fecal coliform or the new indicators. Bacteria listed with the new indicators will only be delisted with the new indicators.

Table 3-8. Recreation Use—Bacterial Indicator Criteria

Water Body/Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS				Unclassified Water Bodies			
		Most Typically Designated Recreation Use	Designated Criteria geometric mean/ single sample as cfu/100 mLs	Eliminate samples collected below the 7Q2 ②	Presumed 7Q2 if not published or no information to contrary	Recreation Use for all Unclassified Waters ①	Designated Criteria geometric mean/ single sample as cfu/100 mLs	Eliminate samples below 7Q2 ③	Presumed 7Q2 if not published with or no information to contrary
Freshwater Stream	***Freshwater Perennial Stream*** ④	Contact	126/394 *E. coli* 200/400 fecal coliform	Yes	0.1 cfs	Contact	126/394 *E. coli* 200/400 fecal coliform	Yes	0.1cfs
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life⑥	Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	0.0 cfs	Contact	126/394 *E. coli* 200/400 fecal coliform	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	0.0 cfs	Contact	126/394 *E. coli* 200/400 fecal coliform	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	Freshwater Intermittent Stream, but within the area of influence of a permitted wastewater load ⑦ the observed flow-type is altered (intermittent to perennial, or intermittent to intermittent with perennial pools) as a result of the discharge ⑧	Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	0.0 cfs	Contact	126/394 *E. coli* 200/400 fecal coliform	No 7Q2 is 0.0 cfs	0.0 cfs
Reservoir	***Reservoir***	Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	n/a	Contact	126/394 *E. coli* 200/400 fecal coliform 0/3.0	n/a	n/a
Tidal Stream	***Tidal Stream***	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a
Estuary	***Estuary***	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a
Ocean	***Ocean***	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a	n/a	n/a	n/a	n/a
Freshwater Wetland	***Freshwater Wetland***	Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	n/a	Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	n/a
Saltwater Wetland	***Saltwater Wetland***	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a	Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a

Table 3-8. Recreation Use—Bacterial Indicator Criteria

Water Body/Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS				Unclassified Water Bodies			
		Most Typically Designated Recreation Use	Designated Criteria geometric mean/ single sample as cfu/100 mLs	Eliminate samples collected below the 7Q2 ②	Presumed 7Q2 if not published or no information to contrary	Recreation Use for all Unclassified Waters ①	Designated Criteria geometric mean/ single sample as cfu/100 mLs	Eliminate samples below 7Q2 ③	Presumed 7Q2 if not published with or no information to contrary
Freshwater Perennial Stream	***Freshwater Perennial Stream*** Segment 2308 only	Non Contact	605/no single sample for *E. coli* 2000/4000 fecal coliform	yes	see Implementation Procedures	n/a	n/a	n/a	n/a
Reservoir	***Reservoir*** Segment 0105 only	Non Contact	126/394 *E. coli* 200/400 fecal coliform	n/a	n/a	n/a	n/a	n/a	n/a
Tidal Stream	***Tidal Stream*** Segments 1005, 1701, 2437, 2438, 2484, and 2494 only	Non Contact	35/89 Enterococcus 200/400 fecal coliform	n/a	n/a	n/a	n/a	n/a	n/a

① TCEQ has assigned criteria for contact recreation to all unclassified water bodies as part of the general criteria in the Texas Surface Water Quality Standards (TSWQS).
② Presume event was above the 7Q2 for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.
③ Presume event was above the 7Q2 for unclassified perennial stream if no flow information is available (either severity code or measurement). TSWQS 307.8(a)(1)(F) Criteria do not apply below the 7Q2 for unclassified perennial streams but do apply at all times to unclassified streams and streams with perennial pools.
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
⑥ Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. Generally, an "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ The area of influence is established in the TCEQ permitting process.
⑧ In the stretch of stream upstream and downstream, and outside of the area of influence from wastewater flow, the observed flow-type is used to the establish the flow-type, ALU, and criteria for assessment.

Delisting bacteria impairments on perennial streams. If nonpoint sources are the primary contributors of bacteria to a water body, then bacteria may support if better quality low-flow samples are over represented in the data set. When removing perennial streams from the 303(d) List due to improved conditions for bacterial indicators, consideration should be given to over-representation of low flow conditions in the dataset (the criteria do not apply below the 7Q2 in perennial streams).

Recreational Beaches

Repeated swimming advisories and beach closures result in the loss of recreational and economic opportunity in coastal communities. This is the type of water quality impairment that TCEQ can address through 303(d) listing and the TMDL process. The TCEQ is developing a methodology for the listing of recreational beaches, based on narrative criteria. Components of the methodology will be discussed with the *SWQM Guidance Advisory Workgroup* and TCEQ management for use in the 2010 assessment.

General Use

Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality, rather than for protection of one specific use (see Table 3-9). Water temperature, pH, chloride, sulfate, and total dissolved solids (TDS) are the parameters protecting aquatic life, recreation, public water supply, and other beneficial uses of water resources. For the purpose of assessment, the criteria protecting these multiple uses are evaluated for attainment of a construct that we entitled, “general use”.

Specific criteria for each of the other parameters are assigned to every classified segment in the TSWQS based on physical, chemical, and biological characteristics. Water temperature, pH, chloride, sulfate, and TDS criteria developed for classified segments do not apply to unclassified water bodies. Enterococci criteria are also assigned to two Houston Ship Channel segments to protect general uses.

Concerns for general uses are identified with screening levels for nutrients and chlorophyll *a* (see Table 3-10) for both classified and unclassified water bodies. Although concerns are reported for general use, attainment of the general use for unclassified water bodies is not assessed and therefore not reported.

Water Temperature

Compliance with the temperature criterion is determined by evaluating only the surface samples. The aquatic life use is supported when it is demonstrated that the temperature criterion is not attained due to permitted thermal discharges and it can be demonstrated that there is a healthy and balanced indigenous aquatic community.

Table 3-9. General Use—Criteria for Assessment

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS			Unclassified Water Bodies ③		
		Assigned Criteria and Screening Levels ① See appendix A in the TSWQS and Table 3-10 in the Guidance	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or with no information to contrary**	**Criteria and Screening Levels**	**Eliminate samples below 7Q2**	**Presumed 7Q2 if not published with or no information to contrary**
Freshwater Stream	***Freshwater Perennial Stream*** ④	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	Yes for Water Temp High pH Low pH only	0.1 cfs	Nutrients Chlorophyll *a*	No	0.1 cfs
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑥	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	0.0 cfs	Nutrients Chlorophyll *a*	No	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	0.0 cfs	Nutrients Chlorophyll *a*	No	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** but within the area of influence of a permitted wastewater load ⑦ the observed flow-type is altered (intermittent to perennial, or intermittent to intermittent with perennial pools) as a result of the discharge ⑧	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	0.0 cfs	Nutrients Chlorophyll *a*	No	0.0 cfs

Table 3-9. General Use—Criteria for Assessment

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS			Unclassified Water Bodies ③		
		Assigned Criteria and Screening Levels ① See appendix A in the TSWQS and Table 3-10 in the Guidance	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or with no information to contrary**	**Criteria and Screening Levels**	**Eliminate samples below 7Q2**	**Presumed 7Q2 if not published with or no information to contrary**
Reservoir	***Reservoir***	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	n/a	Nutrients Chlorophyll *a*	n/a	n/a
Tidal Stream	***Tidal Stream***	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	n/a	Nutrients Chlorophyll *a*	n/a	n/a
Estuary	***Estuary***	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	n/a	Nutrients Chlorophyll *a*	n/a	n/a
Ocean	***Ocean***	-Water temperature -High pH -Low pH	n/a	n/a	Screening levels for nutrients and chlorophyll *a* not available	n/a	n/a
Freshwater Wetland	***Freshwater Wetland***	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	n/a	Screening levels for nutrients and chlorophyll *a* not available	n/a	n/a

Table 3-9. General Use—Criteria for Assessment

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS			Unclassified Water Bodies ③		
		Assigned Criteria and Screening Levels ① See appendix A in the TSWQS and Table 3-10 in the Guidance	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or with no information to contrary**	**Criteria and Screening Levels**	**Eliminate samples below 7Q2**	**Presumed 7Q2 if not published with or no information to contrary**
Saltwater Wetland	***Saltwater Wetland***	-Water temperature -High pH -Low pH -Dissolved solids -Nutrients -Chlorophyll *a*	n/a	n/a	Screening levels for nutrients and chlorophyll *a* not available	n/a	n/a
Tidal Stream	*Tidal Stream* Segments 1006 and 1007 only	Enterococcus ⑨	n/a	n/a	n/a	n/a	n/a

① General Use criteria are listed in Appendix A of the Texas Surface Water Quality Standards (TSWQS). Nutrient and chlorophyll *a* screening levels are listed in Table 3-10.
② Presume event was above the 7Q2 for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.
③ General Use criteria are not assigned in the TSWQS to unclassified water bodies.
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
⑥ Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. An “adequate pool” to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ The area of influence is established in the TCEQ permitting process.
⑧ In the stretch of stream upstream and downstream, and outside of the area of influence from wastewater flow, the observed flow-type is used to the establish the flow-type, ALU, and criteria for assessment.
⑨ Enterococcus 30-day geometric mean - 168 colonies/100ml; the maximum enterococcus density in 10% of samples in a 30-day period if greater than ten samples or in a single sample if fewer than ten samples are collected is 500 colonies/100mL.

High and Low pH

Values of pH are evaluated over the mixed surface layer when data are available. The median of the values in the mixed surface layer for each sample event is determined and these median values are compared to the high and low criteria for evaluation with the binomial method. Use of the median measurement avoids comparing the criteria to extreme values observed at times in the summer near the surface and caused by natural conditions.

Chloride, Sulfate, and Total Dissolved Solids

Chloride, sulfate, and TDS criteria in the TSWQS were developed to represent annual averages of all values that were collected when stream flow equaled or exceeded the 7Q2 value established for each segment. Due to infrequent monitoring and absence of stream flow information at many sites, all of the chloride, sulfate, and TDS values are averaged for all sites within the segment and compared to the criterion for each parameter. The assessment of general uses based on the average concentration applies to the entire length or area of the segment. Samples collected at the surface are used when they are available. For cases where TDS were not measured, a value is calculated by multiplying specific conductance measured at the surface by a factor of 0.65. The chloride, sulfate, and TDS criteria are not supported if the average value exceeds the criteria.

Enterococci—Segments 1006 and 1007

An Enterococci bacterial screening level is established for two Houston Ship Channel Segments (1006 and 1007) to provide indication of contamination, rather than protection of a recreational use. Due to heavy ship and barge traffic on the Houston Ship Channel, local statutes have been enacted to discourage any kind of water based recreation. Attainment of the Enterococci criteria is based on the number of exceedances for a given sample size or the long-term geometric mean.

Screening Levels for Nutrients and Chlorophyll a

Water bodies are protected from excessive nutrient levels in order to support the general uses. The screening levels listed for nutrients and chlorophyll *a* in Table 3-10 were statistically derived from the most recent ten years of SWQM monitoring data. The 85th percentile values for each parameter in freshwater streams, tidal streams, reservoirs, and estuaries are shown in Table 3-10. A concern for water quality is identified if the screening level is exceeded greater than 20 percent of the time using the binomial method, based on the number of exceedances for a given sample size (see Appendixes A and B).

Narrative Criteria for Nutrient Enrichment

Excessive Plant Growth—Algae

The growth of microscopic algae can be stimulated by nutrient enrichment. Excessive growth of algae can result in unhealthy levels of DO for aquatic life as well as interfere with recreational uses of the water body and imparts unpleasant taste to drinking water. This nutrient enrichment is

typically identified for management action through the listing of water bodies for DO and development of TMDLs. TCEQ is developing nutrient criteria for sensitive water bodies that will use chlorophyll, a measure of algal biomass, to evaluate nutrient enrichment.

Physicochemical conditions, including nutrients can stimulate a bloom of golden algae, and the subsequent formation of toxins by *Prymnesium parvum*. The excessive growth of golden algae is identified as a concern or impairment for general use attainment.

Table 3-10. Screening Levels for Nutrient Parameters

Water Body Type	Nutrients	Screening Level
Freshwater Stream	NH_3-N	0.33 mg/L
	NO_3-N	1.95 mg/L
	OP	0.37 mg/L
	TP	0.69 mg/L
	Chl *a*	14.1 µg/L
Reservoir	NH_3-N	0.11 mg/L
	NO_3-N	0.37 mg/L
	OP	0.05 mg/L
	TP	0.20 mg/L
	Chl *a*	26.7 µg/L
Tidal Stream	NH_3-N	0.46 mg/L
	NO_3-N	1.10 mg/L
	OP	0.46 mg/L
	TP	0.66 mg/L
	Chl *a*	21.0 µg/L
Estuary	NH_3-N	0.10 mg/L
	NO_3-N	0.17 mg/L
	OP	0.19 mg/L
	TP	0.21 mg/L
	Chl *a*	11.6 µg/L

Excessive Plant Growth—Macrophytes

Excessive growth of water weeds can impair beneficial uses of recreation and aquatic life. Methods for the evaluation of the areal extent, severity, and persistence of macrophytes, particularly in lakes, will be developed by the TCEQ for future assessments.

Dissolved Oxygen Swings

Extreme swings in DO can result from eutrophic conditions or hydromodification. Such conditions can limit the development of healthy aquatic communities or cause fish kills. When these effects on aquatic life are documented, an impairment of the general use is established.

Narrative Criteria for Color

To ensure support of the general uses, Section 307.4 (b)(5) of the TSWQS specifies that waste discharges shall not cause substantial and persistent changes from ambient conditions of turbidity or color.

Support of the color standard will be a judgement made by the assessor and based on an evaluation of a number of factors. Visible changes in the water downstream of a colored wastewater discharge must be reported by field observers for an assessment to be made. Some of the factors that may be used include:

Quantitative data. The platinum-cobalt method (Standard Method 2120B) for water samples collected from both upstream and downstream of discharges. The magnitude and areal extent of color changes will be quantified.

Qualitative information. Photographic evidence. Local information (public or professional).

Additional information may be considered, such as, color sample results for other water bodies in the same ecoregion.

Support of this narrative criterion under 307.4(b)(5) applies only to surface waters directly influenced by waste discharges. Determination of support of 307.4(b)(5) will be based on a combination of the methods described above, and should include quantitative measures using the platinum-cobalt method or other applicable methods approved by the TCEQ executive director.

Fish Kill Reports and Support of Other Narrative Criteria

Additional information is solicited from CRP partners, TCEQ central and regional office staffs, and other basin stakeholders to document conditions that may contribute to narrative criteria concerns or nonsupport. Such information may consist of water quality studies, occurrence of fish kills or contaminant spills, photographic evidence, local knowledge, and best professional judgment.

TCEQ is developing assessment methods to evaluate narrative criteria for excessive sediment build-up and radionuclides in surface water.

Trophic Status of Lakes

Reservoirs and lakes become more eutrophic as they age. Eutrophication of reservoirs and lakes in southern states is enhanced due to warm, fertile climates. Human activities can accelerate the process by increasing the rate at which nutrients and organic substances enter the impoundments and their surrounding watersheds. Sewage discharges, agricultural and urban runoff, leaking septic tanks, and erosion of stream banks can increase the flow of nutrients and organic

substances into reservoirs and lakes. These substances may overstimulate the growth of algae and aquatic plants, creating conditions that interfere with contact recreation (swimming), boating (noncontact recreation), and the health and diversity of native fish, plant, and animal populations. Over-production of bacteria, fungi, and algae may also impart foul odors and tastes to the water.

Section 314 of the CWA of 1987 requires all states to classify lakes and reservoirs according to trophic state. The trophic state of a reservoir refers to its nutritional status. Various classification schemes or indices have been developed that group reservoirs into discrete quality (trophic) states along a continuum from oligotrophic (poorly nourished) to hypereutrophic (over nourished). The basis for the trophic state index concept is that, in many reservoirs, the degree of eutrophication may be related to increased nutrient concentrations. Typically, phosphorus is the nutrient of concern, and an increase in its concentration may trigger a responding increase in the amount of algae (estimated by chlorophyll *a*) in the reservoir. Due to increased algal biomass, water transparency, as measured by a Secchi disk or submarine photometer, decreases.

Major Texas reservoirs are evaluated and ranked by the TCEQ using Carlson's Trophic State Index (TSI). Carlson's Index was developed to compare Secchi disk depths, chlorophyll *a* concentrations, and total phosphorus concentrations obtained by in- reservoir sampling (Carlson, 1977). These three variables are highly correlated and are considered estimators of algal biomass. By using multiple regression analysis, the index relates Secchi disk depth to total phosphorus concentration and to chlorophyll *a* concentration. The final result of the analysis is a ranking of reservoirs from the least to most eutrophic.

Fish Consumption Use

Fish consumption use attainment is evaluated with three assessment methods described below. For a full assessment of use attainment for fish consumption and a determination of fully supporting, a DSHS risk assessment or advisory is required. Risk assessments are costly and conducted only on water bodies where the screening has indicated a risk from consumption and as a result, few waterbodies are identified as fully supporting the fish consumption use.

Advisories Closures, and Risk Assessments

The fish consumption use is assessed by review of Texas Department of State Health Services (DSHS) published fish tissue data, human risk assessment information, consumption advisories, and aquatic life closures. The TSWQS require that surface waters shall not be toxic to humans from consumption of aquatic organisms. The DSHS Web site (**www.tdh.state.tx.us/bfds/ssd/default.htm**) is a source of information concerning fish consumption advisories and aquatic life closures. The DSHS is consulted concerning recent data and information on existing and imminent fish consumption advisories and aquatic life closures. Results of fish/shellfish tissue sampling by the DSHS are available in their latest publication, *DSHS Fish Sampling Data, 2000-2001*. Data are no longer published but are available electronically.

The fish consumption use is supported in water bodies where the DSHS has collected tissue data and a subsequent risk assessment for parameters of local concern indicates no significant risk due to consumption over a person's lifetime. Where risk assessments have been performed for only a limited number of pollutants or the risk assessment is not up to date, yet no risk is identified, a support of no concern is reported.

The use is not supported when a restricted-consumption advisory or no consumption advisory has been issued for the general population, or a subpopulation that could be at greater risk (children or women of child-bearing age), or when an aquatic life closure has been issued that prohibits the taking of aquatic life from the affected water body.

Parameters causing nonsupport of the criteria are identified by a review of the DSHS risk assessment that forms the basis for an advisory. Parameters identified as nonsupporting are based on measured concentrations in fish tissue (see Appendix D).

Evaluation of the fish consumption use differs from evaluation of attainment of other uses. Full support of fish consumption use is only reported when a risk assessment has been done by DSHS for parameters of local concern and they report that consumption of fish does not pose a significant risk.

Human Health Criteria for Bioaccumulation and Fish Consumption Use

Support of the fish consumption use is also determined by review of human health criteria for toxics in water, designated in the TSWQS (see Table 3-11). For each toxicant parameter, across the segment, the average of all values for water samples collected during a five-year period is computed. The averages are evaluated for human health criteria as indicated in Table 3-12. The assessment of fish consumption use with human health criteria applies to all of the AUs with a sustainable or incidental fishery.

Should the average be exceeded over the period of record, the data set is subsequently evaluated to ensure the criterion is also exceeded more than one time. If the average exceeds, and this is the result of only an occasional high value, the assessor will use judgement in the evaluation of the data set and a concern rather than impairment, is identified. Additional monitoring is initiated when a concern for toxic contaminants is identified.

Column A criteria are used for freshwater bodies which are designated for public water supply. These levels of contaminants pose a risk to humans when they are exposed through both drinking water and eating fish from the water body. The constituents listed in both Column A and Column B are evaluated for support of fish consumption use. Column B criteria are used for fresh waters that are capable of supporting sustainable fisheries and that are not designated for public water supply. Ten times the levels in Column B are used for unclassified perennial water bodies that are less than third order streams, reservoirs less than 50 acres in size, or other water bodies with only an incidental fishery. Column C criteria are used for classified and unclassified tidally-influenced

water bodies and protect humans from contaminated fish. The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Table 3-11. Human Health Criteria in Water

PWS = public water supply; FCU= fish consumption use

Use for this Parameter		Parameter Code	Parameter	Column A	Column B	Column C
FCU	PWS			Water and Fish µg/L	Freshwater Fish Only µg/L	Tidal-Water Fish Only µg/L
✔	✔	34215	Acrylonitrile	1.28	10.9	7.3
✔	✔	39330	Aldrin	0.00408	0.00426	0.0028
	✔	1000	Arsenic (d)	50[1]	—	—
	✔	1005	Barium (d)	2,000[1]	—	—
✔	✔	34030	Benzene	5[1]	106	70.8
✔	✔	39120	Benzidine[2]	0.00106	0.00347	0.00232
✔	✔	34526	Benzo(a) anthracene	0.099	0.810	0.540
✔	✔	34247	Benzo(a) pyrene	0.099	0.810	0.540
✔	✔	34268	Bis(chloromethyl)ether	0.00462	0.0193	0.0129
✔	✔	01025	Cadmium (d)	5[1]	—	—
✔	✔	32102	Carbon tetrachloride	3.76	8.4	5.6
✔	✔	39350	Chlordane[3]	0.0210	0.0213	0.0213
✔	✔	34301	Chlorobenzene	776	1,380	920
✔	✔	32106	Chloroform	100[1]	1,292	861
✔	✔	01030	Chromium (d)	100[1]	3,320	2,216
✔	✔	34320	Chrysene	0.417	8.1	5.4
✔	✔	79778	Cresols	3,313	13,116	8,744
	✔	00722	Cyanide (free) [4]	200[1]	—	—
✔	✔	39360	4',4'-DDD	0.0103	0.010	0.007
✔	✔	39365	4',4'-DDE	0.00730	0.007	0.005
✔	✔	39370	4',4'-DDT	0.00730	0.007	0.005
	✔	39730	2,4-D	70[1]	—	—
✔	✔	04320	Danitol[6]	0.709	0.721	0.481
✔	✔	32105	Dibromochloromethane	9.20	71.6	47.7
✔	✔	77651	1,2,-Dibromoethane	0.014	0.335	0.223
✔	✔	34561	1,3 Dichloropropene	22.8	161	107
✔	✔	39380	Dieldrin[2]	0.00171	0.002	0.001
	✔	34571	*p*-Dichlorobenzene	75[1]	—	—
✔	✔	34531	1,2-Dichloroethane	5[1]	73.9	49.3
✔	✔	34501	1,1-Dichloroethylene	1.63	5.84	3.9
✔	✔	39780	Dicofol	0.215	0.217	0.144

Table 3-11. Human Health Criteria in Water

PWS = public water supply; FCU= fish consumption use

Use for this Parameter		Parameter Code	Parameter	Column A	Column B	Column C
FCU	PWS			Water and Fish µg/L	Freshwater Fish Only µg/L	Tidal-Water Fish Only µg/L
✔	✔	—	Dioxins/Furans (TCDD Equivalents)[2] Congener/Isomer — Toxic Equivalency Factors 2,3,7,8 TCDD — 1.0 1,2,3,7,8 PeCDD — 0.5 2,3,7,8 HxCDD's — 0.1 2,3,7,8 TCDF 0.1 — 0.1 1,2,3,7,8 PeCDF — 0.05 2,3,4,7,8 PeCDF — 0.5 2,3,7,8 HxCDF's — 0.1	1.34E-07	1.40E-07	9.33E-08
✔	✔	39390	Endrin	1.27	1.34	0.893
	✔	00951	Flouride	4,000[1]	—	—
✔	✔	39410	Heptachlor[2]	0.00260	0.00265	0.00177
✔	✔	39420	Heptachlor epoxide	0.159	1.1	0.723
✔	✔	39700	Hexachlorobenzene	0.0194	0.0198	0.0132
✔	✔	34391	Hexachlorobutadiene	2.99	3.6	2.4
✔	✔	39337	Hexachlorocyclohexane (alpha)	0.163	0.413	0.275
✔	✔	39338	Hexachlorocyclohexane (beta)	0.570	1.45	0.964
✔	✔	39782	Hexachlorocyclohexane (gamma) (Lindane)	0.2[1]	2.00	1.34
✔	✔	34396	Hexachloroethane	84.2	278	185
✔	✔	88813	Hexachlorophene	0.0531	0.053	0.036
✔	✔	01049	Lead (d)	4.98	25.3	16.9
✔	✔	71900	Mercury[3]	0.0122	0.0122	0.0250
✔	✔	39480	Methoxychlor	2.21	2.22	1.48
✔	✔	81595	Methyl ethyl ketone	52,917	9.94E06	6.63E06
	✔	620	Nitrate Nitrogen	10,000	—	—
✔	✔	34447	Nitrobenzene	37.3	233	156
✔	✔	73611	*N*-Nitrosodiethylamine	0.0382	7.68	5.12
✔	✔	73609	*N*-Nitroso-di-*n*- Butylamine	1.84	13.5	8.98
✔	✔	39516	PCBs (Polychlorinated Biphenyls)[5]	0.0013	0.0013	8.85E-04
✔	✔	77793	Pentachlorobenzene	6.10	6.68	4.45
✔	✔	39032	Pentachlorphenol	1.0[1]	135	90
✔	✔	77045	Pyridine	88.1	13,333	8,889
	✔	01147	Selenium	50[1]	—	—
✔	✔	77734	1,2,4,5- Tetrachlorobenzene	0.241	0.243	0.162
✔	✔	34475	Tetrachloroethylene	5[1]	323	215
✔	✔	39400	Toxaphene[2]	0.005	0.014	0.009
✔	✔	39760	2,4,5 - TP (silvex)	47.0	50.3	33.6
✔	✔	77687	2,4,5-Trichlorophenol	953	1,069	712

Table 3-11. Human Health Criteria in Water

PWS = public water supply; FCU= fish consumption use

Use for this Parameter		Parameter Code	Parameter	Column A	Column B	Column C
FCU	PWS			Water and Fish µg/L	Freshwater Fish Only µg/L	Tidal-Water Fish Only µg/L
✔	✔	39180	Trichloroethylene	5[1]	612	408
✔	✔	34506	1,1,1-Trichloroethane	200[1]	12,586	8,391
	✔	82080	TTHM (sum of total trihalomethanes)	100[1]	—	—
✔	✔	39175	Vinyl Chloride	2[1]	415	277

[1] Based on maximum contaminant levels (MCLs) specified in 30 TAC §290 (relating to water hygiene).

[2] Calculations based on measured bioconcentration factors with no lipid correction factor (7.6 and 3.0) applied.

[3] Calculations based on USFDA action levels in fish tissue.

[4] Compliance will be determined using the analytical method for cyanide amenable to chlorination or weak-acid dissociable cyanide.

[5] Calculated as the sum of seven PCB congeners: 1016, 1221, 1232, 1242, 1254, 1248, and 1260.

[6] Laboratory analytical method is under development.

(d) Indicates the criteria are for the dissolved fraction in water. All other criteria are for total recoverable concentrations.

Table 3-12. Fish Consumption Use—Human Health Criteria

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS See Table 3-11—Human Health Criteria and Table 3-13—Tissue Screening Levels in the Guidance				Unclassified Water Bodies See Table 3-11—Human Health Criteria in the Guidance		
		Criteria for water bodies designated for public water supply Human Health Criteria—Col. A ① Screening levels for bioaccumulative substances in tissue	**Criteria for fresh water bodies capable of supporting sustainable fishery, not designated for public water supply②** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Eliminate samples collected below the harmonic mean flow (cfs)**	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. C Screening levels for bioaccumulative substances in tissue	**Criteria for fresh water bodies capable of supporting sustaninable fishery ②** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Criteria for freshwater bodies with incidental fishery ③** Ten times Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. C Screening levels for bioaccumulative substances in tissue
Freshwater Stream	***Freshwater Perennial Stream*** ④	Human Health Criteria—Col. A FW tissue screening levels	Human Health Criteria—Col. B FW tissue screening levels	Yes	n/a	Human Health Criteria—Col. B FW tissue screening levels	Ten times Human Health Criteria—Col. B FW tissue screening levels	n/a
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑥	Human Health Criteria—Col. A FW tissue screening levels	Human Health Criteria—Col. B FW tissue screening levels	Yes	n/a	Human Health Criteria—Col. B FW tissue screening levels	Ten times Human Health Criteria—Col. B FW tissue screening levels	n/a
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	Human Health Criteria—Col. A FW tissue screening levels	Human Health Criteria—Col. B FW tissue screening levels	Yes	n/a	n/a	n/a	n/a
Freshwater Stream	***Freshwater Intermittent Stream*** but within the area of influence of a permitted wastewater load ⑦ the observed flow-type is altered (intermittent to perennial, or intermittent to intermittent with perennial pools) as a result of the discharge ⑧	Human Health Criteria—Col. A FW tissue screening levels	Human Health Criteria—Col. B FW tissue screening levels	Yes	n/a	n/a	n/a	n/a

Table 3-12. Fish Consumption Use—Human Health Criteria

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS See Table 3-11—Human Health Criteria and Table 3-13—Tissue Screening Levels in the Guidance				Unclassified Water Bodies See Table 3-11—Human Health Criteria in the Guidance		
		Criteria for water bodies designated for public water supply Human Health Criteria—Col. A ① Screening levels for bioaccumulative substances in tissue	**Criteria for fresh water bodies capable of supporting sustainable fishery, not designated for public water supply②** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Eliminate samples collected below the harmonic mean flow (cfs)**	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. C Screening levels for bioaccumulative substances in tissue	**Criteria for fresh water bodies capable of supporting sustaninable fishery ②** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Criteria for freshwater bodies with incidental fishery ③** Ten times Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. C Screening levels for bioaccumulative substances in tissue
Reservoir	***Reservoir***	Human Health Criteria—Col. A FW tissue screening levels	Human Health Criteria—Col. B FW tissue screening levels	n/a	n/a	Human Health Criteria—Col. B FW tissue screening levels	Ten times Human Health Criteria — Col. B FW tissue screening levels	n/a
Tidal Stream	***Tidal Stream***	n/a	n/a	n/a	Human Health Criteria—Col. C SW tissue screening levels	n/a	n/a	Human Health Criteria—Col. C SW tissue screening levels
Estuary	***Estuary***	n/a	n/a	n/a	Human Health Criteria—Col. C SW tissue screening levels	n/a	n/a	Human Health Criteria—Col. C SW tissue screening levels
Ocean	***Ocean***	n/a	n/a	n/a	Human Health Criteria— Col. C SW tissue screening levels	n/a	n/a	Human Health Criteria—Col. C SW tissue screening levels

Table 3-12. Fish Consumption Use—Human Health Criteria

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS See Table 3-11—Human Health Criteria and Table 3-13—Tissue Screening Levels in the Guidance				Unclassified Water Bodies See Table 3-11—Human Health Criteria in the Guidance		
		Criteria for water bodies designated for public water supply Human Health Criteria—Col. A ① Screening levels for bioaccumulative substances in tissue	**Criteria for fresh water bodies capable of supporting sustainable fishery, not designated for public water supply②** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Eliminate samples collected below the harmonic mean flow (cfs)**	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. C Screening levels for bioaccumulative substances in tissue	**Criteria for fresh water bodies capable of supporting sustaninable fishery ②** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Criteria for freshwater bodies with incidental fishery ③** Ten times Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. C Screening levels for bioaccumulative substances in tissue
Freshwater Wetland	***Freshwater Wetland***	Human Health Criteria—Col. A FW tissue screening levels	Human Health Criteria—Col. B FW tissue screening levels	n/a	n/a	Human Health Criteria—Col. B FW tissue screening levels	Ten times Human Health Criteria — Col. B FW tissue screening levels	n/a
Saltwater Wetland	***Saltwater Wetland***	n/a	n/a		Human Health Criteria—Col. C SW tissue screening levels	n/a	n/a	Human Health Criteria—Col. C SW tissue screening levels

① Only those constituents listed in Column A that are also listed in Column B are evaluated.
② *Sustainable fisheries*—Descriptive of water bodies which potentially have sufficient fish production or fishing activity to create significant long-term human consumption of fish. Sustainable fisheries include perennial streams and rivers with a stream order of three or greater; lakes and reservoirs greater than or equal to 150 acre-feet andor 50 surface acres; all bays, estuaries, and tidal rivers. Water bodies which are presumed to have sustainable fisheries include all designated segments listed in Appendix A unless specifically exempted.
③ *Incidental fishery*—A level of fishery which applies to water bodies that are not considered to have a sustainable fishery but which have an aquatic life use of limited, intermediate, high, or exceptional. Water bodies with minimal aquatic life use, such as intermittent streams, are not assigned either a sustainable or incidental fishery (noted as "no fishery" in the assessment and not assessed for fish consumption use).
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
⑥ Definition of Intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. An "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ The area of influence is established in the TCEQ permitting process.
⑧ In the stretch of stream upstream and downstream, and outside of the area of influence from wastewater flow, the observed flow-type is used to the establish the flow-type, ALU, and criteria for assessment.

Bioaccumulative Substances in Fish Tissue

The screening levels for concentrations of toxicants in fish tissue were developed from human health criteria in the TSWQS, except for the metals. Screening levels for these nine metals are based on DSHS screening levels that are slightly lower than the levels used to issue consumption advisories (see Table 3-13). The human health criteria in the TSWQS are expressed as *allowable concentrations of toxicants in surface waters*. This allowable concentration in water is determined by calculating an allowable concentration in fish tissue and then dividing by the bioaccumulation factor for that particular toxicant. The formulas for deriving human health criteria were developed by the EPA.

The screening levels for 31 organic substances and copper in fish tissue are used to determine concerns for the fish consumption use (see Table 3-13). Screening levels developed by the DSHS are used for the other six metals (see Table 3-13). Five years of data are screened using these levels. Identification of concerns for water quality is determined when the screening levels are exceeded greater than 20 percent of the time based on the binomial method. The assessment of fish consumption use with tissue screening levels applies to all of the AUs with a sustainable or incidental fishery. The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Table 3-13. Screening Levels for Metals and Organic Substances in Tissue
(All values listed as mg/kg Wet Weight)

Parameter Code	Parameter	Freshwater	Tidal Water
Metals			
01004	Arsenic	0.036	0.036
71940	Cadmium	0.227	0.227
71939	Chromium	5.25	5.25
71937	Copper	250	250
71936	Lead	0.6	0.6
71930	Mercury	0.525	0.525
01069	Nickel	35	35
01149	Selenium	4.375	4.375
71938	Zinc	525	525
Pesticides			
34680	Aldrin	0.1360	0.0904
39074	*alpha*-Hexachlorocyclohexane	0.3660	0.2440
34258	*beta*-Hexachlorocyclohexane	1.2810	0.8540
39075	*gamma*-Hexachlorocyclohexane (lindane)	5.8520	3.9010
34682	Chlordane	0.3000	0.3000
81897	DDD	9.6060	6.4040

Table 3-13. Screening Levels for Metals and Organic Substances in Tissue
(All values listed as mg/kg Wet Weight)

Parameter Code	Parameter	Freshwater	Tidal Water
Pesticides (continued)			
81896	DDE	5.4500	3.6340
39376	DDT	5.2770	3.5180
85684	Dicofol (Kelthane)	5.239	3.493
39406	Dieldrin	0.0570	0.0379
34687	Heptachlor	0.2020	0.1350
34686	Heptachlor epoxide	0.2530	0.1690
34688	Hexachlorobenzene	0.6090	0.4060
81645	Mirex	0.0355	0.0236
39515	PCBs	0.1340	0.0891
85679	Pentachlorobenzene	14.1870	9.4580
34691	Toxaphene	0.8270	0.5520
Semivolatile Organic Substances			
34241	Benzidine	0.0003	0.0002
34530	Benzo(a)anthracene	0.3150	----
34251	Benzo(a)pyrene	0.315	----
88812	Cresols, total	886.667	591.111
34324	Chrysene	0.3150	----
34395	Hexachlorobutadiene	11.140	7.427
34400	Hexachloroethane	164.6670	109.7780
88815	Hexachlorophene	5.3200	3.5470
34451	Nitrobenzene	8.8670	5.9110
88818	N-Nitrosodiethylamine	0.0077	0.0051
88821	N-Nitrosodi-n-butylamine	0.4270	0.2850
39060	Pentachlorophenol	532.0000	354.6670
88824	Pyridine	17.7330	11.8220
88827	1,2,4,5-Tetrachlorobenzene	5.3200	3.5470

Public Water Supply Use

Surface Water

Human Health Criteria for Public Water Supply Use

The public water supply use is evaluated for surface water bodies by comparing the average of constituents in Column A of the human health criteria from the TSWQS (see Table 3-11). These screening levels are in part based on the primary maximum contaminant level adopted in 30 TAC §290. These assessments are restricted to 219 water bodies designated in the TSWQS for public water supply use (see Table 3-12). The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Should the average be exceeded over the period of record, the data set is subsequently evaluated to ensure the criterion is also exceeded more than one time. If the average exceeds, and this is the result of only an occasional high value, the assessor will use judgement in the evaluation of the data set and a concern rather than impairment, is identified. Additional monitoring is initiated when a concern for toxic contaminants is identified.

Toxic Substances Long-Term Average Concerns

Some organic compounds (at this time only alachlor, atrazine, MTBE, and perchlorate) that have potential human health impacts are evaluted. When data are available for surface waters designated or currently used for public water supply, concerns for water quality will be identified if the average concentrations of all sites in the segment exceed human health screening guidelines established by the TCEQ for drinking water. Human health screening levels are 2 µg/L for alachlor, 3 µg/L for atrazine, 240 µg/L for MTBE, and 22 µg/L for perchlorate. The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Finished Drinking Water

Chloride, Sulfate, and TDS

All finished water samples (minimum of 4) collected over the most recent five-year period are used to compute an average to compare to the secondary drinking water criteria in 30 TAC §290.118(b). Evaluation of these criteria is limited to chloride (300 mg/L), sulfate (300 mg/L), and TDS (1,000 mg/L). Sample results are reported and evaluated for individual water utilities and the water bodies that serve as the raw water supply. These criteria were developed to ensure that water supply utilities can treat and deliver water that is free of objectionable tastes at reasonable costs to consumers and utilities. Waters that exceed the secondary MCLs are identified as concerns, typically for the entire segment.

MCL Running Averages

The drinking water *maximum contaminant levels* (MCLs) for organic chemicals are shown in Table 3-15 and MCLs for inorganic chemicals are shown in Table 3-16. The criteria apply to finished (after treatment) drinking water that is sampled at the point of entry to distribution systems and typically are applied to the entire segment. Public water supply use support is based on a running annual average of samples (minimum of 4) computed and compared to the organic and inorganic drinking water standards. Assessment information is provided by TCEQ's Water Supply Division for the five-year assessment period.

MCL Concerns

A segment is considered a concern if information provided by TCEQ's Water Supply Division indicates finished drinking water concentrations are above one-half the MCL for primary drinking water standards greater than 10 percent of the time in the last five years. These concerns are not included on the 303(d) List.

Although no drinking water standards have been developed, MTBE and perchlorate are evaluated in the same manner as MCLs.

Increased Treatment Cost

Implementation of advanced treatment may be required for water supplies with elevated chloride, sulfate, and TDS concentrations. Public water supply systems that experience increased costs for demineralization or taste and odor treatment are identified as concerns for dissolved solids or nuisance algae, typically for the entire segment.

Table 3-14 Public Water Supply Use— Criteria and Screening Levels for Assessment of Surface Water

Water Body/Segment Type	Flow -Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	219 Classified Water Bodies in Appendix A of TSWQS with Public Water Supply Use Assigned			Unclassified Water Bodies
		Criteria and Screening Levels ‣ ***Secondary drinking water standards*** for chloride, sulfate and TDS (see PWS Surface Water section) ‣ ***Human Health Criteria***—Col A (see Table 3-11) ‣ ***alachlor, atrazine, MTBE and perchlorate*** (see Concerns for PWS Surface and Finished Drinking Water sections)	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or no information to contrary**	Unclassified water bodies are not designated for Public Water Supply Use and surface water is not screened for attainment of criteria. Finished drinking water is evaluated for compliance with the primary and secondary MCLs and the source water body is identified, for both classified and unclassified water bodies.
Freshwater Stream	***Freshwater Perennial Stream*** ④	Dissolved solids Human Health Criteria Alachlor, atrazine, MTBE, and perchlorate	No	0.1 cfs	
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑥	Dissolved solids Human Health Criteria Alachlor, atrazine, MTBE, and perchlorate	n/a	0.0 cfs	
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	Dissolved solids Human Health Criteria Alachlor, atrazine, MTBE, and perchlorate	n/a	0.0 cfs	
Freshwater Stream	***Freshwater Intermittent Stream***, but within the area of influence of a permitted wastewater load ⑦ the observed flow-type is altered (intermittent to perennial, or intermittent to intermittent with perennial pools) as a result of the discharge ⑧	Dissolved solids Human Health Criteria Alachlor, atrazine, MTBE, and perchlorate	n/a	0.0 cfs	
Reservoir	***Reservoir***	Dissolved solids Human Health Criteria Alachlor, atrazine, MTBE, and perchlorate	n/a	0.0 cfs	
Tidal Stream	***Tidal Stream***	n/a	n/a	n/a	
Estuary	***Estuary***	n/a	n/a	n/a	

Table 3-14 Public Water Supply Use— Criteria and Screening Levels for Assessment of Surface Water

Water Body/Segment Type	Flow -Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	219 Classified Water Bodies in Appendix A of TSWQS with Public Water Supply Use Assigned			Unclassified Water Bodies
		Criteria and Screening Levels ‣ ***Secondary drinking water standards*** for chloride, sulfate and TDS (see PWS Surface Water section) ‣ ***Human Health Criteria***—Col A (see Table 3-11) ‣ ***alachlor, atrazine, MTBE and perchlorate*** (see Concerns for PWS Surface and Finished Drinking Water sections)	**Eliminate samples collected below the 7Q2 ②**	**Presumed 7Q2 if not published or no information to contrary**	Unclassified water bodies are not designated for Public Water Supply Use and surface water is not screened for attainment of criteria. Finished drinking water is evaluated for compliance with the primary and secondary MCLs and the source water body is identified, for both classified and unclassified water
Ocean	***Ocean***	n/a	n/a	n/a	
Freshwater Wetland	***Freshwater Wetland***	n/a	n/a	n/a	
Saltwater Wetland	***Saltwater Wetland***	n/a	n/a	n/a	

① Public Water Supply is assigned to 219 streams and reservoirs in Appendix A of the Texas Surface Water Quality Standards (TSWQS).
② Presume event was above the 7Q2 for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.
③ Presume event was above the 7Q2 for unclassified perennial stream if no flow information is available (either severity code or measurement).
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
⑥ Definition of Intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. An “adequate pool ” to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ The area of influence is established in the TCEQ permitting process.
⑧ In the stretch of stream upstream and downstream, and outside of the area of influence from wastewater flow, the observed flow-type is used to the establish the flow-type, ALU, and criteria for assessment.

Table 3-15. Maximum Contaminant Levels for Organic Chemicals in Finished Drinking Water

Contaminant	µg/L	Contaminant	µg/L
Alachlor	2	Ethylene dibromide (EDB)	0.05
Aldicarb	3	Glyphosate	70
Aldicarb sulfone	2	Heptachlor	0.4
Alicarb sulfoxide	4	Heptachlor epoxide	0.2
Atrazine	3	Hexachlorobenzene	1
Benzene	5	Hexachlorocyclopentadiene	50
Benzo(a)pyrene	0.2	Lindane	0.2
Carbofuran	40	Methoxychlor	40
Carbon tetrachloride	5	Methyl tert-butyl ether (MTBE)[1]	15
Chlordane	2	Monochlorobenzene	100
2,4-D	70	Oxamyl (vydate)	200
Dalapon	200	Pentachlorophenol	1
Dibromochloropropane (DBCP)	0.2	Perchlorate [1]	22
Di(2-ethylhexyl) adipate	400	Picloram	500
Di(2-ethylhexyl) pthalate	6	Polychlorinated biphenyls (PCBs)	0.5
o-Dichlorobenzene	600	Simazine	4
p-Dichlorobenzene	75	Styrene	100
1,2-Dichloroethane	5	2,3,7,8-TCDD (Dioxin)	0.00003
1,1-Dichloroethylene	7	Tetrachloroethylene	5
cis-1,2-Dichloroethylene	70	Toluene	1000
trans-1,2-Dichloroethylene	100	Toxaphene	3
Dichloromethane	5	2,4,5-TP (Silvex)	50
1,2-Dichloropropane	5	1,2,4-Trichlorobenzene	70
Dinoseb	7	1,1,1-Trichloroethane	200
Diquat	20	1,1,2-Trichloroethane	5
Endothall	100	Trichloroethylene	5
Endrin	2	Vinyl chloride	2
Ethylbenzene	700	Xylenes (total)	10000

[1] These contaminants, although not MCLs, are reviewed in both surface water and finished drinking water as part of the assessment to identify concerns for public water supply use.

Table 3-16. Maximum Contaminant Levels for Inorganic Chemicals in Finished Drinking Water

Contaminant[1]	mg/L	Applicable System[2]
Antimony	0.006	C, N
Arsenic	0.05	C, N
Asbestos	7 million fibers/liter (longer than 10 µm)	C, N
Barium	2.0	C, N
Beryllium	0.004	C, N
Cadmium	0.005	C, N
Chromium	0.1	C, N
Cyanide	0.2 (as free cyanide)	C, N
Fluoride	4.0	C
Mercury	0.002	C, N
Nickel	0.1	C, N
Nitrate	10.0 (as nitrogen)	C, N, T
Nitrite	1.0 (as nitrogen)	C, N, T
Nitrate + Nitrite (total)	10.0 (as nitrogen)	C, N, T
Selenium	0.05	C, N
Thallium	0.002	C, N

[1] Dissolved fraction analyzed for metals
[2] C = Community; N = Non-transient, non-community; T = Transient, non-community

Oyster Waters Use

Oyster water use is assigned to most coastal bays to protect existing and potential harvest of edible species of clams, oysters, and mussels. The oyster water use is not designated in the TSWQS in a 1000 foot buffer zone. Oyster waters use is not assessed within the buffer zone, which is measured from the shoreline to ordinary high tide. Concentrations of bacteria in water must not exceed criteria established to maintain seafood safe for human consumption. These criteria are 14 colonies per 100 mL, with not more than 10 percent of all samples exceeding 43 colonies per 100 mL. The Department of State Health Services (DSHS) has authority to administer the National Shellfish Sanitation Program for Texas. This authority allows the DSHS to classify shellfish growing areas and to issue certificates for the interstate shipment of shellfish. The Texas Parks and Wildlife Department (TPWD) has the responsibility for enforcement of laws concerning harvesting of shellfish.

Oyster Water Classification Categories

The DSHS annually publishes maps that depict the classification of shellfish growing areas in Texas estuaries into one of these four categories. These maps provide the most likely status of shellfish growing areas. Status (open or closed) of shellfish growing areas is subject to change by the DSHS at any time. These changes may be due to high rainfall and runoff, flooding, hurricanes

and other extreme weather conditions, major spills, red tides, or the failure or inefficient operation of wastewater treatment facilities.

Assessment of the oyster waters use is made using the most recent DSHS Seafood Safety Division *Classification of Shellfish Harvesting Area Maps*. The maps are located on the Web at **www.tdh.state.tx.us/bfds/ssd/clasmap.html**.

The DSHS classifies shellfish growing areas into one of four categories:

Approved area. An *approved area* is a shellfish growing area approved by the DSHS for growing and harvesting shellfish for direct marketing. The approved area is not subject to contamination from human and/or animal fecal matter in amounts that may present an actual or potential hazard to public health. The approved area is not contaminated with pathogenic organisms, poisonous substances, or marine biotoxins. The classification of an approved area is determined by a sanitary survey conducted by the DSHS. Approved areas meet the standard except under extreme conditions and are—*Fully Supporting*.

Conditionally approved area. A *conditionally approved area* is determined by the DSHS to meet approved criteria for a predictable period. Events causing the degraded water quality must be predictable and definable (river stage, wastewater treatment plant effluents, run-off conditions). A conditionally approved shellfish growing area is closed when the area does not meet the approved criteria. Conditionally approved areas are assessed as supporting the oyster waters use—*Fully Supporting*

Restricted area. *Restricted areas* are shellfish growing areas classified by the DSHS as threatened or contaminated by poor water quality. Shellfish may be harvested from these areas only if permitted and subjected to a suitable and effective cleansing process. The harvested shellfish must be cleaned by *depuration* (moved to processing plants for cleansing in clean water) or by *relaying* (moved to estuarine waters in a clean area).

Areas are classified as restricted due to poor water quality and are impaired—*Not Supporting*.

Some restricted areas have recent water quality surveys indicating acceptable fecal coliform densities, yet the area is restricted based on high risk of microbial contamination (proximity to marinas and wastewater treatment plants, stormwater runoff, drainage from areas frequented by livestock or waterfowl). Areas classified as restricted for reasons other than water quality impairment are reported as not assessed—*Not Assessed*.

Prohibited area. A *prohibited area* is where there are recent DSHS sanitary surveys or other monitoring program data which indicate that fecal material, pathogenic microorganisms, poisonous or deleterious substances, marine toxins, or radionuclides may reach the area in excessive concentrations. The taking of shellfish for any human food purposes from such areas is prohibited. Shellfish from a prohibited area may not be taken for cleansing by depuration or relaying.

Prohibited areas with sanitary surveys indicating poor water quality, or where the DSHS has determined that water quality is likely to be poor based in historical surveys are assessed as not supporting the oyster waters use—*Not Supporting*.

Areas that are classified as prohibited for reasons other than water quality impairment or are prohibited solely because DSHS does not have the resources to conduct sanitary surveys are reported as not assessed—*Not Assessed*.

Reporting Oyster Water Use Attainment

The assessment describes the general attainment condition for large areas of the bay and reflects both water quality conditions and administrative decisions of the DSHS shellfish safety program. Because the same attainment status is assigned to entire assessment units for the Texas Water Quality Inventory and 303(d) List, area-specific detail may be made in the planning stages of a TMDL.

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CHAPTER 4
METHODOLOGY FOR ASSIGNING POLLUTANT CAUSES AND SOURCES

Cause and Source Codes for Pollutants

For each water body or portion of a water body where a designated use is partially supported or not supported, the cause(s) and source(s) are identified from available information (SWQM data, field observations, land use, CRP assessments, nonpoint source assessment reports, special studies, and intensive surveys). The origin of the information and level of confidence are also reported.

Whenever possible, analysts link pollution causes and stressors with their sources for the analysis. *Causes* are those pollutants (for example, pesticides, metals, or low dissolved oxygen) that contribute to actual nonsupport or partial support of designated uses (see Table 4-1). *Stressors* are factors or conditions (for example, stream flow, siltation, or habitat alterations) other than specific pollutants that cause nonsupport of uses. Activities, facilities, or conditions that contribute pollutants or stressors are sources that result in nonsupport of designated uses in a water body (see Table 4-2).

Nonpoint source pollution is diffuse runoff that originates from precipitation moving over and through the ground. As nonpoint source runoff moves, natural pollutants and pollutants resulting from human activity are carried with it to water bodies. Nonpoint sources include agricultural and urban storm water runoff.

Point source pollution has as its source any discernible, confined, and discrete conveyance, such as any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, concentrated animal feeding operation, or vessel or floating craft, from which pollutants are discharged to surface water bodies. Point sources are regulated by Texas Pollutant Discharge Elimination System (TPDES) permits, which may include effluent limitations, monitoring, and reporting requirements. Consistent with the TPDES, storm water discharges from separate storm sewer systems from cities and storm water discharges associated with industry and construction are considered point sources of pollution.

Table 4-1. List of EPA Causes and Stressors with Associated Codes			
EPA Cause Code	**EPA Cause Name**	**EPA Cause Code**	**EPA Cause Name**
7	1,1,1-Trichloroethane	156	Chromium, trivalent
9	1,1,2-Trichloroethane	157	Chrysene (C1-C4)
11	1,1-Dichloroethane	158	Ciguatera fish poisoning (CFP) biotoxins
19	1,2-Dichloroethane	160	Color
67	Abnormal Fish Histology (Lesions)	161	Combination Benthic/Fishes Bioassessments (Streams)
68	Acenaphthene	162	Combined Biota/Habitat Bioassessments (Streams)
69	Acenaphthylene	163	Copper
77	Alachlor	175	DDD
84	Alteration in stream-side or littoral vegetative covers	176	DDE
85	Alterations in wetland habitats	177	DDT
87	Aluminum	186	Diarrhetic shellfish poisoning (DSP) biotoxins
88	Ambient Bioassays—Acute Aquatic Toxicity	188	Dibenz[a,h]anthracene
89	Ambient Bioassays— Chronic Aquatic Toxicity	198	Dieldrin
91	Ammonia (Un-ionized)	203	Dioxin (including 2,3,7,8-TCDD)
92	Amnesic shellfish poisoning (ASP) biotoxins	205	Dissolved oxygen saturation
94	Anthracene	213	Endrin
96	Arsenic	215	Enterococcus
99	Atrazine	217	Bacteria, Escherichia coli
100	BOD, Biochemical oxygen demand	218	Estuarine Bioassessments
101	BOD, carbonaceous	227	Excess Algal Growth
102	BOD, nitrogenous	229	Fish Kills
103	BOD, sediment load (Sediment Oxygen Demand)	230	Fishes Bioassessments (Streams)
104	Barium	232	Fluoranthene
105	Benthic-Macroinvertebrate Bioassessments (Streams)	233	Fluorene
109	Benzo(a)pyrene (PAHs)	243	Habitat Assessment (Streams)
110	Benzo[a]anthracene	244	Heptachlor
111	Benzo[b]fluoranthene	245	Heptachlor epoxide
112	Benzo[g,h,i]perylene	246	Hexachlorobenzene
113	Benzo[k]fluoranthene	247	Hexachlorobutadiene
127	Cadmium	259	Indeno[1,2,3-cd]pyrene
131	Carbon Disulfide	266	Lake Bioassessments
134	Chemical oxygen demand (COD)	267	Lead
137	Chlordane	268	Lindane

Table 4-1. List of EPA Causes and Stressors with Associated Codes

EPA Cause Code	EPA Cause Name	EPA Cause Code	EPA Cause Name
138	Chloride	270	Low flow alterations
154	Chromium (total)	271	Malathion
155	Chromium, hexavalent	274	Mercury
288	Methylmercury	445	Abnormal Fish deformities, erosions, lesions, tumors (DELTS)
299	Naphthalene	446	Habitat Assessment (Lakes)
300	Neurotoxic shellfish poisoning (NSP) biotoxins	447	Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)
301	Nickel	448	Nutrient/Eutrophication Biological Indicators
302	Nitrates	452	Nitrogen, Nitrate
307	Nitrogen, Nitrite	456	Nitrate/Nitrite (Nitrite + Nitrate as N)
308	Ammonia (Total)	460	Aquatic Plants - Native
312	Non-Native Aquatic Plants	462	Phosphorus (Total)
313	Nonnative Fish, Shellfish, or Zooplankton	463	Impairment Unknown
322	Oxygen, Dissolved	464	Single Sample Toxic Exceedence
328	Paralytic shellfish poisoning (PSP) biotoxins	465	Fish Advisory - No Restriction
331	Particle distribution (Embeddedness)	466	Sediment Screening Value (Exceedence)
337	Phenanthrene	467	Mercury in Fish Tissue
340	Phosphate	468	Mercury in Water Column
341	Phosphorus, Elemental	472	PCB in Fish Tissue
344	Physical substrate habitat alterations	473	PCB in Water Column
356	Pyrene	475	Sediment Bioassays -- Acute Toxicity Freshwater
369	Sediment Bioassays -- Chronic Toxicity Freshwater	476	Other
370	Sediment Bioassays for Estuarine and Marine Water	478	Aquatic Plants (Macrophytes)
371	Sedimentation/Siltation	479	Aquatic Algae
372	Selenium		
375	Silver		
385	Sulfates		
387	Suspended Algae		
388	Temperature, water		
398	Bacteria, Total Coliform		
399	Total Dissolved Solids		
400	Fecal Coliform		
403	Total Suspended Solids (TSS)		
405	Toxaphene		
423	Zinc		

Table 4-1. List of EPA Causes and Stressors with Associated Codes			
EPA Cause Code	**EPA Cause Name**	**EPA Cause Code**	**EPA Cause Name**
429	m-Dichlorobenzene		
441	pH		
445	Abnormal Fish deformities, erosions, lesions, tumors (DELTS)		
429	m-Dichlorobenzene		
441	pH		

Table 4-2. List of EPA Source Codes and Source Categories

Code	Source Category Name
1	Above Ground Storage Tank Leaks (Tank Farms)
2	Acid Mine Drainage
4	Animal Feeding Operations (NPS)
6	Aquaculture (Not Permitted)
7	Aquaculture (Permitted)
8	Atmospheric Deposition - Acidity
9	Atmospheric Deposition - Nitrogen
10	Atmospheric Deposition - Toxics
11	Auction Barns
13	Baseflow Depletion from Groundwater Withdrawals
17	Changes in Ordinary Stratification and Bottom Water Hypoxia / Anoxia - Coastal
18	Changes in Tidal Circulation / Flushing
19	Channel Erosion / Incision from Upstream Hydro-modifications
20	Channelization
23	Combined Sewer Overflows
27	Construction Stormwater Discharge (Permitted)
28	Contaminated Sediments
31	Dairies (Outside Milk Parlor Areas)
32	Dam Construction (Other than Upstream Flood Control Projects)
33	Discharges from Biosolids (SLUDGE) Storage, Application, or Disposal
35	Discharges from Offshore Oil and Gas Exploration
36	Drainage / Filling / Loss of Wetlands
38	Dredging (E.g., for Navigation Channels)
39	Drought - related impacts
40	Dry Weather Flows with NPS Pollutants
41	Erosion from Derelict Land (Barren Land)
42	Flow Alterations from Water Diversions
43	Forest Roads (Road Construction and Use)
44	Freshettes or Major Flooding
45	Golf Courses
46	Grazing in Riparian or Shoreline Zones

Table 4-2. List of EPA Source Codes and Source Categories

Code	Source Category Name
49	Highway / Road / Bridge Runoff (Non-construction Related)
50	Highways, Roads, Bridges Infrastructure (New construction)
51	Historic Bottom Deposits (Not Sediment)
53	Illegal Dumping
54	Illegal Dumps or Other Inappropriate Waste Disposal
55	Illicit Connections / Hook-ups to Storm Sewers
56	Impacts from Abandoned Mine Lands (Inactive)
58	Impacts from Hydro-structure Flow Regulation / modification
59	Impacts from Land Application of Wastes
60	Impacts from Resort Areas (Winter and Non-winter Resorts)
61	Industrial Land Treatment
62	Industrial Point Source Discharge
63	Industrial Thermal Discharges
64	Industrial / Commercial Site Stormwater Discharge (Permitted)
65	Internal Nutrient Recycling
66	Irrigated Crop Production
67	Land Application of Wastewater (non-agricultural)
68	Land Application of Wastewater Biosolids (Non-agricultural)
69	Landfills
70	Leaking Underground Storage Tanks
71	Littoral / shore Area Modifications (Non-riverine)
72	Loss of Riparian Habitat
73	Managed Pasture Grazing
75	Marina Boat Maintenance
76	Marina Dredging Operations
77	Marina Fueling Operations
78	Marina-related Shoreline Erosion
79	Marina / boating Pumpout Releases
80	Marina / Boating Sanitary On-vessel Discharges
81	Mill Tailings
84	Municipal (Urbanized High Density Area) Runoff
85	Municipal Point Source Discharges

Table 4-2. List of EPA Source Codes and Source Categories

Code	Source Category Name
86	Municipal Point Source Impacts from Inadequate Industrial / Commercial Pre-treatment
87	Non-irrigated Crop Production
89	NPS Pollution from Military Base Facilities (Other Than Port Facilities)
90	NPS Pollution from Military Port Facilities
91	Off-road Vehicles
92	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
94	Other Marina / Boating On-vessel Discharges
95	Other Recreational Pollution Sources
100	Permitted Runoff from Confined Animal Feeding Operations (CAFOs)
101	Permitted Silvicultural Activities
102	Petroleum / Natural Gas Activities
103	Petroleum / Natural Gas Production Activities (Permitted)
104	Pipeline Breaks
107	Post-development Erosion and Sedimentation
108	Rangeland Grazing
109	RCRA Hazardous Waste Sites
111	Residential Districts
113	Saltwater Intrusion from Groundwater Overdrafting
114	Sand / Gravel / Rock Mining or Quarries
115	Sanitary Sewer Overflows (Collection System Failures)
116	Septage Disposal
118	Silviculture - Large Scale (Industrial) Unpermitted Forestry
122	Site Clearance (Land Development or Redevelopment)
123	Specialty Crop Production
124	Spills from Trucks or Trains
125	Streambank Modifications / De-stabilization
126	Subsurface (Hardrock) Mining
127	Surface Mining
128	Total Retention Domestic Sewage Lagoons
129	UIC Wells (Underground Injection Control Wells)
130	Unpermitted Discharge (Domestic Wastes)
131	Unpermitted Discharge (Industrial / commercial Wastes)

Table 4-2. List of EPA Source Codes and Source Categories

Code	Source Category Name
132	Upstream Impoundments (e.g. PL-566NRCS Structures)
133	Wastes from Pets
134	Waterfowl
135	Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)
136	Wildlife Other than Waterfowl
137	Woodlot Site Clearance
138	Woodlot Site Management
139	Yard Maintenance
140	Source Unknown
141	Unknown Non-point Source
142	Dam or Impoundment
143	Livestock (Grazing or Feeding Operations)
144	Crop Production (Crop Land or Dry Land)
145	Natural Conditions - Water Quality Standards Use Attainability Analyses Needed
146	Sources Outside State Jurisdiction or Borders
147	Upstream Source
148	Sediment Re-suspension (Clean Sediment)
149	Sediment Re-suspension (Contaminated Sediment)
152	Transfer of Water from an Outside Watershed
153	Wet Weather Discharges (Non-Point Sources)
155	Natural Sources
156	Agriculture
157	Habitat Modification - other than Hydromodification
161	Pesticide Application
164	Impervious Surface / Parking Lot Runoff
165	Coal Mining
166	Silviculture Activities
167	Unspecified Domestic Waste
168	Sewage Discharges in Unsewered Areas
169	Unspecified Urban Stormwater
174	Unrestricted Cattle Access
173	Manure Runoff

Table 4-2. List of EPA Source Codes and Source Categories

Code	Source Category Name
175	Contaminated Groundwater
176	Rural (Residential Areas)
177	Urban Runoff / Storm Sewers
180	Introduction of Non-native Organisms (Accidental or Intentional)
458	Point Source Unknown

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CHAPTER 5
CATEGORIZING WATER QUALITY CONDITIONS FOR MANAGEMENT ACTION

Introduction

The goal of the CWA is the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters, to attain water quality which provides for protection and propagation of fish and wildlife, and provide recreation. This translates into the TCEQ's goal that all water quality standards are attained for all surface waters in Texas.

The initial step in determining what management action is necessary to assure clean water is to assess conditions in the state's surface waters. See Chapters 2 and 3 for general assessment methods.

This chapter describes the process by which TCEQ assigns:

1. a management category for a water body and its conditions based on available data,
2. the appropriate follow-up action depending on the category,

Assigning categories is part of the TCEQ's strategy for overall management of water quality, and supports administration of the various programs that implement protection and improvement strategies.

Describing Water Bodies and Standards Attainment

The TCEQ and its cooperators monitor the state's surface waters, analyze the data and information, and assess the health of surface waters by comparing the data to the water quality standards. Water quality standards are composed of *designated uses* and their associated *criteria* for instream conditions necessary to support those uses. The uses are the purposes designated for a water body, such as *aquatic life use*—providing a suitable environment for fish and other aquatic life, or *contact recreation use*—providing water that is safe for swimming or other recreational purposes. The criteria may be expressed in terms of desirable conditions, or as numeric limits on certain pollutants. These pollutants or conditions are collectively referred to as *parameters*. For example, a *high aquatic life use* is generally associated with an average *criterion* of 5 mg/L of *dissolved oxygen*; the parameter (or condition) in this case is dissolved oxygen. In other words, each criterion consists of a measurable value and a parameter.

Uses and criteria are assigned to a *segment*. A segment is a water body or part of a water body with a specific location, defined dimensions, and designated or presumed uses. Segments are the basic geographic unit used in defining and measuring water quality.

If a criterion is not attained, the use is *impaired*. The combination of one particular parameter with one particular impaired use is called an *impairment*. If nonattainment of a criterion is

imminent, then the use is *threatened*. In some cases there are insufficient data to determine if the standard is attained, but the available data may point to a *concern* that water quality may be declining. Since more than one use is usually applied to any segment, the water quality may be adequate to support one use, but not another. For instance, the contact recreation use may be impaired, while the aquatic life use is still supported.

To increase the accuracy of the assessment, many segments may be further divided into AUs in order to evaluate conditions in areas that are more homogeneous in chemical, physical, and hydrological characteristics than are whole segments. An AU may be evaluated using data from one or more monitoring sites. See Chapter 2 for a more complete definition of AUs.

Water Quality Categories

One of five categories is assigned to each of the segments. The categories indicate the status of water quality in the segment. Categories 4 and 5 are further divided into subcategories that communicate the specific strategies the state is using, or plans to use, to address surface waters that are not meeting standards.

The subcategories 5a, 5b, and 5c represent the TCEQ's method for assigning priority for developing TMDLs, as required under 40 CFR 130.7(b)(4) and 130.10(b)(2). Subcategory 5a is the group with the highest priority for TMDL development, followed by 5c for medium priority and 5b for lowest priority.

Strategies for water bodies in Categories 1, 2, and 3 include additional data collection and assessment, and implementation through wastewater permits and other protective measures. Strategies for water bodies in Categories 4 and 5 are summarized in the subcategories, and targeted for the specific AUs and uses that are impaired. Strategies for AUs in 4 and 5 include review of water quality standards; projects to characterize the sources, extent, and severity of impairments; and projects to improve water quality or restore support of an impaired use.

The five categories for segments are:

1. All standards are attained; no evidence that nonattainment of any standard will occur in the near future.

2. Some standards are attained; no evidence that nonattainment of any standard will occur in the near future; and insufficient or no data and information are available to determine if the remaining standards are attained.

3. Insufficient or no data and information to determine if any standard is attained.

4. Standard is not attained or nonattainment is predicted in the near future due to one or more parameters, but no TMDLs are required.
   a. All TMDLs have been completed and approved by EPA.
   b. Other control requirements are reasonably expected to result in the attainment of all standards.
   c. Nonattainment of the standard for one or more parameters is shown to be caused by pollution, not by pollutants and that the water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process.

5. Standard is not attained or nonattainment is predicted in the near future for one or more parameters.
   a. TMDLs are underway, scheduled, or will be scheduled for one or more parameters.
   b. A review of the standards for one or more parameters will be conducted before TMDLs are scheduled.
   c. Additional data or information will be collected for one or more parameters before TMDLs are scheduled.

For some uses, multiple parameters are measured and examined in combination with each other to determine support of a particular use. This is exemplified with the aquatic life use, in which the following parameters are measured to determine use support: dissolved oxygen, toxic substances in water and sediment, habitat, and fish and macrobenthic communities. If any one of the criteria for these parameters does not attain the standard, then the use is considered impaired unless it can be demonstrated through an examination of all the parameters that there is a healthy, diverse aquatic community.

Determining the Category Assignment for Segments

The category for a segment is dependent on the categories of all the AUs which are part of it. AUs are also assigned to categories based on the attainment of each individual parameter and the measurement criterion used to evaluate support of a use. Because multiple parameters are used to evaluate most uses, each parameter must first be evaluated against the associated criteria before the overall use support for the AU can be determined. Similarly, the use support of each AU within a segment must be determined to evaluate the overall use support of that segment.

For example, Segment 0101 is composed of two AUs. Two uses are designated for the segment—support of aquatic life and contact recreation. In AU_01 both uses are supported, so the AU is assigned to Category 1. In AU_02, the aquatic life use is supported but there is insufficient data to determine whether the contact recreation use is supported, so that AU is assigned to Category 1 for the aquatic life use and Category 3 for the contact recreation use. Overall, the segment would be assigned to Category 2—one or more uses are supported but there is insufficient information to determine use attainment for others.

Similarly, in another segment, if some of the uses are supported, but others are not, then the segment would be assigned to Category 4 or 5, depending on whether the state is already taking action to improve water quality (Category 4), or plans to take such action in the future (Category 5).

Table 5-1 shows the progression from categorizing a particular parameter and criterion in one AU, to categorizing each use in each AU within a segment, and then determining the final segment category. It also summarizes the strategies associated with the subcategories of Categories 4 and 5.

Table 5-1. Assigning Categories to Parameters, Uses, AUs, and Segments

Category Number	Category for Each Parameter within AU (parameter AU)	Category for Each Overall Use within AU (use/AU)	Overall Category for AU (all uses/AU)	Overall Category for Segment (all uses/ all AUs)
1		Overall Use is attained for this AU. (General Use is attained unless there is an impairment.)	All uses are assessed and attained	All uses are attained; no evidence that nonattainment of any standard will occur in the near future
2			Some uses are assessed and attained, others are not assessed	Some uses are attained; no evidence that nonattainment of any use will occur in the near future; and insufficient or no data and information are available to determine if the remaining uses are attained
3		Overall Use not assessed for this AU	No uses are assessed	Insufficient or no data and information to determine if any use is attained
4		Overall Use not attained but a TMDL is not required	Some uses are not attained in the AU, but a TMDL is not required	Use is not attained or nonattainment is predicted in the near future for one or more parameters, but no TMDLs are required
4a	TMDL completed and approved by EPA for this parameter			
4b	Other control requirements are reasonably expected to result in attainment of the standard in the near future for this parameter			
4c	Nonattainment of the standard is shown to be caused by pollution, not by a pollutant for this parameter			
5		Overall Use not attained and a TMDL may be required for a parameter	Some uses are not attained and a TMDL may be required	One or more uses are not attained or nonattainment is predicted in the near future for one or more parameters, and a TMDL may be required.
5a	A TMDL is underway, scheduled, or will be scheduled for this parameter			
5b	A review of the standard will be conducted before a TMDL is scheduled for this parameter			
5c	Additional data or information will be collected before a TMDL is scheduled for this parameter			

Management Actions

As stated previously, the category assignment determines the strategies that will be pursued in anaging the state's surface waters. For example, impairments in Category 5—the 303(d) List—may require development of a TMDL. TCEQ has chosen to subdivide Category 5 in order to prioritize impairments for TMDL development (5a) and to identify AUs where water quality standards need to be reviewed (5b) or additional data is needed (5c). For Category 4 TMDL Implementation Plans (4a) are developed or underway. Where uses are attained or there is insufficient data, as in Categories 1 through 3, routine monitoring and protective, rather than restorative, actions are required.

Assessments are carried out every two years. Upon reassessment, water quality conditions may have changed as a result of changes in pollutant loading, the actions taken or as a result of natural conditions. Regardless of the reason, an AU may be moved from one category to another for any use, and this in turn will affect the overall category for the segment (see Figure 5-1). Although it is theoretically possible for an AU to move from one category to almost any other category, the figure represents the most common possible routes for re-categorizing use attainment for an AU in subsequent assessments.

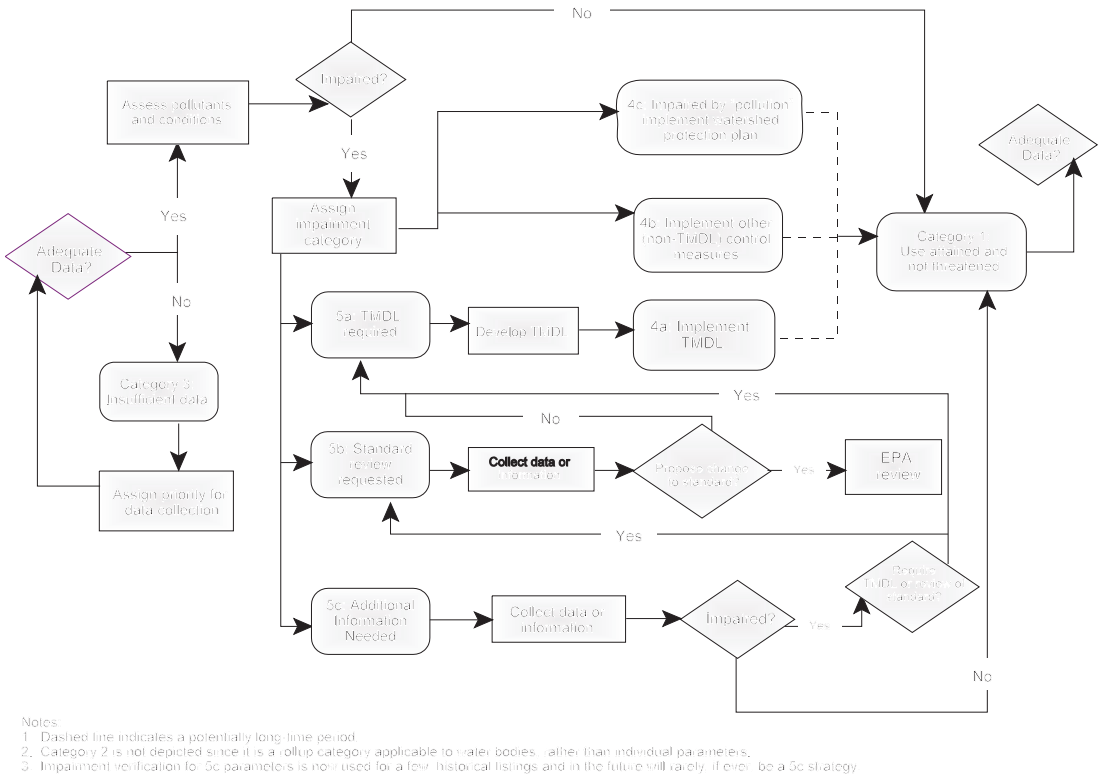

Figure 5-1. Common Pathways for Categorizing Parameters in the Texas Water Quality Inventory and 303(d) List.

Categories 1, 2, and 3

The management actions and the most common ways that segments move from one category to another during subsequent biennial assessments are detailed for segments assigned to Categories 1 through 3 in Table 5-2.

For some uses in both Category 1 and 3, the available data may indicate what is termed a "concern" (see Chapter 2). A concern is identified in Category 1 segments if the standard is attained and there is no threat, but one or more data points do exceed the standard. A concern may be identified in Category 3 segments, even though there are fewer than the minimum number of samples required for full assessment, if one or more of these samples exceeds the standard.

Category 4

Category 4 is for those impairments that do not require a TMDL. The uses and parameters in this category are not part of the 303(d) List. Category 4 is divided into three sub-categories. These subcategories convey the status and plans for different kinds of impairments (see Table 5-3).

Note that for Category 4 impairments, because there are water quality controls in place, or the non-support is not amenable to TMDL processes, impairments are removed from this category when water quality standards are attained without the additional level of assurance required for delisting form Category 5 (that no more than 10% of the samples exceed).

Category 4a

A parameter is moved into Category 4a during the assessment that immediately follows EPA approval of a TMDL for that parameter. Depending on when the EPA approves the TMDL, the actual move to Category 4a may take place as long as two years after approval. In any case, immediately after the TCEQ submits the TMDL to EPA, and in some cases before the submission, the TCEQ leads the effort to develop an implementation plan (I-Plan) to carry out the TMDL. Depending on the types of actions needed to restore the use of the water body, other agencies play a leadership or partnership role in the development of the I-Plan and in carrying it out.

Approximately six months to one year after submission of a TMDL to EPA, the TCEQ finalizes the implementation plan. Attainment of the standard is expected upon full implementation of the plan, although that may take many years or decades. In some cases, an adaptive management approach is used that allows for periodic revisions of the TMDL or the I-Plan. If control measures do not lead to attainment of the standard in the time frame set out in the I-Plan, the TCEQ may revise the TMDL and/or the I-Plan. The impairment may remain in Category 4a for administrative purposes, even if recent data indicate use support, until the implementation plan has been put into action.

The I-Plan includes a description of the regulatory and voluntary actions needed to restore the use of the water body. The I-Plan also includes a description of the monitoring needed to show the effectiveness of the control actions and management measures. In some cases, routine monitoring may be sufficient for this purpose; in other cases a more extensive monitoring program will be needed. Whether or not TCEQ is the lead agency on implementation, the TCEQ TMDL Program will track progress towards standards attainment and implementation of planned activities. The

TCEQ produces an annual report on progress for all TMDL I-Plans; the first report was produced in 2004.

Table 5-2. Categories 1,2, and 3—Management Strategies

Category	Action	Most Common Category Reassignment
1. All standards are attained; no evidence that nonattainment of any standard will occur in the near future	TCEQ and/or other agencies: ▸Set priorities for data collection based on concerns, the importance of the resource, and local interest. Information about pollution risk, intensity of use (for example, how often is a water body used for swimming), and water quality concerns is considered during annual planning meetings at the river basin scale involving agency staff and local monitoring entities. The cooperative multi-agency routine monitoring schedule and more details on the monitoring strategy are available on the TCEQ Web site at: www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/mtr/coop_monitoring.html ▸Conduct routine monitoring to document ongoing conditions. ▸Reassess uses based on new data.	▸If there is insufficient data to assess any one of the uses (using the most recent five years of data), segment is moved to Category 2. ▸If there is insufficient data to assess any use (using the most recent five years of data), segment is moved to Category 3. ▸If a standard is not attained, then the segment is assigned to Category 4 or 5 as appropriate.
2. Some standards are attained. No evidence that nonattainment of any standard will occur in the near future. Insufficient or no data and information are available to determine if the remaining standards are attained.	TCEQ and/or other agencies: ▸Set priorities for data collection based on concerns, the importance of the resource, and local interest. Information about pollution risk, intensity of use (for example, how often is a water body used for swimming), and water quality concerns is considered during annual planning meetings at the river basin scale involving agency staff and local monitoring entities. The cooperative multi-agency routine monitoring schedule and more details on the monitoring strategy are available on the TCEQ Web site at: www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/mtr/coop_monitoring.html ▸Conduct routine monitoring to document ongoing conditions. ▸Reassess uses based on new data.	▸If there is sufficient data to assess all of the uses, and standards are attained (using the most recent five years of data), segment is moved to Category 1. ▸If there is insufficient data (using the most recent five years of data), segment is moved to Category 3. ▸If a standard is not attained, then the segment is assigned to Category 4 or 5 as appropriate.
3. Insufficient or no data and information to determine if any standard is attained.	TCEQ and/or other agencies: ▸Set priorities for data collection based on concerns, the importance of the resource, and local interest. ▸Conduct routine monitoring to document ongoing conditions. ▸Reassess uses based on new data. In addition, the TCEQ is developing a statistically-based monitoring program to provide information on various classes of water bodies (for example, small streams). This additional information will be used to target monitoring for water bodies that are likely to have impairments or concerns.	If there are sufficient data for assessment of use attainment, the segment is moved to Category 1, 2, 4, or 5, as appropriate.

With each subsequent assessment, the AU may be moved to a different category. The ultimate goal is to attain all uses so it can be removed from Category 4a. It is also possible, though less likely, that data or information collected under the I-Plan would indicate that the parameter should be moved to Category 5b or 4c.

Table 5-3. Category 4–Management Strategies

CATEGORY 4 Use is not supported or is threatened, but does not require a TMDL.		
Category	**Action**	**Most Common Category Reassignment**
4a. TMDL completed and approved by EPA.	▸TCEQ develops an implementation plan (I-Plan) to reduce pollutant load, based on TMDL(s). ▸TCEQ issues or renews TPDES permits according to the TMDL, adjusting effluent limitations as needed. ▸Local, state or federal authorities, or private entities, implement other actions according to the I-Plan. ▸TMDL program tracks implementation of all planned activities and progress toward standards attainment. ▸If control measures do not lead to attainment of the standard in the time frame set out in the I-Plan, TCEQ may revise the TMDL and/or the I-Plan. ▸TCEQ or other agencies continue routine monitoring and conduct additional monitoring as described in the I-Plan.	If standard is attained, and all other uses are met, the AU and segment are removed from Category 4a.
4b. Other control requirements are reasonably expected to result in attainment of the standard in the near future.	▸TCEQ will not permit additional loading that will cause or contribute to the impairment. ▸Local, state, or federal authorities, or private entities, implement actions that are expected to result in standards attainment. ▸ SWQM tracks progress towards standards attainment through monitoring program. ▸TCEQ or other agencies continue routine monitoring.	If standard is attained, the AU and segment are removed from Category 4.
4c.Nonattainment of the standard is shown to be caused by pollution, not by a pollutant for this parameter.	▸TCEQ will not permit additional loading that will cause or contribute to the impairment. ▸TCEQ or other agencies may develop and implement a plan that includes the following, as appropriate: (1) regulatory and/or non-regulatory actions to restore attainable uses of the water body, and (2) monitoring to confirm there is no pollutant-caused nonsupport of standards and to document effectiveness of actions. ▸TCEQ or other agencies continue routine monitoring.	If standard is attained, the AU and segment are removed from Category 4; otherwise parameter remains in Category 4c indefinitely.

Category 4b

A parameter is placed in this category when controls other than a TMDL are expected to result in attainment of the standard within a reasonable time frame. These other controls must be in progress or planned, and the TCEQ must provide credible evidence that these measures will result in standards attainment. The exact definition of a “reasonable time frame” will vary depending on the impaired use, but will be defined in the reason the TCEQ presents to place the AU into Category 4b.

From EPA's *Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act* (July 29, 2005):

"EPA will evaluate on a case-by-case basis a state's decisions to exclude certain segment/pollution combinations from Category 5 (the Section 303(d) List) based on the 4b alternative. States should provide in their submission the rationale which supports their conclusion that there are "other pollutant control requirements" sufficiently stringent to achieve applicable water quality standards with a reasonable period of time".

Some Category 4b examples are:

- TCEQ placed the lakes that were threatened for atrazine in this category, because a comprehensive approach was being pursued to implement a variety of best management practices (BMPs) in the corresponding watersheds. These BMPs limited the runoff of atrazine from the watersheds into the lakes. Monthly sampling over a three year period were required to show that the standard continued to be met, and to determine if atrazine concentrations were declining as a result of the watershed plans.

- Impairments due to legacy pollutants where remediation under a superfund project or natural attenuation (in the absence of a current source) is projected to result in standards attainment.

- AUs where a specific discharger is known to be the source of the impairment and enforcement actions are underway to correct the problem.

- A watershed protection plan has been prepared with nine required elements, and the watershed plan is approved by the Commission as part of the Water Quality Management Plan and a commitment to implement water quality controls that will restore water quality

TCEQ will provide a description of pollution controls and how they will achieve water quality standards, and the measures that will track the progress in restoring water quality so the plan can be revised as needed.

If these other controls result in attainment of the standard, the AU is removed from Category 4b. If the measures have not been successful in the expected time frame, the AU will be moved to one of the subcategories of Category 5. It is also possible, though less likely, that more recent data or information would indicate that the parameter should be moved to Category 5b or 4c.

Category 4c

This category is reserved for those water bodies where the impairment is caused by stressors other than specific pollutants that can be allocated under a TMDL. Although there is some support for a broader definition of TMDLs that would address water quality degradation not due to a specific pollutant (for example, habitat loss)(Reckhow, K.H. 2001), the TCEQ uses the more narrow definition of a TMDL. Impairments that fall outside of this narrow definition are placed in Category 4c, and some restoration activity—but not a TMDL—is identified where possible.

Definitions

Pollution and pollutants. Definitions of these terms are contained within the CWA and the Texas Water Code (TWC).

CWA Section 502(6). The term "pollutant" means dredged spoil, solid waste, incinerator residue, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, salt, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. This term does not mean (A) "sewage from vessels" within the meaning of section 312 of the Act; or (B) water, gas, or the materials which are injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in the degradation of ground or surface water resources.

CWA Section 502(19). The term "pollution" means the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.

Texas Surface Water Quality Standards (TWC §26.023). The term "pollution" is defined as the alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Nonsupport of Standards in Category 4c

There are conceivably many types of non-pollutant impairments (see text box above). The TCEQ has laid out a process for determining other possible types of non-pollutant impairments in future assessments. Prior to the release of a draft 303(d) List, candidates for Category 4c are identified. This step includes consideration of the appropriateness of the standard, and thus whether the impairment more appropriately belongs in Category 5b.

1. When information confirms that nonsupport of criteria of the standard is caused by pollution, the impairment is put in Category 4c. The available data and information are researched to rule out a pollutant as the cause of the impairment. It is possible that some small level of a pollutant loading might be identified, but TCEQ must demonstrate that the pollutant loading is inconsequential. In some cases, the TCEQ may not have the staff resources to carry out this step at the time of the assessment; and in that case the parameter is placed in Category 5c, and this additional assessment work is carried out at a later date.

2. When available information confirms that the nonsupport of criteria and standard is caused by natural conditions or sources of pollutants that cannot be allocated and controlled through TMDL, the impairment is put into Category 4c. For example:

- Natural low flow conditions of water which prevent the attainment of the use
- Physical conditions related to the natural features of the water body which preclude attainment of the use
- A naturally occurring pollutant concentrations not attributed to waste discharges or the activity of man which prevents attainment of criteria not related to human health, e.g., rather aquatic life use criteria.

3. Justification for the placement of the impairment in Category 4c is drafted and this information is provided with the draft list. The justification may include information such as the probable causes and potential restoration activities, although this is not a commitment by the TCEQ or any other agency to carry out the activities.

Once a parameter is in Category 4c, TCEQ will not permit additional loading that causes or contributes to the impairment. However, TCEQ may consider trading opportunities. Restoration activities for Category 4c impairments may be led by the TCEQ or by another agency or organization, depending on the type of impairment, as well as the authority and resources of the responsible entity. If restoration activities result in attainment of the standard, the parameter is removed from Category 4c. It is also possible, though less likely, that the water body would become further impaired due to a controllable pollutant, in which case the AU is moved to Category 5.

Category 5

Category 5 is for those impairments which may require a TMDL or other water quality management action. This category is divided into three subcategories indicating the priority for scheduling a TMDL or for taking other action. These subcategories are a useful management tool for the TCEQ, and inform stakeholders of the status and plans for different kinds of impairments (see Table 5-4).

Category 5a

Impairments are placed in this category only after the TCEQ determines that the impairment does not more appropriately belong in categories 5b, 5c, 4b, or 4c. Some common Category 5a examples are:

- Toxicity caused by an identified pollutant.
- Dissolved oxygen not meeting the 24-hour average (based on 24-hour sampling), or not meeting the minimum AND caused by pollutant.
- Bacteria for contact recreation:

    1. 10 or more samples and a geometric mean greater than 1260 for *E. coli*, or 350 for Entercoccus, or
    2. 18 or more samples and a geometric mean greater than 126 for *E.coli*, or 35 for Enterococcus, and significant contact recreation occurs, or
    3. For water bodies not supporting the contact recreation use, but with a geometric mean greater than the value listed above in (2) but less than the values listed above in (1) and connected to an impaired water body (for example, a tributary), or in watersheds adjacent to an impaired water body also in Category 5a.

Table 5-4. Category 5–Management Strategies

CATEGORY 5 Use is not supported or is threatened		
Category	**Action**	**Most Common Category Reassignment**
5A. A TMDL is underway, scheduled, or will be scheduled.	‣TCEQ schedules a TMDL dependent upon available funding and develops a TMDL for each pollutant or condition. ‣TCEQ will not permit additional loading that will cause or contribute to the impairment. ‣In some cases, new data and information gathered for the TMDL may lead to a different restoration approach prior to completion of the TMDL. ‣TCEQ or other agencies continue routine monitoring.	If TMDL is approved, parameter moves to Category 4a. If the parameter is fully supporting, it remains in Category 5a until the TMDL is approved, or in 4a if the Implementation Plan is completed.
5B. A review of the standard will be conducted before a TMDL is scheduled.	‣TCEQ will not permit additional loading that will cause or contribute to the impairment. ‣TCEQ sets priorities for these impairments then initiates a use attainability analysis (UAA) or other special study for each affected AU. If appropriate, a new standard (designated use and/or site-specific criterion) will be proposed to EPA. ‣TCEQ or other agencies continue routine monitoring.	If TCEQ does not propose standards revision, or if TCEQ proposes a change that EPA disapproves, the parameter moves to Category 5a if impairment continues and pollutant is identified. If impairment is not caused by a pollutant, the parameter is moved to Category 4c.
5C. Additional data or information will be collected before a TMDL is scheduled.	‣TCEQ will not permit additional loading that will cause or contribute to the impairment. TCEQ or other agencies: ‣carry out parameter or area-specific study. ‣continue routine monitoring.	If pollutant is identified, parameter moves to Category 5a. If impairment is not caused by a pollutant, the parameter is moved to Category 4c. In rare instances, additional data may show the affected use is being met, and the parameter is moved to Category 1.

- Impaired fish community, benthos, or habitat where the impairment is caused by a pollutant.
- Temperature impairment caused by a discharge.
- A TMDL had already been initiated, between listing cycles.
- The impairment has been listed for many years and additional monitoring is not likely to further characterize the impairment.

In each of these cases, the TCEQ would identify the pollutant prior to placing the impairment in Category 5a. If it is unclear that the impairment is caused by a pollutant, it is placed in Category 5c. If the impairment is clearly not caused by a pollutant, the AU is placed in Category 4c.

After the 303(d) List is finalized, but prior to submission to EPA, the TCEQ develops a schedule for TMDLs for parameters in Category 5a. The schedule includes the resources to be used to complete the TMDLs, and the anticipated date of submittal of the TMDLs to EPA for those TMDLs that will be completed in the next two years.

Upon approval of the TMDL by EPA, the parameter is moved to Category 4a during the subsequent assessment, unless the standard is attained prior to the next listing, in which case the AU and segment are moved to Category 1. In some cases, new data and information gathered for the TMDL may lead to a different approach prior to completion of the TMDL, and the parameter is moved to Category 4b, 4c or 5b, as appropriate.

Category 5b

Parameters are placed in this subcategory if TCEQ staff have determined that the designated use or water quality criteria should be reviewed. Water bodies listed on the Section 303(d) list may be considered candidates for a use attainability analysis (UAA). UAAs are conducted on classified (Appendix A in the TSWQS) or on unclassified water bodies for which uses and criteria have been established (Appendix D in the TSWQS). Aquatic Life Assessments (ALA) are conducted on unclassified water bodies where the presumed aquatic life use and/or the associated dissolved oxygen criteria are not attained. The purpose of the UAA or ALA is to determine if existing uses and criteria are appropriate and, if not, to develop uses, presumed uses, and criteria adjustment information. For example, the water body may have:

The TCEQ has developed a process for prioritizing these water bodies for the development a UAA or site-specific criterion. The factors used to prioritize water bodies for standards review are:

- Adequacy of the data set describing the extent and severity of the nonsupport, including direct measurements of use support such as biological data
- Comparison of conditions and measurements at similar sites in the ecoregion
- History of recent UAAs or other standard-related work
- Changes in water quality since a previous review of the standards
- The extent to which natural causes and sources are believed to contribute to nonsupport of the existing standards

Common examples of Category 5b parameters are:

- total dissolved solids, chloride, and sulfate where current or historical data set indicate criteria should be reviewed
- dissolved oxygen, where (1) the criteria are not supported but the biological community is healthy; or (2) modeling shows that the dissolved oxygen criteria cannot be met under natural conditions; or (3) data collected for a pending permit prompts a review of the standard
- biological community is impaired based on a presumed or designated use, where information indicates that to be an inappropriate use designation.

If a standard revision is proposed by the TCEQ, the parameter remains in Category 5b until EPA takes action on the proposed standard. A reassessment against the new standard will then determine the new category for the parameter. If the impairment still exists, the parameter is moved to Category 4b, 4c, 5a, or 5c, as appropriate. If revision of the standard is not proposed by the TCEQ, or if the TCEQ proposes a change that EPA disapproves, the parameter moves to Category 4b, 4c, 5a, or 5c as appropriate.

Category 5c

Parameters commonly are placed in Category 5c if there is insufficient information to determine the best course of action. The information needed, and therefore the action required, for each Category 5c impairment is parameter-specific (see Table 5-5). Some impairments may be the result of poor water quality conditions observed for only a few years. It may be prudent to continue sampling for several more years and reassess to confirm that the impairment is persistent and characteristic of the water body before initiating a TMDL or standards review.

Parameters in Category 5c are prioritized for the additional work that is needed. The main factors that the TCEQ considers at this stage are spatial attributes such as the proximity to other water quality impairments, watershed size or land use characteristics, the number of samples on which the assessment is based, the severity of the impairment, and the length of time that an impairment has been on the 303(d) list.

After this additional work has been completed, the parameter is reassessed and placed in the appropriate category. If the pollutant has been identified, the parameter is moved to Category 5a. If it is determined that a pollutant is not the cause, the parameter is moved to Category 4c. Categories 4b and 5b are also possible.

TABLE 5-5. Category 5c Management Strategies

Parameter		Action
Metals, where the original listing was based on outdated sampling or analytical methods.	➤	Resample using better sampling or analytical methods (for example, ultra-clean sampling).
Mercury, where atmospheric deposition is the most significant source.	➤	Monitor to characterize the impairment condition. Develop notification/education for fish consumption advisories.
Toxicity, where the pollutant causing the toxicity has not been identified	➤	Collect data or information to identify pollutant.
Bacteria for water bodies where the geometric mean is < 1260 for E. coli, or < 350 for Entercoccus; and there is insufficient data to schedule a TMDL.	➤	Collect E.coli to identify potential sources and fill in data gaps to meet data requirements for 5a determination (see Section on 5a, above).
Narrative criteria where the TMDL endpoint needs to be identified.	➤	Collect data or information to identify the TMDL endpoint.
pH where the pollutant is not known.	➤	Collect data or information to identify pollutant.
Impaired fish community, benthic community or habitat, where the pollutant is not known.	➤	Collect data or information to identify pollutant.
Temperature, where thermal discharges may contribute to criteria nonattainment.	➤	Collect data or information to demonstrate either aquatic life use impairment and/or that the criteria is appropriate to protect the balanced indigenous population.
TDS where the average concentration is less than 10% over the criterion.	➤	Collect routine data, review historical data to determine if there is a trend and if the condition is natural or caused in part by human activities in the watershed.
Biological community impairment	➤	Identify the cause of biological nonsupport. For unclassified water bodies, collect biological and habitat data to allow criteria to be developed and evaluated.
DO criteria not supported	➤	Identify the cause of the low DO. For unclassified water bodies, collect DO, biological and habitat data to allow criteria to be developed and evaluated.

Management actions for water quality concerns. Water quality concerns are prioritized though routine monitoring. Priorities for routine monitoring are directed toward the following:

1). Completing data sets where limited information indicates that a water quality criterion shows a standard is not supported but with a limited data set.
2). Concerns for water bodies that are near nonattainment.
3). Waters with known water quality concerns.
4). No specific priority for bodies that have no known water quality problems or without current water quality data.

These priorities for routine monitoring are outlined in Table 5-6. More detailed description of TCEQ's monitoring and information gathering processes for waters with concerns and impaired waters can be found in the most current version of the *Texas Surface Water Quality Monitoring and Assessment Strategy*. The TCEQ SWQM Program and Texas CRP provide for an integrated evaluation of physical, chemical, and biological characteristics of aquatic systems in relation to human health concerns, ecological condition, and designated uses. The monitoring strategy outlines the basis for the establishment of effective TCEQ management policies that promote the protection, restoration, and responsible use of Texas surface-water resources.

Table 5-6. Monitoring Objectives to Address Concerns

Level of Support for Parameter	General Monitoring Objective	Priority
Concern for standard support (**CN**) or not supporting (**NS**) with a limited data set (**LD**) (small data set; < 10 samples) or even insufficient data (**ID**) (<10 samples)	Sample until an adequate data set is available for assessment. The few samples collected in these AUs show problems.	1st
Concern near nonattainment of standard support (**CN**) with adequate data (**AD**) for water quality criteria. Or concerns (**CS**) for DO grab samples	Continue routine monitoring to establish that near nonattainment is ongoing. When DO grab samples identify a concern, schedule 24-hour sampling to determine if the mean criterion is supported.	2nd
Concern for support (**CS**) with adequate data (**AD**) for narrative screening criteria, i.e., nutrients and sediment	Continue monitoring to establish that concern is ongoing. Monitor other water quality causes and sources related to the parameter of concern.	3rd
For water bodies where uses are fully supported (**FS**) with adequate data (**AD**), or no concern (**NC**) with limited data (**LD**)	Continue monitoring to establish that the designated uses are supported. Include conventional parameters on high use water bodies and water bodies of local interest. Monitor at least one station in each classified segment and important water body. Monitor toxics and biological monitoring in areas where this monitoring has not been conducted.	4th
For water bodies that have not been monitored previously (or recently) **(NA)**	Implement monitoring to develop an adequate data set to assess uses and concerns.	no specific priority

References

Reckhow, K.H. 2001. *Assessing the TMDL approach to water quality management. Committee to Assess the Scientific Basis of the Total Maximum Daily Load Approach to Water Pollution Reduction*. National Research Council, Washington, D.C.

Appendix A

Number of Samples and Exceedances to Identify Concern, Impairment, or to Delist a Parameter by the Binomial Method---Tables

Table A-1. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Conventional* Parameters.

Number of Samples	LISTING: To identify a water body as **impaired** with an intended Type-1 error rate of no more than 20% at an exceedance rate of 10% and a Type-2 error rate of less than about 40% at an exceedance rate of 30%. A minimum number of **three** exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					CONCERN: To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exceedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1 at 8% Exceedance	Actual Type-2 at 20% Exceedance
4	1				**3**	1	28	41
	2					**2**	**3**	**82**
	3					3	0	97
5	1				**3**	1	34	33
	2					**2**	**5**	**74**
	3					3	0.1	94
6	1				**3**	1	39	26
	2					**2**	**8**	**66**
	3					3	1	90
7	1				**3**	1	44	21
	2					**2**	**10**	**58**
	3					3	1	85
8	1				**3**	1	49	17
	2					**2**	**13**	**50**
	3					3	2	80
9	1				**3**	1	53	13
	2					**2**	**16**	**44**
	3					3	3	74
10	1	65	11	3	**3**	1	57	11
	2	26	38	15		**2**	**19**	**38**
	3	**7**	**68**	**38**		3	4	68
11	1	69	09	2	**3**	1	60	9
	2	30	32	11		2	22	32
	3	**9**	**62**	**31**		**3**	**5**	**62**
12	1	72	7	1	**3**	1	63	7
	2	34	27	9		2	25	27
	3	**11**	**56**	**25**		**3**	**7**	**56**
13	1	75	5	1	**3**	1	66	5
	2	38	23	6		2	28	23
	3	**13**	**50**	**20**		**3**	**8**	**50**
	4	3	75	42		4	2	75

Table A-1. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Conventional* Parameters (continued).

Number of Samples	LISTING					CONCERN		
	To identify a water body as **impaired** with an intended Type-1 error rate of no more than 20% at an exceedance rate of 10% and a Type-2 error rate of less than about 40% at an exceedance rate of 30%. A minimum number of **three** exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exccedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1 at 8% Exceedance	Actual Type-2 at 20% Exceedance
14	1	77	4	1	**3**	1	69	4
	2	42	20	5		2	31	20
	3	**16**	**45**	**16**		**3**	**10**	**45**
	4	4	70	36		4	2	70
15	1	79	4	1	**3**	1	71	4
	2	45	17	4		2	34	17
	3	**18**	**40**	**13**		**3**	**11**	**40**
	4	6	65	30		4	3	65
16	1	81	3	0	**4**	1	74	3
	2	49	14	3		2	37	14
	3	21	35	10		**3**	**13**	**35**
	4	**7**	**60**	**25**		4	3	60
17	1	83	2	0	**4**	1	76	2
	2	52	12	2		2	40	12
	3	24	31	8		**3**	**15**	**31**
	4	**8**	**55**	**20**		4	4	55
18	1	85	2	0	**4**	1	78	2
	2	55	10	1		2	43	10
	3	27	27	6		**3**	**17**	**27**
	4	**10**	**50**	**16**		4	5	50
19	1	86	1	0	**4**	1	79	1
	2	58	8	1		2	46	8
	3	29	24	5		**3**	**19**	**24**
	4	**12**	**46**	**13**		4	6	46
20	1	88	1	0	**4**	1	81	1
	2	61	7	1		2	48	7
	3	32	21	4		3	21	21
	4	**13**	**41**	**11**		**4**	**7**	**41**

Table A-2. Maximum Threshold Number of Exceedances to Delist a Water Body for *Conventional* Parameters.

Number of Samples	DELISTING: To identify a water body as **attaining its use,** and delisted with an exceedances rate of no more than 10%, resulting in a Type-1 error rate of no more than 70% at an exceedance rate of 11% and no more than 38% at an exceedance rate of 20%; and a Type-2 error rate of 8 to 25% at an exceedance rate of 5%.				
	Number of Exceedances	Actual Type-1 at 11% Exccedance	Actual Type-1at 20 % Exceedance	Actual Type-2 at 5% Exceedance	Actual % Exceedance When Delisting
10	0	31	11	40	**10**
	1	**70**	**38**	**9**	
	2	91	68	1	
11	0	28	9	43	**9**
	1	**65**	**32**	**10**	
	2	89	62	2	
12	0	25	7	46	**8**
	1	**61**	**27**	**12**	
	2	86	56	2	
13	0	22	5	49	**8**
	1	**57**	**23**	**14**	
	2	83	50	2	
14	0	20	4	51	**7**
	1	**53**	**20**	**15**	
	2	81	45	3	
15	0	17	4	54	**6**
	1	**50**	**17**	**17**	
	2	78	40	4	
16	0	16	3	56	**6**
	1	**46**	**14**	**19**	
	2	76	35	4	
17	0	14	2	58	**6**
	1	**43**	**12**	**21**	
	2	71	31	5	
18	0	12	2	60	**6**
	1	**40**	**10**	**23**	
	2	68	27	6	
19	0	11	1	62	**5**
	1	**37**	**8**	**25**	
	2	65	24	7	
20	0	10	1	64	**10**
	1	34	7	26	
	2	**67**	**27**	**8**	

Table A-3. Minimum Threshold Number of Exceedances to Identify a Concern for *Dissolved Oxygen*.

CONCERN			
Number of Samples	To identify a water body as a **concern** (using an average of dissolved oxygen grabs) with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1at 8% Exccedance	Actual Type-2 at 20 % Exceedance
4	1	28	41
	2	**3**	**82**
	3	0	97
5	1	34	33
	2	**5**	**74**
	3	0.1	94
6	1	39	26
	2	**8**	**66**
	3	1	90
7	1	44	21
	2	**10**	**58**
	3	1	85
8	1	49	17
	2	**13**	**50**
	3	2	80
9	1	53	13
	2	**16**	**44**
	3	3	74
10	1	57	11
	2	**19**	**38**
	3	4	68
11	1	60	9
	2	22	32
	3	**5**	**62**
12	1	63	7
	2	25	27
	3	**7**	**56**
13	1	66	5
	2	28	23
	3	**8**	**50**
	4	2	75

Table A-3. Minimum Threshold Number of Exceedances to Identify a Concern for *Dissolved Oxygen* (continued).

Number of Samples	CONCERN		
	To identify a water body as a **concern** (using an average of dissolved oxygen grabs) with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1at 8% Exccedance	Actual Type-2 at 20 % Exceedance
14	1	69	4
	2	31	20
	3	**10**	**45**
	4	2	70
15	1	71	4
	2	34	17
	3	**11**	**40**
	4	3	65
16	1	74	3
	2	37	14
	3	**13**	**35**
	4	3	60
17	1	76	2
	2	40	12
	3	**15**	**31**
	4	4	55
18	1	78	2
	2	43	10
	3	**17**	**27**
	4	5	50
19	1	79	1
	2	46	8
	3	**19**	**24**
	4	6	46
20	1	81	1
	2	48	7
	3	21	21
	4	**7**	**41**

Table A-4. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Bacteria* Parameters.

Number of Samples	LISTING: To identify a water body as **impaired** with an intended Type-1 error rate of no more than 20% at an exceedance rate of 25% and a Type-2 error rate of less than about 40% at an exceedance rate of 50%. A minimum number of **five** exceedances are required for 303(d) listing.				CONCERN: To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 25% Exccedance	Actual Type-2 at 50% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 20% Exceedance	Actual Type-2 at 40% Exceedance
4	2			n/a	1	59	13
	3				**2**	**18**	**48**
	4				3	3	82
5	3			**5**	1	67	8
	4				2	26	34
	5				**3**	**6**	**68**
6	3			**5**	1	74	5
	4				2	34	23
	5				**3**	**10**	**54**
7	2			**5**	1	79	3
	3				2	42	16
	4				**3**	**15**	**42**
	5				4	3	71
8	1			**5**	1	83	2
	2				2	50	11
	3				**3**	**20**	**32**
	4				4	6	59
	5				5	1	83
9	1			**5**	1	87	1
	2				2	56	7
	3				3	26	23
	4				**4**	**9**	**48**
	5				5	2	73
10	1	94	0	**5**	1	89	1
	2	76	1		2	62	5
	3	47	5		3	32	17
	4	22	17		**4**	**12**	**38**
	5	**8**	**38**		5	3	63
11	1	96	0	**5**	1	91	0
	2	80	1		2	68	3
	3	54	3		3	38	12
	4	29	11		**4**	**16**	**30**
	5	**11**	**27**		5	5	53

Table A-4. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Bacteria* Parameters (continued).

Number of Samples	LISTING				CONCERN		
	To identify a water body as **impaired** with an intended Type-1 error rate of no more than 20% at an exceedance rate of 25% and a Type-2 error rate of less than about 40% at an exceedance rate of 50%. A minimum number of **five** exceedances are required for 303(d) listing.				To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 25% Exccedance	Actual Type-2 at 50% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 20% Exceedance	Actual Type-2 at 40% Exceedance
12	1	97	0	**5**	1	93	0
	2	84	0		2	73	2
	3	61	2		3	44	8
	4	35	7		4	21	23
	5	**16**	**19**		**5**	**7**	**44**
13	1	98	0	**6**	1	95	0
	2	87	0		2	77	1
	3	67	1		3	50	6
	4	42	5		4	25	17
	5	21	13		**5**	**10**	**35**
	6	**8**	**29**		6	3	57
14	1	98	0	**6**	1	96	0
	2	90	0		2	80	1
	3	72	1		3	55	4
	4	48	3		4	30	12
	5	26	9		**5**	**13**	**28**
	6	**11**	**21**		6	4	49
15	1	99	0	**6**	1	96	0
	2	92	0		2	83	1
	3	76	0		3	60	3
	4	54	2		4	35	9
	5	31	6		**5**	**16**	**22**
	6	**15**	**15**		6	6	40
16	1	99	0	**6**	1	97	0
	2	94	0		2	86	0
	3	80	0		3	65	2
	4	60	1		4	40	7
	5	37	4		**5**	**20**	**17**
	6	**19**	**11**		6	8	33

Table A-4. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Bacteria* Parameters (continued).

Number of Samples	LISTING				CONCERN		
	To identify a water body as **impaired** with an intended Type-1 error rate of no more than 20% at an exceedance rate of 25% and a Type-2 error rate of less than about 40% at an exceedance rate of 50%. A minimum number of **five** exceedances are required for 303(d) listing.				To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 25% Exccedance	Actual Type-2 at 50% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 20% Exceedance	Actual Type-2 at 40% Exceedance
17	1	99	0	**7**	1	98	0
	2	95	0		2	88	0
	3	84	0		3	69	1
	4	65	1		4	45	5
	5	43	2		5	24	13
	6	23	7		**6**	**11**	**26**
	7	**11**	**17**		7	4	45
18	1	99	0	**7**	1	98	0
	2	96	0		2	90	0
	3	86	0		3	73	1
	4	69	0		4	50	3
	5	48	2		5	28	9
	6	28	5		**6**	**13**	**21**
	7	**14**	**12**		7	5	37
19	1	100	0	**7**	1	99	0
	2	97	0		2	92	0
	3	89	0		3	76	1
	4	74	0		4	54	2
	5	53	1		5	33	7
	6	33	3		**6**	**16**	**16**
	7	**17**	**8**		7	7	31
20	1	100	0	**8**	1	99	0
	2	98	0		2	93	0
	3	91	0		3	79	0
	4	77	0		4	59	2
	5	59	1		5	37	5
	6	38	2		**6**	**20**	**13**
	7	21	6		7	9	25
	8	**10**	**13**		8	3	42

Table A-5. Maximum Threshold Number of Exceedances to Delist a Water Body for *Bacteria* Parameters.					
DELISTING					
Number of Samples	To identify a water body as **attaining its use,** and delisted with an exceedance rate of no more than 25%, resulting in a Type-1 error rate of no more than 59% at an exceedance rate of 26%, and no more than 17% at an exceedance rate of 40%; and a Type-2 error rate of 4 to 20% at an exceedance rate of 13%. To delist a bacteria impairment, the geometric mean criterion must also be attained.				
	Number of Exceedances	Actual Type-1at 26% Exceedance	Actual Type-1at 40% Exceedance	Actual Type-2 at 13% Exceedance	Actual % Exceedance When Delisting
10	0	5	1	75	**20**
	1	22	5	38	
	2	**50**	**17**	**13**	
	3	75	38	3	
11	0	4	0	78	**18**
	1	18	3	43	
	2	**42**	**12**	**16**	
	3	69	30	4	
12	0	3	0	81	**17**
	1	14	2	47	
	2	**36**	**8**	**20**	
	3	62	23	6	
13	0	2	0	84	**23**
	1	11	1	52	
	2	30	6	23	
	3	**55**	**17**	**8**	
	4	77	35	2	
14	0	1	0	86	**21**
	1	9	1	56	
	2	25	4	27	
	3	**49**	**12**	**10**	
	4	71	28	3	
15	0	1	0	88	**20**
	1	7	1	60	
	2	21	3	31	
	3	**43**	**9**	**12**	
	4	65	22	4	

Table A-5. Maximum Threshold Number of Exceedances to Delist a Water Body for *Bacteria* Parameters (continued).

Number of Samples	DELISTING: To identify a water body as **attaining its use,** and delisted with an exceedance rate of no more than 25%, resulting in a Type-1 error rate of no more than 59% at an exceedance rate of 26%, and no more than 17% at an exceedance rate of 40%; and a Type-2 error rate of 4 to 20% at an exceedance rate of 13%. To delist a bacteria impairment, the geometric mean criterion must also be attained.				
	Number of Exceedances	Actual Type-1at 26% Exceedance	Actual Type-1at 40% Exceedance	Actual Type-2 at 13% Exceedance	Maximum number of exceedances when delisting in 2004
16	0	1	0	89	**25**
	1	5	0	63	
	2	17	2	35	
	3	37	7	14	
	4	**59**	**17**	**5**	
17	0	1	0	91	**24**
	1	4	0	67	
	2	14	1	38	
	3	32	5	17	
	4	**54**	**13**	**6**	
	5	73	26	2	
18	0	0	0	92	**22**
	1	3	0	70	
	2	12	1	42	
	3	27	3	20	
	4	**48**	**9**	**7**	
	5	68	21	2	
19	0	0	0	93	**21**
	1	3	0	73	
	2	9	1	46	
	3	23	2	23	
	4	**43**	**7**	**9**	
	5	63	16	3	
20	0	0	0	94	**25**
	1	2	0	75	
	2	8	0	49	
	3	20	2	26	
	4	38	5	11	
	5	**58**	**13**	**4**	
	6	75	25	1	

Table A-6. Minimum Threshold Number of Exceedances to Identify a Concern for *Screening Level* Parameters.

Number of Samples	CONCERN: To identify a water body as a screening level **concern** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 20% Exccedance	Actual Type-2 at 40 % Exceedance
4	1	59	13
	2	**18**	**48**
	3	3	82
5	1	67	8
	2	26	34
	3	**6**	**68**
6	1	74	5
	2	34	23
	3	**10**	**54**
7	1	79	3
	2	42	16
	3	**15**	**42**
	4	3	71
8	1	83	2
	2	50	11
	3	**20**	**32**
	4	6	59
9	1	87	1
	2	56	7
	3	26	23
	4	**9**	**48**
10	1	89	1
	2	62	5
	3	32	17
	4	**12**	**38**
	5	3	63
11	1	91	0
	2	68	3
	3	38	12
	4	**16**	**30**
	5	5	53

Table A-6. Minimum Threshold Number of Exceedances to Identify a Concern for *Screening Level* Parameters (continued).			
Number of Samples	**CONCERN**		
	To identify a water body as a screening level **concern** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 20% Exccedance	Actual Type-2 at 40 % Exceedance
12	1	93	0
	2	73	2
	3	44	8
	4	21	23
	5	**7**	**44**
13	1	95	0
	2	77	1
	3	50	6
	4	25	17
	5	**10**	**35**
	6	3	57
14	1	96	0
	2	80	1
	3	55	4
	4	30	12
	5	**13**	**28**
	6	4	49
15	1	96	0
	2	83	1
	3	60	3
	4	35	9
	5	**16**	**22**
	6	6	40
16	1	97	0
	2	86	0
	3	65	2
	4	40	7
	5	**20**	**17**
	6	8	33

Table A-6. Minimum Threshold Number of Exceedances to Identify a Concern for *Screening Level* Parameters (continued).			
Number of Samples	**CONCERN**		
	To identify a water body as a screening level **concern** with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 20% Exccedance	Actual Type-2 at 40 % Exceedance
17	1	98	0
	2	88	0
	3	69	1
	4	45	5
	5	24	13
	6	**11**	**26**
	7	4	45
18	1	98	0
	2	90	0
	3	73	1
	4	50	3
	5	28	9
	6	**13**	**21**
	7	5	37
19	1	99	0
	2	92	0
	3	76	1
	4	54	2
	5	33	7
	6	**16**	**16**
	7	7	31
20	1	99	0
	2	93	0
	3	79	0
	4	59	2
	5	37	5
	6	**20**	**13**
	7	9	25
	8	3	42

Table A-7. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Toxic* Parameters.

Number of Samples	LISTING: To identify a water body as **impaired** with an intended Type-1 error rate of no more than 40% at an exceedance rate of 10% and a Type-2 error rate of less than about 20% at an exceedance rate of 30%. A minimum number of **two** exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					CONCERN: To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 40% at an exceedance rate of 8% and a Type-2 error rate of less than about 20% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exccedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 8% Exceedance	Actual Type-2 at 20% Exceedance
4	1				**2**	**1**	**28**	**41**
	2					2	3	82
	3					3	0	97
5	1				**2**	**1**	**34**	**33**
	2					2	5	74
	3					3	0.1	94
6	1				**2**	**1**	**39**	**26**
	2					2	8	66
	3					3	1	90
7	1				**2**	1	44	21
	2					**2**	**10**	**58**
	3					3	1	85
8	1				**2**	1	49	17
	2					**2**	**13**	**50**
	3					3	2	80
9	1				**2**	1	53	13
	2					**2**	**16**	**44**
	3					3	3	74
10	1	65	11	3	**2**	1	57	11
	2	**26**	**38**	**15**		**2**	**19**	**38**
	3	7	68	38		3	4	68
11	1	69	9	2	**2**	1	60	9
	2	**30**	**32**	**11**		**2**	**22**	**32**
	3	9	62	31		3	5	62
12	1	72	7	1	**2**	1	63	7
	2	**34**	**27**	**9**		**2**	**25**	**27**
	3	11	56	25		3	7	56
13	1	75	5	1	**2**	1	66	5
	2	**38**	**23**	**6**		**2**	**28**	**23**
	3	13	50	20		3	8	50
	4	3	75	42		4	2	75

Table A-7. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for, Use-Attainment of *Toxic* Parameters (continued).

Number of Samples	LISTING: To identify a water body as **impaired** with an intended Type-1 error rate of no more than 40% at an exceedance rate of 10% and a Type-2 error rate of less than about 20% at an exceedance rate of 30%. A minimum number of **two** exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					CONCERN: To identify a water body as a **concern for near non-attainment** with an intended Type-1 error rate of no more than about 40% at an exceedance rate of 8% and a Type-2 error rate of less than about 20% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exccedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 8% Exceedance	Actual Type-2 at 20% Exceedance
14	1	77	4	1	**2**	1	69	4
	2	42	20	5		**2**	**31**	**20**
	3	**16**	**45**	**16**		3	10	45
	4	4	70	36		4	2	70
15	1	79	4	1	**2**	1	71	4
	2	45	17	4		**2**	**34**	**17**
	3	**18**	**40**	**13**		3	11	40
	4	6	65	30		4	3	65
16	1	81	3	0	**2**	1	74	3
	2	49	14	3		**2**	**37**	**14**
	3	**21**	**35**	**10**		3	13	35
	4	7	60	25		4	3	60
17	1	83	2	0	**3**	1	76	2
	2	52	12	2		**2**	**40**	**12**
	3	**24**	**31**	**8**		3	15	31
	4	8	55	20		4	4	55
18	1	85	2	0	**3**	1	78	2
	2	55	10	1		2	43	10
	3	**27**	**27**	**6**		**3**	**17**	**27**
	4	10	50	16		4	5	50
19	1	86	1	0	**3**	1	79	1
	2	58	8	1		2	46	8
	3	**29**	**24**	**5**		**3**	**19**	**24**
	4	12	46	13		4	6	46
20	1	88	1	0	**3**	1	81	1
	2	61	7	1		2	48	7
	3	**32**	**21**	**4**		**3**	**21**	**21**
	4	13	41	11		4	7	41

Table A-8. Maximum Threshold Number of Exceedances to Delist a Water Body for *Toxic* Parameters.

DELISTING					
Number of Samples	To identify a water body as **attaining its use,** and delisted with an exceedance rate of no more than 8%, resulting in a Type-1 error rate of no more than 71% at an exceedance rate of 9%, and no more than 27% at an exceedance rate of 20%; and a Type-2 error rate of 12 to 43% at an exceedance rate of 5%.				
	Number of Exceedances	Actual Type-1at 9% Exceedance	Actual Type-1at 20% Exceedance	Actual Type-2 at 5% Exceedance	Actual % Exceedance When Delisting
10	**0**	**39**	**11**	**40**	**0**
	1	77	38	9	
	2	95	68	1	
11	**0**	**35**	**9**	**43**	**0**
	1	74	32	10	
	2	93	62	2	
12	0	32	7	46	**8**
	1	**71**	**27**	**12**	
	2	91	56	2	
13	0	29	5	49	**8**
	1	**67**	**23**	**14**	
	2	89	50	2	
14	0	27	4	51	**7**
	1	**64**	**20**	**15**	
	2	87	45	3	
15	0	24	4	54	**7**
	1	**60**	**17**	**17**	
	2	85	40	4	
16	0	22	3	56	**6**
	1	**57**	**14**	**19**	
	2	83	35	4	
17	0	20	2	58	**6**
	1	**54**	**12**	**21**	
	2	81	31	5	
18	0	18	2	60	**6**
	1	**51**	**10**	**23**	
	2	78	27	6	
19	0	17	1	62	**5**
	1	**48**	**8**	**25**	
	2	76	24	7	
20	0	15	1	64	**5**
	1	**45**	**7**	**26**	
	2	73	27	8	

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Appendix B

Number of Samples and Exceedances to Identify Impairment, Concern, and to Delist Parameters by the Binomial Method-Graphic Tables

Figure B-1. Binomial Method for Listing and Delisting Conventional Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:	**General Use:**
-DO grab minimum	-Temperature
-24-Hour DO average	-High / Low pH
-24-Hour DO minimum	- Enterococcus for Segments 1006 and 1007

Fully Supporting (FS), **No Concern (NC)**, **Concern for Near Non-attainment but Supporting(CN)**, **Not Supporting (NS)**. **Note that fewer samples than illustrated are not assessed (NA)**. ***Exceedance ratios less than that indicated (≤10%) by the thick line can be delisted.***

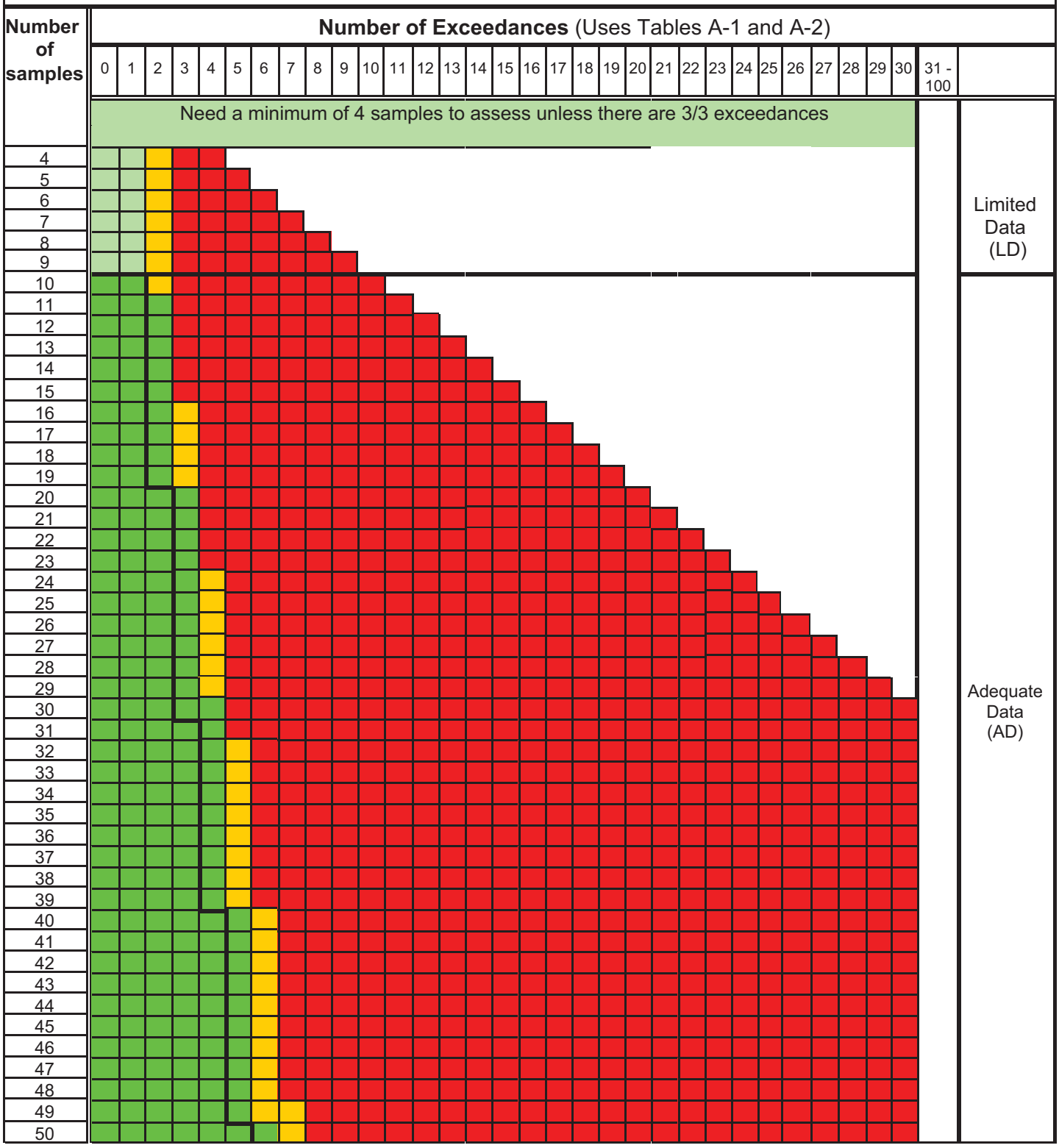

Figure B-1. Binomial Method for Listing and Delisting Conventional Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:	**General Use:**
-DO grab minimum	-Temperature
-24-Hour DO average	-High / Low pH
-24-Hour DO minimum	- Enterococcus for Segments 1006 and 1007

Fully Supporting (FS), **No Concern (NC)**, **Concern for Near Non-attainment but Supporting(CN)**, **Not Supporting (NS)**. **Note that fewer samples than illustrated are not assessed (NA)**. ***Exceedance ratios less than that indicated (≤10%) by the thick line can be delisted.***

Figure B-2. Binomial Method for Determining Dissolved Oxygen Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:
DO grab screening level (against criteria for average)

No Concern (NC), **Concern (CS)**. **Note that fewer samples than illustrated are not assessed (NA)**.

Number of samples	Number of Exceedances (Uses Table A3)																																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31 - 100	
4	NC	NC	CS	CS	CS																												Limited Data (LD)
5	NC	NC	CS	CS	CS	CS																											
6	NC	NC	CS	CS	CS	CS	CS																										
7	NC	NC	CS	CS	CS	CS	CS	CS																									
8	NC	NC	CS	CS	CS	CS	CS	CS	CS																								
9	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS																							
10	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS																						Adequate Data (AD)
11	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS																					
12	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS																				
13	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS																			
14	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS																		
15	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS																	
16	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS																
17	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS															
18	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS														
19	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS													
20	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS												
21	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS											
22	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS										
23	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS									
24	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS								
25	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS							
26	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS						
27	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS					
28	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS				
29	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS			
30	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
31	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
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33	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
34	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
35	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
36	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
37	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
38	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
39	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
40	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
41	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
42	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
43	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
44	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
45	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
46	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
47	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
48	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
49	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		
50	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS		

Figure B-2. Binomial Method for Determining Dissolved Oxygen Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:
DO grab screening level (against criteria for average)

No Concern (NC), Concern (CS). Note that fewer samples than illustrated are not assessed (NA).

Number of samples	Number of Exceedances (Uses Table A3)																																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31 - 100	
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Figure B-3. Binomial Method for Listing and Delisting Bacterial Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:

Recreational Use:

Bacteria single sample

Fully Supporting (FS), **No Concern (NC)**, **Concern for Near Non-attainment but Supporting (CN)**, **Not Supporting (NS)**. **Note that fewer samples than illustrated are not assessed (NA).** ***Exceedance ratios less than that indicated (≤ 25%) by the thick line can be delisted*.**

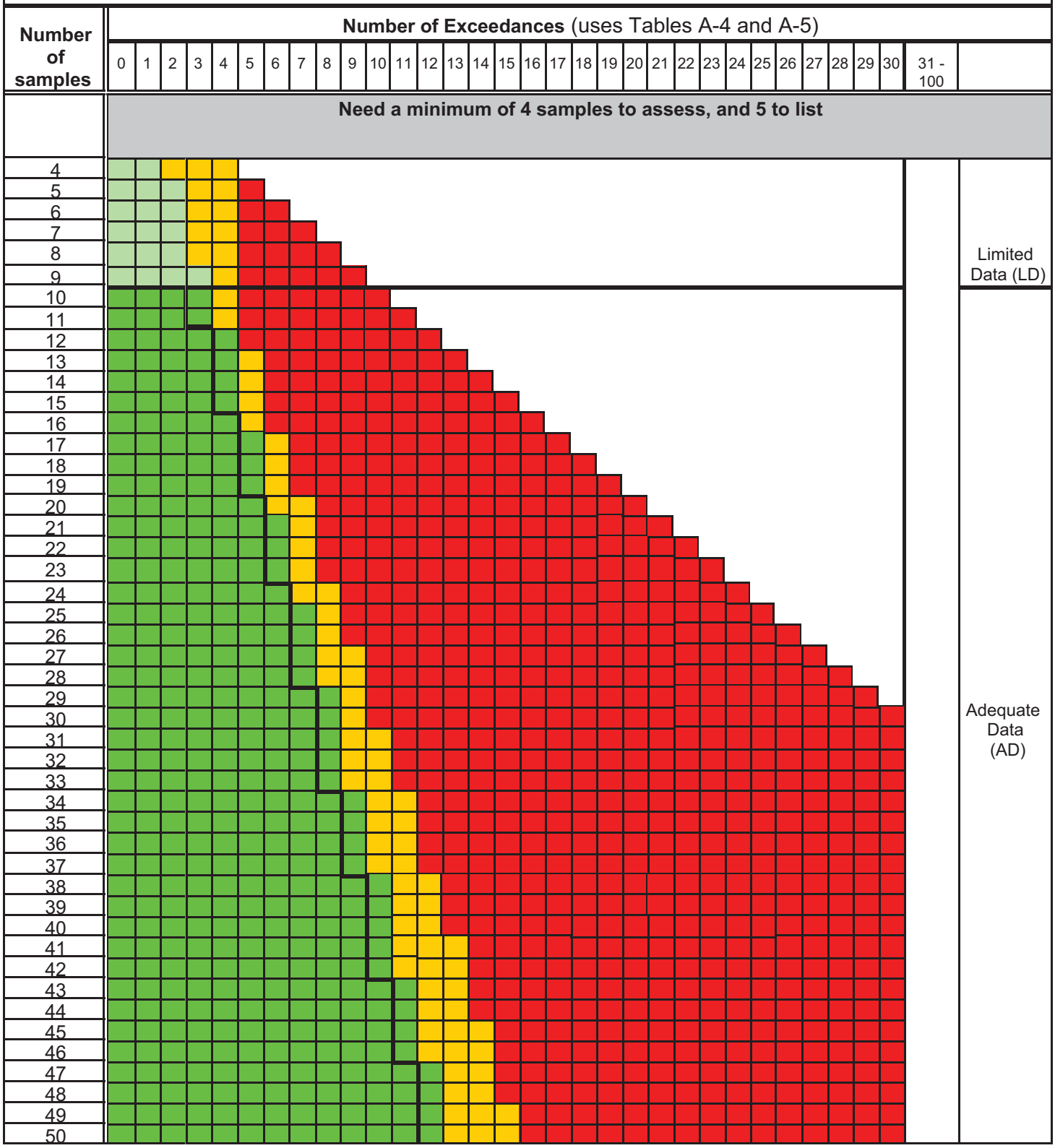

Figure B-3. Binomial Method for Listing and Delisting Bacterial Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:

Recreational Use:

Bacteria single sample

Fully Supporting (FS), No Concern (NC), Concern for Near Non-attainment but Supporting (CN), Not Supporting (NS). Note that fewer samples than illustrated are not assessed (NA). ***Exceedance ratios less than that indicated (≤ 25%) by the thick line can be delisted*.**

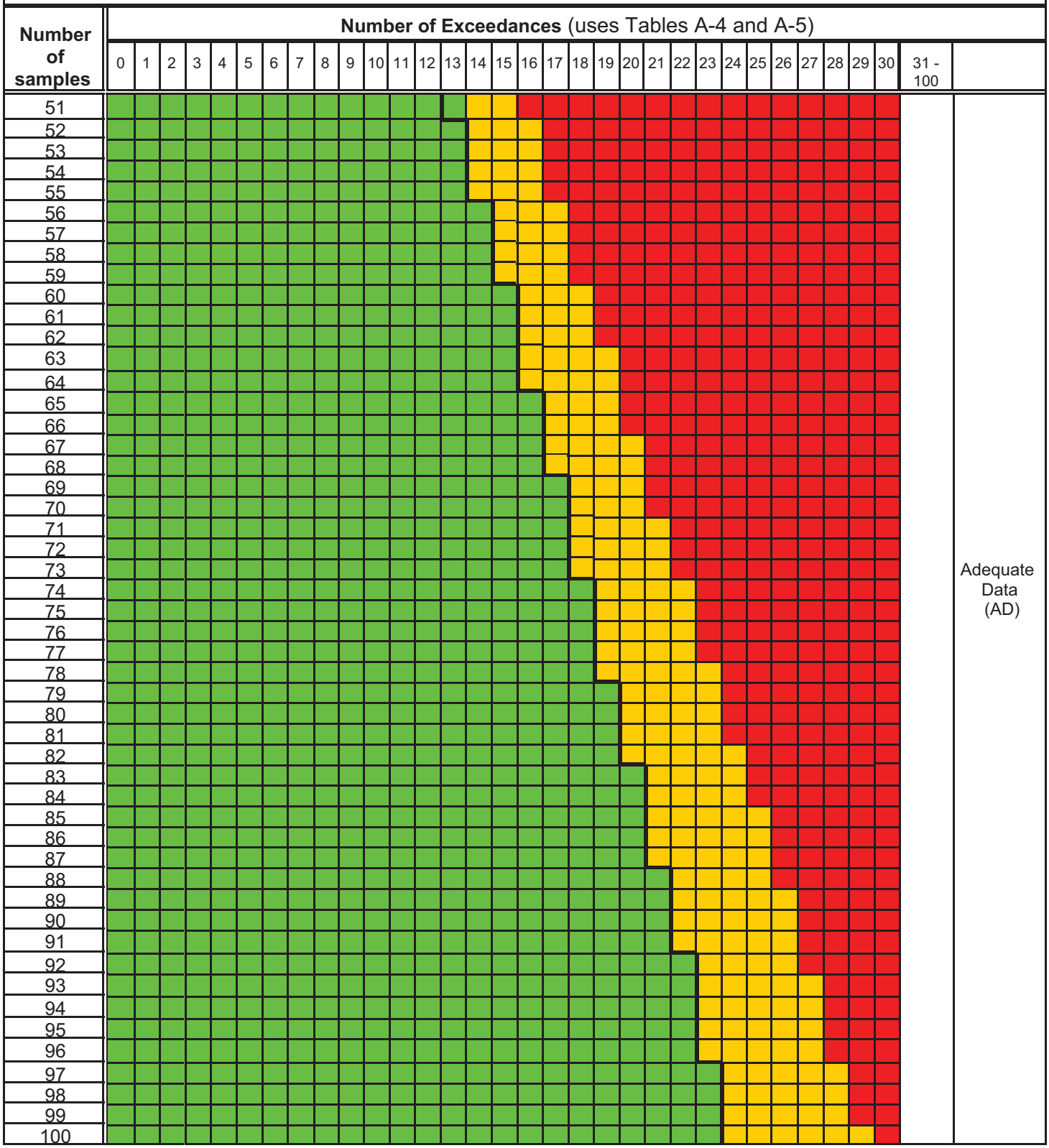

Figure B-4. Binomial Method for Determining Screening Level Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:
Toxic Substances in Sediment

General Use:
-Nutrient Screening Levels
-Chlorophyll Screening Levels

Fish Consumption Use:
-Bioaccumulative Toxics in Tissue

No Concern (NC), **Screening Level Concern (CS)**. **Note that fewer samples than illustrated are not assessed (NA)**.

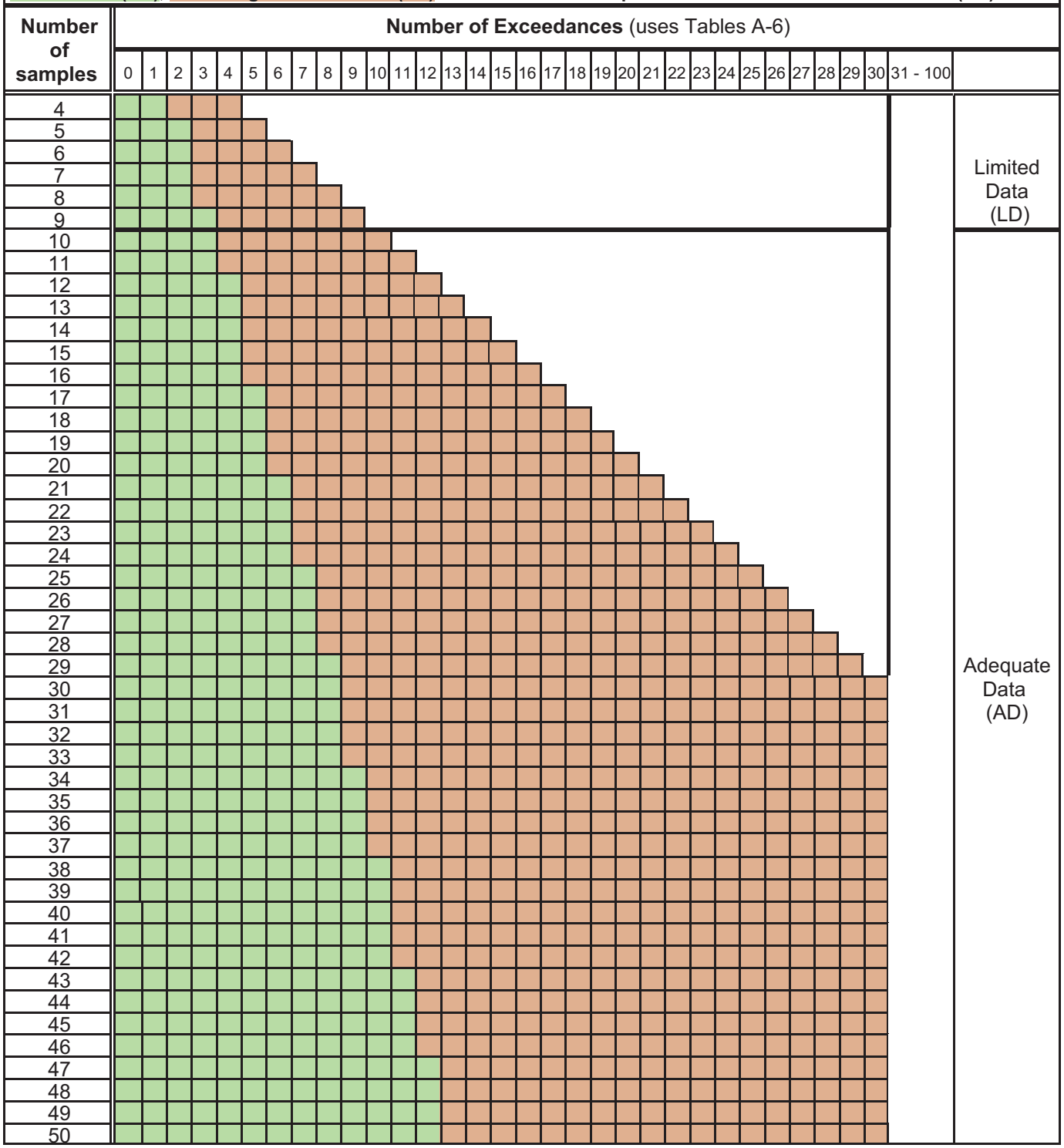

Figure B-4. Binomial Method for Determining Screening Level Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:
Toxic Substances in Sediment

General Use:
-Nutrient Screening Levels
-Chlorophyll Screening Levels

Fish Consumption Use:
-Bioaccumulative Toxics in Tissue

No Concern (NC), **Screening Level Concern (CS)**. **Note that fewer samples than illustrated are not assessed (NA)**.

Number of samples	Number of Exceedances (uses Tables A-6)																															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31 - 100
51	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
52	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
53	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
54	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
55	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
56	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
57	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
58	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
59	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
60	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
61	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
62	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
63	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
64	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
65	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
66	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
67	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
68	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
69	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	Adequate Data (AD)
70	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
71	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
72	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
73	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
74	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
75	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
76	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
77	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
78	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
79	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
80	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
81	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
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83	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
84	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
85	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
86	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
87	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
88	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	
89	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	
90	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	
91	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	CS	
92	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	
93	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	
94	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	
95	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	
96	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	CS	
97	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	
98	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	
99	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	
100	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	CS	CS	CS	CS	CS	CS	CS	

Figure B-5. Binomial Method for Listing and Delisting Toxic Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:
Aquatic Life-use:
-Acute toxic substances in water
-Acute and chronic ambient toxicity tests in water
-LOE Toxic sediment condition (individual samples or areas of sediment, based on lines of evidence)

Fully Supporting (FS),**No Concern (NC)**, **Concern for Near Non-attainment but Supporting(CN)**, **Not Supporting (NS)**.
Note that fewer samples than illustrated are not assessed (NA). ***Exceedance ratios less than that indicated (≤ 8%) by the thick line can be delisted.***

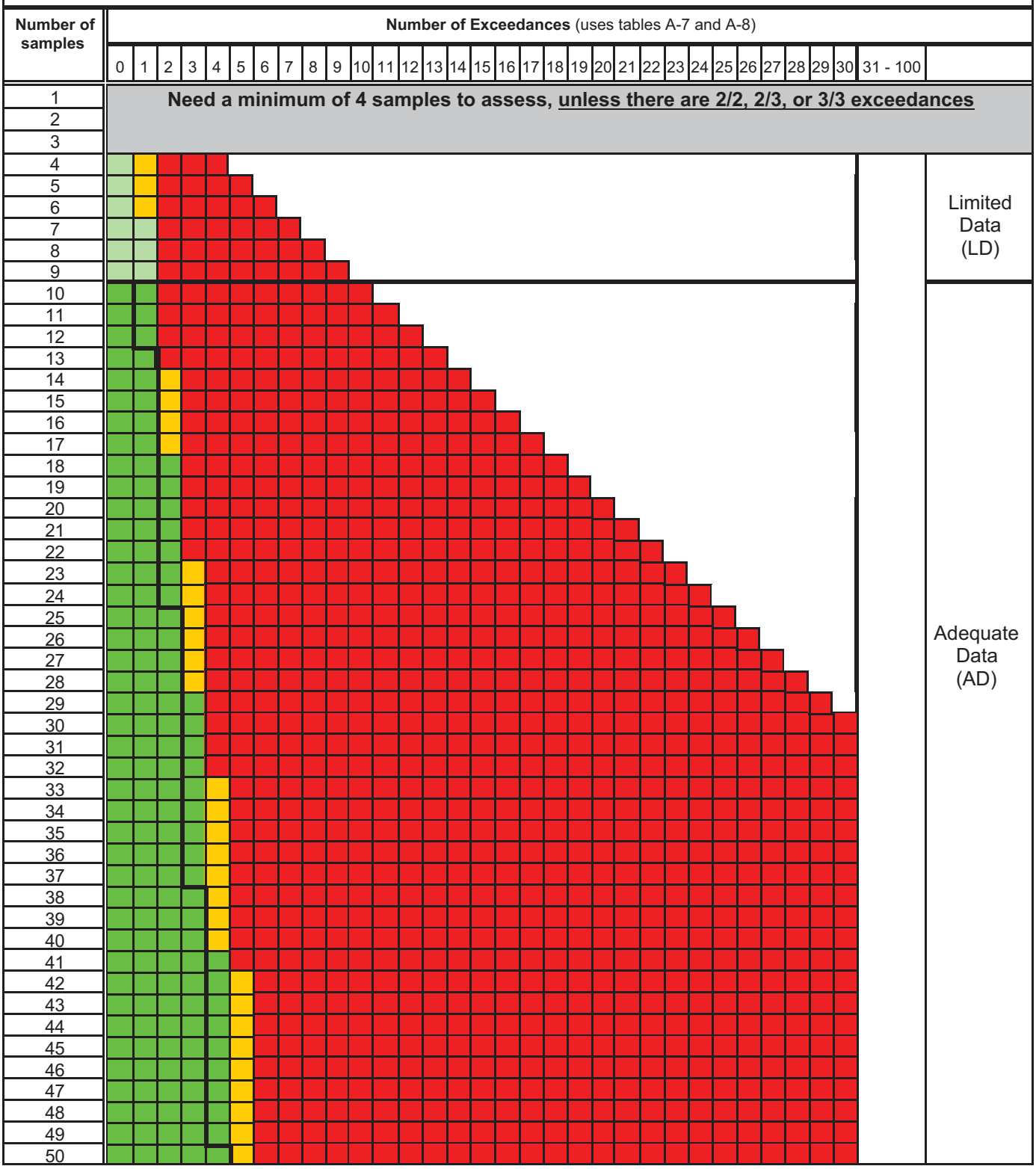

Figure B-5. Binomial Method for Listing and Delisting Toxic Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:
Aquatic Life-use:
-Acute toxic substances in water
-Acute and chronic ambient toxicity tests in water
-LOE Toxic sediment condition (individual samples or areas of sediment, based on lines of evidence)

Fully Supporting (FS),**No Concern (NC)**, **Concern for Near Non-attainment but Supporting(CN)**, **Not Supporting (NS)**.
Note that fewer samples than illustrated are not assessed (NA). ***Exceedance ratios less than that indicated (≤ 8%) by the thick line can be delisted.***

Number of samples	Number of Exceedances (uses tables A-7 and A-8)																															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31 - 100
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Adequate Data (AD)

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APPENDIX C
EVALUATING SEDIMENT TOXICITY

Ambient sediment toxicity assessment is formulated upon multiple lines of evidence (LOE) to reach a decision on risk characterization leading to risk management. The LOE process described in this guidance document is appropriate for defining use support and listing or delisting on the 303(d) List. Planning water quality restoration and decisions about implementation, will require additional sampling and information gathering.

The framework by which ambient sediments are to be assessed is considered a weight of evidence approach. This is commonly defined as a determination related to possible ecological impacts based upon multiple lines of evidence. This determination incorporates judgments concerning the quality, extent and congruence of the data contained in the different lines of evidence.

Whole Sediment Toxicity Tests

Sediment toxicity. Sediment toxicity tests provide direct information on the effects of sediment at a site upon a representative benthic species at that site. In these tests, sediment collected from ambient sites is populated with benthic organisms (typically midges and/or amphipods) in a laboratory setting.

The sediment may exhibit toxicity from chemicals present, physical textural conditions, invasive predatory organisms, ammonia, chlorides, high sediment oxygen demand, pathogens, etc. It is the objective of the test assessment in the laboratory to eliminate superfluous information such as unexpected predation from transient organisms in the sediment or adverse test environmental conditions.

The laboratory sediment tests typically use whole sediment and are placed into test containers and covered with laboratory water. Whenever possible comparison to a reference sediment, collected at an uncontaminated site in the same or similar water body and having similar textural, organic and inorganic characteristics, is used to evaluate toxicity.

For purposes of assessment in the SWQM program, the test duration is usually not longer than 10 days and measures survival and growth. Longer tests can be conducted that include measurements of survival, growth (length/weight) and reproduction and this evidence will be considered. However, longer tests do not necessarily add more information to the assessment since at the ten-day exposure most chemicals have reached equilibrium in biological tissue and have had effects on survival of these short-lived organisms if concentrations and subsequent dosing are at toxic thresholds. Sediment tests should be supplemented with all available data on site conditions and water/sediment quality to enable judgment in interpretation of the results. Sediment characteristics such as texture, organic carbon, pH, and AVS are important in understanding the absence or presence of sediment toxicity. Acid volatile sulfide may bind some metals making them biologically unavailable and could account for the absence of toxicity expected at some contaminated sites.

Whole sediment toxicity tests provide a strong line of evidence for assessing ambient toxicity for the following reasons:

- Test organisms used are endemic to benthic habitats
- Test conditions attempt to reproduce the ambient conditions

Approved Methods. The following methods are approved for whole sediment toxicity tests:

Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates (EPA/600/R-99/064)

Standard Test Methods for Measuring the Toxicity of Sediment Associated-Contaminants with Freshwater Invertebrates (ASTM,2005, E1706-05)

Considerations. The following considerations should be taken into account when assessing sediment toxicity data:

- Adverse conditions during the test (presence of predatory organisms, high ammonia levels).
- Procedures employed, including modifications to standard protocols. Modifications to existing methods must be well documented within the published method and well described. Applications for alternate testing procedures will be made to the executive director.
- Temporal and spatial distribution of the samples which are representative of the assessment area.
- Porewater samples—Do these indicate elevated levels of contaminants?
- Potentially confounding affects of other constituents—acid volatile sulfide (AVS), total organic carbon (TOC), grain size.
- Although tests may be performed, confounding effects may necessitate that the assessor rely on other supporting data, information and best professional judgement (BPJ).

Evidence of toxicity. The evidence of toxicity will depend exclusively on the toxicological endpoint of the tests employed. To determine the presence of toxicity, ambient samples will be compared whenever possible to a reference sediment. In the absence of a suitable reference sediment, a "clean" laboratory sediment is used. The magnitude of the difference in either mortality (lethality) between the ambient samples and clean samples (control) will determine toxicity. Statistical tests used in the assessment of lethal toxicological endpoints for the typical 7 or 10 day test will employ an alpha level of 0.05.

The statistical tests used in the determination of toxicity will vary based upon the distribution of the data. The survival proportions will be transformed using Arcsine transformation (/p2 i), where pi = proportion surviving in replicates. The data will then be examined for homogeneity of variance and departure from normality using Bartlett's and Shapiro-Wilks tests, respectively. If the Bartletts and Shapiro tests indicate the transformed data are normally distributed, then the data will analyzed using a one-way ANOVA. If the ANOVA is significant at the specified alpha level then Dunnett's Multiple Comparison Test will be used to identify specific significant differences between ambient and control sediments. Nonnormal data sets and\or data sets with nonhomogeneous variances will be analyzed using Steel's Many-one Rank Test to determine significant toxicity.

Elutriate Toxicity Tests

In these tests, sediments are vigorously mixed with laboratory test water for a specified period of time, the laboratory test water is then siphoned off and water column test organisms (typically minnows and/or water fleas) are introduced to the test water (the elutriate) in the absence of sediments. Contaminants associated with the sediments would thus be transferred to the water, exposing the aquatic organisms. These tests are useful for representing the exposure to chemicals that can occur after sediments have been resuspended into the water column or after they have passed through the water column as part of dredged material disposal operations. In terms of assessing ambient sediment toxicity, elutriate tests have been the subject of considerable debate

as to their utility and will be used as evidence of potential toxicity which must be supported by other lines of evidence. In effect, they can identify a concern.

Results of these tests should be considered a weaker line of evidence when evaluating ambient sediment toxicity, indicating the potential for *in situ* sediment toxicity. The following aspects should be considered when using elutriate tests to evaluate ambient toxicity:

- These tests were developed to evaluate the effects of dredge disposal on aquatic organisms. Sediment used in this method is prepared in a way which is not representative of ambient conditions (samples are often shaken for 24 hours). However, these tests may represent conditions experienced under high flow events where substantial amounts of sediment resuspension may occur.

- These tests are conducted on water column organisms which may be affected differently than the benthic organisms.

- Elutriate tests have shown correlation with whole sediment tests and serve well as a screening tool to indicate a need for additional lines of evidence.

Draft results from a comparative study of elutriate and whole sediment toxicity tests, conducted by EPA ORD and Region 6, demonstrated that acute elutriate tests are more likely to produce false negatives than false positives as compared to whole sediment tests. This suggests that the elutriate tests are less sensitive than whole sediment tests and, as such, would be indicative of toxic conditions at more acutely toxic sites. It would not be unreasonable to conclude that elutriate testing may provide meaningful results in the terms of identifying sites that need immediate attention. Elutriate tests have a place in the routine assessment of sites suspected of toxicity and the prioritization of acutely toxic sites for further testing or management action.

Approved methods. The following methods adapted by the EPA Region 6 Ambient Toxicity Monitoring Program are approved as described in SOP B-01 Procedures for Aquatic Biology Revision 6.0, U.S. EPA Region 6, October 2003.

Sediment elutriates are prepared by combining a subsample from the homogenized sediment sample with appropriate culture water. The sediment and water are combined in a sediment-to-water ratio of 1:4 by volumetric displacement. After combining, the mixture is tumbled end-over-end for approximately 24 hours, after which the mixture is allowed to settle for an additional 24 hours at 3-4 °C. After settling, the elutriate is siphoned off and filtered through a 1.5 micron glass fiber filter. Standard laboratory tests and statistical data analyses are conducted according to

- *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (U.S. EPA 1994).
- *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (U.S. EPA 1994).
- *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (U.S. EPA 1993).

Considerations. The following considerations should be taken into account when assessing sediment elutriate data:

- Test organisms used in the tests.

- Procedures employed, including modifications to standard protocols. Modifications to existing methods must be well documented within the published method and well described. Applications for alternate testing procedures will be made to the executive director.
- Temporal and spatial distributions of the samples which are representative of the assessment area.
- Potentially confounding effects of other constituents—AVS, TOC, grain size.
- Sublethal toxicity should not be assessed.
- Some contaminants are released under elutriate test conditions, but may not be bioavailable under ambient conditions.

Evidence of toxicity. The evidence of toxicity will depend exclusively on the toxicological endpoint of the tests employed. To determine the presence of toxicity, ambient samples will be compared to "clean" laboratory sediment samples. The magnitude of the difference in mortality (lethality) between the ambient samples and clean samples (control) will determine toxicity. Statistical tests used in the assessment of lethal toxicological endpoints for the typical 7 or 10 day test will employ an alpha level of 0.05.

The statistical tests used in the determination of toxicity will vary based upon the distribution of the data. The survival proportions will be transformed using Arcsine transformation (/p2 i), where pi = proportion surviving in replicates. The data will then be examined for homogeneity of variance and departure from normality using Bartlett's and Shapiro-Wilks tests, respectively. If the Bartletts and Shapiro tests indicate the transformed data are normally distributed, then the data will analyzed using a one-way ANOVA. If the ANOVA is significant at the specified alpha level then Dunnett's Multiple Comparison Test will be used to identify specific significant differences between ambient and control sediments. Nonnormal data sets and\or data sets with nonhomogeneous variances will be analyzed using Steel's Many-one Rank Test to determine significant toxicity.

Biological Communities

Benthic community. In the presence of well defined indices of biotic integrity, direct measurement of the health of the biological community can be made at the site of interest. This important line of evidence can be a direct measure of toxic effects in the population to be protected. Prevailing conditions, however, such as ambient water temperature and salinity can affect the community more than chemical stressors. The reservoir and estuarine environments are more challenging to biological communities than freshwater streams or offshore environments.

The benthic community analysis is indicative of ambient conditions and should be compared to reference conditions that have been firmly established. Indices that are indicative of the condition of environmental health are preferred such as those used for wadeable Texas streams. For many ecosystems a defensible index with adequate reference conditions and site comparisons that can be used to determine biological condition is lacking. When such metrics are available and agreed upon, benthic analysis deserves considerable weight of evidence in any site assessment. Comparison to a site-specific reference location or water body can also be employed. Other factors for evaluating biological data can be based on the relationship between levels of contamination and fundamental measures of community structure such as species richness, abundance, and occurrence of tolerant and intolerant species.

Considerations. The following considerations should be taken into account when assessing biological community data:

- Communities assessed—nekton or benthos.

- Biological integrity assessment methods—Are there accepted indices by which to assess biological communities? Although TCEQ does not have established methods for assessment of estuarine and reservoir benthic biological integrity, scientifically valid methods to evaluate the health of biological communities should be considered, for example those using least-impacted reference conditions. Where the Agency determines methods proposed for a sediment toxicity evaluation project are acceptable, the methods may be used for evaluating the health of biological communities as a Line of Evidence.
- TCEQ's Index of Biotic Integrity (IBI), used to evaluate aquatic life use support in wadeable streams, may not be sensitive enough to demonstrate toxicity to all sensitive species or life stages.

Sediment Contaminants

The level of contaminants in the sediment can be used to imply a cause for observed ambient toxicity. A toxicity identification evaluation (TIE) may be necessary to identify a specific pollutant for load reduction (regulatory activity). These tests, however, are expensive and may not be successful for some groups of pollutants.

Sediment chemistry. Sediment chemistry may be indicative of toxic sediments if the chemicals present are responsible for toxicity. Ideally, elevated levels of chemicals should coincide spatially and temporally with observed toxicity. The chemical analyses should be structured to identify toxicants such as ammonia, which may be naturally occurring or the result of test conditions, and substrate texture that is physically harmful to test organisms. Chemistry can be compared to screening benchmarks for indications of relative sediment quality. Other approaches may consider equilibrium partitioning and presence of AVS (for metals) to account for expected toxicity or lack thereof.

Considerations. The following considerations should be taken into account when assessing sediment contaminant concentrations:

- Screening levels used—including probable effects concentrations (PECs), probable effects concentrations (PELs), effects range median (ERMs), effects range limits (ERLs). Current screening levels (secondary effects levels for sediment) were developed for the TCEQ Ecological Risk Assessment Program and can be found in *Guidance for Conducting Ecological Risk Assessments, Remedition Sites in Texas* RG-263 (Revised) located on the Web at **www.tceq.state.tx.us/remediation/eco/eco.html**. Current sediment screening levels are outlined in Table 3-6 in the assessment guidance.
- Temporal and spatial distribution of the samples.
- Potentially confounding affects of other constituents—AVS, TOC, grain size.

Best Professional Judgement

Best professional judgement (BPJ) comprises the use of expert opinion and judgement based on available data and site-specific conditions to determine, for example, environmental status or risk. For the assessment of ambient toxicity in sediment, BPJ will support other lines of evidence to provide final determinations of use support. In many cases, BPJ will provide insight to site specific conditions, biological assessment methodologies, toxicological test conditions and contaminant analyses.

Because the LOE approach relies on judgement of the assessor, the data set qualifier is reported as JQ (see Table 2-4 in the assessment guidance).

Applicability of Ambient Sediment Toxicity to Reservoirs and Intermittent Streams

In order for ambient sediment toxicity to be relevant, the aquatic community must be exposed and affected. Areas that are evaluated for toxicity should have overlying water and conditions which create the potential for an established benthic community.

Weight of Evidence for Determining Use Attainment

Evidence considered for determining ecological risk of areas assessed for ambient sediment toxicity will include: whole sediment toxicity test results, elutriate toxicity test results, biological community data, and contaminant concentrations and related parameters such as AVS and total organic carbon. The decisions will be supported by the interpretation of the data which will include the use of best professional judgement (BPJ), as discussed below and illustrated in Tables C-1 to C-4.

Each line of evidence used in the ecological risk assessment leading to decisions on impairment of the water body has strengths and limitations in data collection and interpretation. These factors for each parameter must be considered and weighted accordingly in the assessment for sediment in an area where data for lines of evidence are available.

As with any assessment determination for a water body or assessment area, the support status is ultimately made with professional judgement of the assessor.

Table C-1: Relative Weights of Lines of Evidence for Sediment Toxicity

Whole Sediment Tests indicate toxicity	Elutriate Tests indicate toxicity	Biological Community Indicates Effects of Toxicity		Level of Contaminants Indicates Potential for Toxicity	BPJ
		established IBI or method	observations but no accepted methods		
50	10	25	10	10	10, 0, or -10
Toxic if > 50 Concern if >15 to 50 No Concern, or Unassessed if < or = 15 No concern requires two of the following: 1). Whole sediment or elutriate tests 2). Sediment contaminants 3). Biological community data Otherwise, not assessed.					
If both whole sediment and elutriate tests are available, use only the whole sediment tests results. If BPJ indicates toxicity then value will be 10 If BPJ indicates a lack of toxicity then value will be -10 If BPJ does not indicate either toxic or not toxic condition, then BPJ value will be zero					

Table C-2. Line of Evidence—Example 1

Line of Evidence	Result	Points
Whole Sediment Tests indicate toxicity	No	0
Elutriate Tests indicate toxicity	No data	0
Biological community indicates effects of toxicity (established IBI)	Yes	25
Level of Contaminants Indicates Potential for Toxicity	Yes	10
BPJ (no toxicity in whole sediment tests)		-10
	Total	25
Identifies a Concern for Ambient Toxicity in Sediment		

Table C-3. Line of Evidence—Example 2

Line of Evidence	Result	Points
Whole sediment tests indicate toxicity	No data	0
Elutriate tests indicate toxicity	Yes	10
Biological community indicates effects of toxicity (no established IBI)	Yes	10
Level of contaminants indicates potential for toxicity	Yes	10
BPJ (levels of contaminants in sediment ranked as highest in the state for that waterbody type. Additional whole sediment tests will confirm or refute impairment)		10
	Total	40
Identifies a Concern for Ambient Toxicity in Sediment		

Table C-4. Line of Evidence—Example 3

Line of Evidence	Result	Points
Whole sediment tests indicate toxicity	Yes	50
Elutriate tests indicate toxicity	No data	0
Biological community indicates effects of toxicity (no established IBI)	No	0
Level of contaminants indicates potential for toxicity	Yes	10
BPJ (toxicity tests and contaminant levels indicated toxicity, limited biological data available)		10
	Total	70
Identifies Aquatic Life Use Impairment for Ambient Toxicity in Sediment		

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APPENDIX D
METHODOLOGY FOR LISTING FISH AND SHELLFISH TISSUE CONTAMINANTS ON THE 303(D) LIST

Introduction

The Texas Department of State Health Services (DSHS), formerly the Texas Department of Health, issues fish and shellfish consumption advisories and aquatic life closures for specific contaminants and/or classes of chemicals in areas of Texas surface waters. The issuance of an advisory or aquatic life order by the DSHS indicates a violation of Texas Surface Water Quality Standards (TSWQS), specifically the narrative criteria that surface waters should not be toxic to humans from the consumption of aquatic organisms. As a consequence, TCEQ has listed water bodies on the 303(d) List for the contaminant or class of chemicals in the DSHS advisory or aquatic life closure.

For past 303(d) Lists, the TCEQ has based the listing on the general information available in the DSHS advisory or aquatic life closure notices. For example, *ADV-19 for Arroyo Colorado, Llano Grande Lake, and Main Floodway* consisted of a map of the advisory area and consumption advice for smallmouth buffalo due to organochlorine pesticide concerns. This information was used to list the entire Arroyo Colorado Above Tidal (Segment 2202) due to "organic compounds in fish tissue" on the 2002 303(d) List. This approach has presented problems in developing Total Maximum Daily Loads (TMDLs), since TMDLs are developed for specific contaminants. In addition, the geographic area described by the DSHS in the advisory is often difficult to match up to the classified and unclassified water body segments that the TCEQ uses to list impairments. For these reasons, the DSHS and the TCEQ have drafted this more detailed methodology that makes greater use of the data and recommendations underlying the advisory or aquatic life closure.

Assessing Fish Tissue Data

Fully supporting fish consumption use. DSHS risk characterization indicates no appreciable risk to consumers.

Not supporting fish consumption use. DSHS issues a restricted-consumption advisory, a no-consumption advisory or an aquatic life closure.

Fish consumption use not assessed. No DSHS risk characterization.

Fish tissue contaminants concern. Determined by evaluating tissue data averages with human health criteria

Overview of Methodology

The DSHS advisories and aquatic life closures are based on detailed risk characterizations (previously called health consultations). The risk characterizations are analyses of the likelihood of adverse health effects (noncancerous and cancerous) from consumption of fish and/or shellfish from each site where specimens were collected. Based on the risk characterization, DSHS may

issue a consumption advisory or an aquatic life closure on the possession of fish from a surface water area. Issuance of a consumption advisory or an aquatic life closure prohibiting the taking of aquatic life for the area is a risk management decision that is taken when all ramifications of such an action have been assessed.

Once an advisory or aquatic life closure has been issued by the DSHS, the TCEQ will use the risk characterizations to determine support of the fish consumption use. The TCEQ will recommend water bodies be listed as not supporting the fish consumption use and scheduled for a TMDL (Category 5a of the 303(d) List). If the DSHS does not issue an advisory or aquatic life closure, the TCEQ will not independently list a water body as impaired for fish consumption use, but will assess the tissue data to determine possible fish tissue concerns.

In the case where the DSHS cites specific contaminants (e.g., heptachlor epoxide; p,p'-DDE, etc.) as a public health hazard in the "Conclusions and Public Health Implications" section of the risk characterizations, the TCEQ will list these same specific contaminants as impairments to the fish consumption use. *In the case where specific contaminants are not cited as public health hazards in the risk characterizations, the TCEQ will apply the following methodology based on the recommendations and data in the DSHS risk characterization.* The TCEQ will use the same **hazard quotients** and **hazard index** information (for noncancerous effects) and the **cancer risk** and the **cumulative cancer risk** (for cancerous effects) developed by the DSHS for each DSHS sampling site to determine which contaminants will be included in Category 5a of the 303(d) List.

To determine which water bodies are contaminated, the TCEQ will use the sampling site information provided in the DSHS risk characterizations, the DSHS advisories, and TCEQ water body segment information to determine which segments are impaired. TCEQ will use flow paths to ensure that not only the TCEQ segment containing the DSHS sampling site but any appropriate connected segments are placed in Category 5a for the appropriate contaminant.

Hazard quotient (HQ). EPA defines a hazard quotient as the ratio of an estimated exposure dose (in mg toxicant/kg body weight/day) to the contaminant's reference dose or minimal risk level. A hazard quotient of less than 1.00 (for a single individual contaminant) is not expected to result in adverse health effects.

Hazard index (HI). The hazard index (HI) is the sum of the hazard quotients derived for contaminants at a site that have the same target organ or that display similar modes of action. DSHS uses the hazard index to assess potential cumulative effects of multiple chemicals occurring in one or more fish from a specific water body. DSHS may issue a consumption advisory or aquatic life closure banning possession of fish from a water body if the hazard index exceeds 1.00. Although these actions are available to the department, issuance of a consumption advisory or a aquatic life closure on possession is a risk management decision that is taken when all ramifications of such an action have been assessed.

Cancer risk. The ratio of the average individual contaminant concentration in fish tissue (in mg/kg) to the contaminant's cancer Health Assessment Comparison (HAC) value multiplied by 10^{-5}. An individual cancer risk less than 1×10^{-4} (1 excess cancer in 10,000 people) is not expected to result in adverse health effects.

Cumulative cancer risk. A cumulative cancer risk is used to assess the potential cumulative effects of multiple carcinogenic chemicals occurring in the same fish/media. The cumulative cancer risk is the sum of all of the cancer risks for carcinogenic contaminants found at a DSHS

sampling site. A cumulative cancer risk greater than 1×10^{-4} (1 excess cancer in 10,000 people) may result in the issuance of consumption advisories by DSHS.

The following methodology will be used when DSHS issues a consumption advisory based on water body-specific data. TCEQ will only place water bodies in Category 5a based on data collected from the areas cited in a DSHS advisory and applicable connected waters.

When contaminant-specific recommendations are not included in the DSHS risk characterizations, TCEQ will automatically regard a contaminant as an impairment to a water body when:

1) the contaminant HQ is greater than or equal to 0.10[1] and the DSHS site HI exceeds 1.00, or
2) the contaminant Cancer Risk is greater than or equal to 1×10^{-5} and the DSHS site Cumulative Cancer Risk exceeds 1×10^{-4}.

The TCEQ will apply this methodology to each and every sampling site in a DSHS risk characterization.

Listing Degradation Products and Metabolites

Uncertainty remains on the source of some contaminants. A contaminant may be the primary source (i.e. commercially manufactured chemical), the secondary source (i.e. degradation product or metabolite of another commercially manufactured contaminant) or both. In light of this uncertainty, when a contaminant recommended for listing is a primary source contaminant, the TCEQ will recommend that the secondary source contaminant(s) also be listed if an HQ or Cancer Risk was determined for the secondary source contaminants(s). When a contaminant recommended for listing is a secondary source contaminant of another contaminant, TCEQ will recommend that the primary contaminant also be listed *if* an HQ or Cancer Risk was determined for the primary source contaminant (see example B). Examples of chemically related contaminants include:

a. DDT, DDD, and DDE
b. dieldrin and aldrin; and
c. heptachlor and heptachlor epoxide

Listing Dioxins and PCBs

Although the DSHS may develop a HQ for a specific dioxin or PCB, TCEQ will simply list for "dioxins" or "PCBs" in Category 5a. A more detailed explanation of dioxin and PCB listings is provided at the end of this methodology.

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[1] The hazard quotient level of 0.10 is a screening level mutually agreed upon by TCEQ and DSHS. This level is based on the February 2001 document by the Agency for Toxic Substances and Disease Registry, "Draft for Public Comment" *Guidance Manual of the Assessment of Joint Toxic Action of Chemical Mixtures*. This document is available on the web at www.atsdr.cdc.gov/interactionprofiles/ipga.html.

Determining Impairments Using Non Cancerous Effects

The HI and HQ methodology will be used ONLY IF the DSHS has not listed contaminant-specific intake advice in risk characterization to protect consumers from noncancerous adverse health effects.

1. Does the HI for the DSHS sampling site exceed 1.00?
   Yes Proceed to Step 2
   No The water body(ies) associated with this sampling site are not impaired and thus should not be placed in Category 5a.

2. Rank the HQs from highest to lowest. Do any of the HQs equal or exceed 0.10?
   Yes Identify the contaminants with an HQ that equals or exceeds 0.10. Subtract the HQ for these contaminants from the HI. These contaminants should be recommended for placement in Category 5a.
   2.1 Do these contaminants (≥0.10) have parent or breakdown compounds identified in the HI?
   Yes These contaminants should also be recommended for placement in Category 5a. Proceed to 3a.
   No Proceed to 3a.
   No Proceed to 3b.

3a. After subtracting each of the HQs ≥0.10 and the HQs for applicable parent/breakdown compounds does the HI still exceed 1.00?
   Yes Subtract the largest HQs (<0.10) from the HI. Repeat this process until the remaining HI is less than 1.00. The contaminants whose HQs were subtracted from the HI should be recommended for placement in Category 5a. If there is more than one contaminant with the same HQ and it is necessary to subtract at least one of the HQs to get below 1.00–TCEQ will recommend that all of the other contaminants with the same HQ be placed in Category 5a.
   No The water body(ies) associated with this site are not impaired by the remaining contaminants and thus the remaining contaminants (whose remaining HI is < 1.00) should not be placed in Category 5a).

3b. Subtract the largest HQs (<0.10) from the HI. Repeat this process until the remaining HI is less than 1.00. The contaminants whose HQs were subtracted from the HI should be recommended for placement in Category 5a. If there is more than one contaminant with the same HQ and it is necessary to subtract at least one of the HQs to get below 1.00–TCEQ will recommend that all of the other contaminants with the same HQ be placed in Category 5a.

Table D-1. Determining Impairments Using Non Cancerous Effects—Example A

Contaminants	Ranked Hazard Quotients	TCEQ Listing Outcome
chlordane	0.65	**Category 5a (Steps 1 and 2)**
heptachlor epoxide	0.54	**Category 5a (Steps 1 and 2)**
dieldrin	0.22	**Category 5a (Steps 1 and 2)**
p,p'-DDE	0.04	Not impaired for these contaminants. Result is HI=0.04
p,p'-DDT	0.004	
hexachlorobenzene	0.003	
p, p' - DDD	0.002	
Aroclor 1260	ND	
HAZARD INDEX, Finfish	**1.46**	

Table D-2. Determining Impairments Using Non Cancerous Effects—Example B

Contaminants	Ranked Hazard Quotients	TCEQ Listing Outcome
heptachlor epoxide	0.48	**Category 5a (Steps 1 and 2)**
chlordane	0.39	**Category 5a (Steps 1 and 2)**
dieldrin	0.36	**Category 5a (Steps 1 and 2)**
p,p'-DDE	0.098	Not impaired for this contaminant. Result is HI=0.827
aldrin	0.098	**Category 5a (Step 1 and 2.1)**
endrin	0.098	Not impaired for these contaminants. Result is HI=0.827
toxaphene	0.098	
p,p'-DDD	0.095	
hexachlorobenzene	0.095	
p,p'-DDT	0.095	
lindane	0.095	
heptachlor	0.095	**Category 5a (Step 1 and 2.1)**
dacthal	0.095	Not impaired for these contaminants. Result is HI=0.827
Aroclor 1260	0.061	
HAZARD INDEX, Finfish	**2.25**	

Determining Impairments Using Cancerous Effects

The cancer risk and cumulative cancer risk methodology will be used ONLY IF the DSHS has not listed contaminant-specific consumption advice in a health consultation to protect consumers from cancerous adverse health effects.

1. Does the Cumulative Cancer Risk exceed 1 x 10^{-4} (1 excess cancer in 10,000 people) for a DSHS sampling site?
   Yes Proceed to Step 2
   No The water body(ies) associated with this sampling site are not impaired and thus should not be placed in Category 5a.

2. Rank the Cancer Risks from highest to lowest. Do any of the Cancer Risks equal or exceed 1 $x10^{-5}$ (1 excess cancer in 100,000)[2]?

   Yes Identify the contaminants with a Cancer Risk that equals or exceeds 1 $x10^{-5}$. Subtract the Cancer Risk for these contaminants from the Cumulative Cancer Risk. These contaminants should be recommended for placement in Category 5a.

   2.1 Do these contaminants ($\geq$1 $x10^{-5}$) have parent or breakdown compounds identified in the Cumulative Cancer Risk table?

   Yes These parent or breakdown contaminants should also be recommended for placement in Category 5a. Proceed to 3a.

   No Proceed to 3a.

   No Proceed to 3b.

3a. After subtracting each of the Cancer Risks ($\geq$1 $x10^{-5}$) and the Cancer Risks for applicable parent/breakdown compounds does the Cumulative Cancer Risk still exceed 1 x 10^{-4}?

   Yes Subtract the remaining largest Cancer Risks from the Cumulative Cancer Risk. Repeat this process until the remaining Cumulative Cancer Risk is less than 1 x 10^{-4}. The contaminants whose Cancer Risks were subtracted from the Cumulative Cancer Risk (and applicable parent/breakdown compounds) should be recommended for placement in Category 5a. If there is more than one contaminant with the same Cancer Risk and it is necessary to subtract at least one of the Cancer Risks to get below 1 x 10^{-4}– TCEQ will recommend that all of the other contaminants with the same Cancer Risk be placed in Category 5a.

   No The water body(ies) associated with this sampling site are not impaired by the remaining contaminants and thus the remaining con-taminants (whose remaining Cumulative Cancer Risk is < 1 x 10^{-4}) should not be placed in Category 5a.

3b. Subtract the largest Cancer Risks from the Cumulative Cancer Risk. Repeat this process until the remaining Cumulative Cancer Risk is less than 1 x 10^{-4}. The contaminants whose Cancer Risks were subtracted from the Cumulative Cancer Risk should be recommended for placement in Category 5a.

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[2] The cancer risk level of 1 $x10^{-5}$ (1 excess cancer in 100,000) for an individual contaminant is a screening level mutually agreed upon by TCEQ and DSHS.

Table D-3. Determining Impairments Using Cancerous Effects—Example C

Contaminants	Ranked Cancer Risks	Increase in Risk	TCEQ Listing Outcome
dieldrin	7.4×10^{-5}	1 in 13,513	Category 5a (Steps 1 and 2)
chlordane	4.9×10^{-5}	1 in 20,408	Category 5a (Steps 1 and 2)
heptaclor epoxide	2.7×10^{-5}	1 in 37,037	Category 5a (Steps 1 and 2)
p,p'-DDE	2.7×10^{-6}	1 in 370,370	Not impaired for these contaminants. Result is Cumulative Cancer Risk = 4.79×10^{-6} (1 in 208,768)
hexachlorobenzene	1.4×10^{-6}	1 in 714,286	
p,p'-DDD	4.1×10^{-7}	1 in 2,439,024	
p,p'-DDT	2.8×10^{-7}	1 in 3,571,429	
Araclor 1260	ND	ND	
Cumulative Cancer Risk,	**1.6×10^{-4}**	**1 in 6,250**	

Table D-4. Determining Impairments Using Cancerous Effects—Example D

Contaminants	Ranked Cancer Risks	Increase in Risk	TCEQ Listing Outcome
chlordane	2.22×10^{-5}	1 in 45,000	Category 5a (Steps 1 and 2)
eldrin	1.33×10^{-5}	1 in 75,000	Category 5a (Steps 1 and 2)
Araclor 1260	9.99×10^{-6}	1 in 100,098	Category 5a (Steps 1, 2.1 and
p,p'-DDT	9.89×10^{-6}	1 in 101,065	Not impaired for these contaminants. Result is Cumulative Cancer Risk = 9.33×10^{-5} (1 in 10,718)
heptaclor epoxide	9.80×10^{-6}	1 in 102,000	
hexachlorobenzene	9.71×10^{-6}	1 in 103,000	
p,p'-DDD	9.62×10^{-6}	1 in 104,000	
lindane	9.52×10^{-6}	1 in 105,000	
heptachlor	9.43×10^{-6}	1 in 106,000	
dacthal	9.35×10^{-6}	1 in 107,000	
dieldrin	9.26×10^{-6}	1 in 108,000	
aldrin	8.69×10^{-6}	1 in 115,000	
p,p'-DDE	8.00×10^{-6}	1 in 125,000	
Cumulative Cancer Risk,	**1.39×10^{-4}**	**1 in 7,194**	

Removing Impairments from the 303(d) List (Delisting)

There are two ways to remove a water body from Category 5a of the 303(d) List, based on fish tissue contaminants listed as a result of a DSHS advisory or closure:

1) if DSHS rescinds the advisory/closure, TCEQ would determine that the impairment no longer exists. If the water body has no other Category 5 parameters, the water body would be moved to Category 1 or 2, as appropriate.

2) if a TMDL is completed for the parameters listed under the advisory/closure, and if the water body has no other Category 5 parameters, the water body would be moved to Category 4a. The water body would remain in Category 4a until the advisory/closure is rescinded (see (1)).

Further Discussions of Dioxins and PCBs

Much of this information was extracted from reports concerning dioxins and PCBs, submitted to the TCEQ by the University of Houston (UH, 2003a; UH, 2003b).

The terms “dioxin” and “PCB” are used as general references to a set of persistent bioaccumulative organic substances, some of which are extremely toxic. Polychlorinated dibenzo-p-dioxins (PCDDs, or dioxins), polychlorinated dibenzofurans (PCDFs, or furans), and polychlorinated biphenyls (PCBs) are halogenated aromatic compounds. These substances are often produced by the oxidation of organic matter in the presence of chlorine, by natural processes and/or as unintended byproducts of human activities.

These three groups of compounds have somewhat similar molecular structures – all three include two linked “benzene rings” and have a number of chlorine atoms attached to the rings – but they differ in the nature of the bonds between the ring structures, and the orientation of the rings relative to each other. Within each group, “congeners” are specific individual compounds defined by the number and placement of chlorine atoms. “Homologues” are groups of congeners that have the same number of chlorine atoms, but attached at different sites. Conventional names for the PCDD and PCDF congeners use numbers and syllables that essentially describe the molecular structure (e.g. 1,2,3,7,8-pentachloro-dibenzofuran or 1,2,3,7,8-PeCDF), but PCB congeners are more simply numbered (e.g. PCB-1, PCB-168, etc.)

There are 75 PCDD congeners, 7 of which exhibit “dioxin-like toxicity” as the term is used today. There are 135 PCDF congeners, 10 of which exhibit dioxin-like toxicity. The 17 PCDD and PCDF congeners considered toxic are those with chlorine substitution in at least the 2, 3, 7, and 8 positions, with 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) recognized as the most toxic of them all. In addition, 13 of 209 PCB congeners have been identified as having dioxin-like toxicity (U.S. Environmental Protection Agency, 2000). Considering all three groups, 30 congeners from a total of 419 may contribute to “dioxin-like toxicity,” which is the effect of concern to water quality scientists and regulators.

Since the toxic congeners may occur together, and are of variable toxicity, environmental effects analyses typically combine the congeners by assigning each a Toxicity Equivalence Factor (TEF) that is indexed to the most toxic (2,3,7,8-TCDD has a TEF of 1.0). In practice, the concentration of each congener in a sample is multiplied by its TEF, and the results summed to derive a 2,3,7,8-TCDD equivalent concentration (TEQ). The TEFs for other congeners range from 0.5 (for the second most toxic) down to 0.00001.
Fish consumption advisories or other concerns regarding dioxins (as the term is generically used) are based on the TEQs of samples, not on the individual congeners observed. The components of the TEQ in various samples from a water body are unlikely to be identical. Attempting to identify specific congeners in relation to 303(d) listings would be extremely tedious, confusing, and tend to obscure the primary issue. Therefore, all listings or discussions related to “dioxin-like toxicity” in the Texas consolidated assessment documents use the generic term “dioxin”. Distinctions among individual congeners can be made during subsequent analyses.

There may also be water quality standards and/or listings labeled as “PCBs” or “Aroclors,” that are distinct from generic dioxins. Besides individual congeners, PCBs may be identified as Aroclor equivalents, or as homologue groups (i.e. monochlorobiphenyl, dichlorobiphenyl, etc). Historically, Aroclor analysis (EPA Method 8082) has been most common.

The Aroclor compounds were at one time commercial products that were deliberately made and sold – those products have been banned, although equipment that contains them will continue to be used for some time. There were slightly more than a dozen Aroclor compounds made, each containing a statistically consistent set of PCB congeners that defined the “fingerprint” of a

specific Aroclor. Different Aroclors are identified by numbers (e.g. Aroclor 1254, Aroclor 1260, etc.). Early laboratory studies of PCB toxicity used Aroclors because those were readily available for controlled exposure experiments, so many of the current water quality standards derived from those studies are expressed in terms of an Aroclor concentration.

Using Aroclor analyses as the basis for environmental effects analyses may yield significant error in determining total PCB concentration or toxicity, because that approach assumes that the distribution of PCB congeners in environmental samples and parent Aroclor compounds is similar (US EPA, 2000). Cogliano (1998) found that bioaccumulated PCBs are more toxic and persistent that the original Aroclor mixtures, and the US EPA (2000) recommends analysis of homologue groups or PCB congeners. However, since all health-based assessments are based on Aroclors, the EPA suggests summing 18 congeners for comparison to total PCB or Aroclor-based screening values, as recommended by the National Oceanic and Atmospheric Administration (NOAA, 1989). The 18 congeners include PCB-8, PCB-18, PCB-28, PCB-44, PCB-52, PCB-66, PCB-77, PCB-101, PCB-105, PCB-118, PCB-126, PCB-128, PCB-138, PCB-153, PCB-169, PCB-170, PCB-180, and PCB-187.

Fish consumption advisories or other data used as the basis for 303(d) listings or other parts of the Texas consolidated assessment may utilize any of the PCB measurement approaches (i.e. Aroclor-equivalents, homologue groups, or congeners), but most are and will be based on Aroclors for the foreseeable future. Listing a water body for a specific Aroclor, or a specific set of congeners, could obscure the issue by seeming to focus the problem too specifically. Therefore, any listings will use the generic term "PCB" rather than attempting to identify specific Aroclor compounds or sets of congeners.

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