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Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data, 2002

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This guidance is also available on the TNRCC Web site, www.tnrcc.state.tx.us.
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Highlights

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General Assessment Methodology

The Texas Natural Resource Conservation Commission (TNRCC) administers water quality management programs with the goal of protecting, maintaining, and restoring Texas water resources. The Texas Surface Water Quality Standards (,TSWQS, TNRCC Rules Chapter 307), adopted by the TNRCC on July 26, 2000, although not yet approved by the Environmental Protection Agency (EPA), 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. Numerical criteria (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 comparing instream water quality conditions to numerical criteria is specified in the TSWQS. For example, dissolved oxygen measurements monitored in a water body may be compared to numerical criteria to determine if the designated aquatic life use is supported. The TSWQS most recently adopted by the TNRCC and approved by the EPA will be used for the assessment. The TSWQS adopted by the TNRCC on July 26, 2000, and pending approval by the EPA, are used in this draft of the guidance.

Texas Drinking Water Standards (TDWS), adopted by the TNRCC on June 4, 1977 (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.

In most instances, this guidance describes how numerical criteria can be compared to conditions within streams and rivers, lakes and reservoirs, and ocean waters, as specified in the TSWQS/TDWS. For example, dissolved oxygen criteria consist of 24-hour average and absolute minimum concentrations. Monitoring must be conducted over at least one complete 24-hour period to generate dissolved oxygen data that can be directly compared to the criteria. Automatic equipment is typically used at monitoring sites to collect field measurements over a complete 24-hour period. In some cases, instantaneous measurements made at equally-

spaced intervals over a 24-hour period are used to generate the required data for direct comparison to the dissolved oxygen criteria.

Some of the numerical criteria in the TSWQS, such as water temperature, pH, chloride, sulfate, and total dissolved solids, are not associated with single, specific uses. Instead, they were established in the TSWQS to ensure support of multiple uses, and as tools to identify and manage the influences of point and nonpoint sources of pollution (see definitions on page 73).

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 long-term monitoring data for this guidance. Recent monitoring data, collected over the last five-year period, are compared to the screening levels to identify areas where elevated concentrations are causes of concern.

The TSWQS also contain narrative criteria (verbal descriptions) that apply to all waters of the state. Narrative criteria include general descriptions, such as existence of excessive aquatic plant growths, foaming of surface waters, taste- and odor-producing substances, eroding sediment, and toxic materials. Narrative criteria are evaluated by using numeric criteria, if they are available. Other information—including water quality studies, existence of fish kills or contaminant spills, photographic evidence, local knowledge, and best professional judgment—is also used to identify narrative criteria concerns and evaluate support of narrative criteria and associated designated uses.

To conduct the assessment, the most recent five years of surface water quality monitoring and finished drinking water data are assembled, ordered by parameter, and evaluated by analysts. In most cases, individual values for each parameter are compared to either numerical water quality criteria or screening levels, and the number of exceedances are determined. Uses and criteria are assessed as *fully supported*, *partially supported*, and or *not supported* based on the number of exceedances for a given sample size. Similar exceedances of numeric screening levels are used to identify water bodies with *no concerns*, or *concerns* for impairment. In a few cases where numeric criteria are established as averages (dissolved oxygen criteria; chloride, sulfate, and total dissolved solids criteria; chronic criteria for toxic substances; public drinking water criteria; and human health criteria), individual concentrations for each parameter are summed, and an average is computed. The average is then directly compared to criteria in the TSWQS/ TDWS to determine if the designated

use is fully supported or not supported, or to identify water quality concerns.

Waters Covered in Assessments

All stream, reservoir, estuary, and Gulf of Mexico sites are evaluated if there is sufficient water quality data to assess at least one designated beneficial use or criterion. This includes sites within classified segments, as specified in the TSWQS, and sites off classified segments (unclassified waters). The general criteria in the TSWQS for the following uses should be applied to assessment of classified and unclassified waters, unless site-specific criteria derived from receiving water assessments are available:

- aquatic life use (dissolved oxygen, toxic substances in water, water and sediment toxicity tests, and biological assessments),
- contact recreation use, and
- fish consumption use (human health criteria, fish consumption advisories, and aquatic life closures).

Narrative criteria should be applied to assessment of unclassified waters unless site-specific criteria derived from receiving water assessments are available. Site-specific criteria developed for classified segments (water temperature, pH, chloride, sulfate, and total dissolved solids) do not apply to unclassified water bodies.

Sources of Data

Information that may be considered includes surface water quality monitoring (SWQM) data stored in the TNRCC Regulatory Activities and Compliance System (TRACS) database, finished drinking water quality data in the TNRCC's Water Permits and Resource Management databases, Clean Rivers Program (CRP) databases, volunteer monitoring programs, and/or other quality-assured data. Water quality data used in the assessment must meet clearly defined acceptance and time line criteria established by the TNRCC (refer to most recent revision of *Methodology for Developing the Texas List of Impaired Water Bodies*).

In addition to SWQM data collected by the TNRCC, the TRACS database contains quality-assured data from other state and federal agencies, river authorities, cities, and other monitoring groups. State agencies include the Texas Department of Health (TDH) and the Texas Parks and Wildlife Department (TPWD). Federal agencies include the U.S. Geological Survey (USGS) and the International Boundary and Water Commission (IBWC). These data are collected using methods consistent with the *Surface Water Quality Monitoring Procedures Manual* (TNRCC, GI-252). SWQM data are collected at fixed stations during routine monitoring and from many other sites selected for special studies and intensive surveys. The TNRCC

will also consider data included in reports and other information that may not be appropriate for inclusion in the TRACS data base. TNRCC staff will evaluate these special study data to determine if they are complete, representative, and of adequate quality.

Finished drinking water data stored in the TNRCC's Water Permits and Resource Management database are considered in assessment of the public water supply use. *Maximum contaminant levels* (MCLs) for organic and inorganic chemicals in systems using surface water supplies are assessed.

All data used in the assessment must have been collected under quality assurance plans that ensure the data are of known and appropriate quality. Individual measurements, especially exceedances of the water quality criteria and screening levels, are reviewed by water quality analysts to determine if samples are representative and accurate.

Although data which do not meet the full requirements for quality assurance can not be used for regulatory purposes, it can be used for planning and for identifying general water quality concerns.

Period of Record

All quality-assured SWQM and finished water data collected during the most recent five-year period are considered for assessment. Most monitoring groups collect data at fixed sites at recurring quarterly or monthly frequencies. For most sites, approximately 20 samples or measurements are available for assessments. In some cases—particularly for toxicants in water, sediment, and fish tissue—samples may be collected less frequently at fixed sites.

In some instances where water quality has dramatically improved or declined recently, the more recent and representative data set may be used for the assessment. 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. Data older than five years may be used for some assessment purposes at the discretion of TNRCC water quality program staff. Such uses may include the determination of trends or the identification of concerns for sediment and tissue contamination.

One method for determining support of the fish consumption use is the issuance of consumption advisories and aquatic life closures by the TDH. The most recent advisory or closure is used to determine support of the use; however, sometimes these may have been issued years prior to the five-year assessment period.

Frequency and Duration of Sampling

The assessment must use a sample set that is spatially and temporally representative of conditions in the water body. Sample locations in streams and open water bodies, such as reservoirs and estuaries, should be characteristic of the main water mass or distinct hydrologic areas.

At a minimum, samples distributed over at least two seasons (to include interseasonal variation) and over two years (to include interyear variation) must be utilized, with some made during an index period (March 15 - October 15). The data set should not be biased toward unusual conditions, such as flow, runoff, or season. Biological sampling and 24-hour dissolved oxygen measurements, however, must be conducted during the index period to be considered in the assessment.

One way of ensuring that a data set is temporally representative is to use data routinely scheduled over several years, with approximately the same intervals of time between sampling events. This routine sampling plan can result in monthly or quarterly sample events. No more than two-thirds of the samples should be in one of the two years, and sampling events should represent the different seasons.

Sediment and fish tissue samples generally do not vary greatly over time and are considered useful integrators of water quality over time and space. Samples collected during the most recent five years as part of a one-time special monitoring event may be used in the assessment. For example, 15 fish samples collected on the same day from a water body would meet the minimum sample requirement, as would 15 sediment samples collected within a hydrologically-related area of a water body.

Minimum Number of Samples

A minimum of 10 samples is required in the following cases:

- all field measurements (dissolved oxygen, pH, and temperature);
- water quality constituents (nutrients, bacteria, chlorophyll *a*, dissolved solids, and ions); and
- toxicants in water, sediment, and fish tissue collected routinely in the water body.

At least 10 samples over the five-year period of record are required at each site for use assessment. The same 10-sample minimum also applies to ambient water and sediment toxicity tests.

Exceptions to the 10-sample minimum per site can be made for:

- streams or reaches of streams that are 25 miles or less in length, where water quality conditions are similar;
- reservoirs or estuarine waters, or portions of reservoirs or estuarine waters (5,120 acres or eight square miles or less, respectively), where water quality conditions are similar; and
- sample sets of three measurements, where all three measurements exceed the criterion or screening level. In this instance, the water body will be identified as a primary concern.

For these water bodies or portions of water bodies, field measurements, constituents in water, sediment, and fish tissue collected at multiple sites may be aggregated to meet the 10-sample minimum requirement. Field measurements and constituents in water must be collected on different days to be included in the count used to determine the minimum number of samples.

Water quality data are not assessed for impairments of aquatic life, recreational, public water supply, fish consumption, and general uses when 3 or fewer samples are available at each site. When only 4 to 9 samples are available at each site, and one exceedance is found, primary water quality concerns are identified (see "Aquatic Life Use" in the "Methodology for Assessing Use Support and Primary Concerns" section for additional explanation).

In finished drinking water, an average calculated from at least 4 samples is required for comparison to the primary and secondary drinking water standards. These minimum sample numbers were chosen to allow confidence in the assessment, while making the best use of limited monitoring resources.

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

One of the primary objectives of water quality assessment is to draw conclusions about a water body based on a group of measurements for a particular variable of interest. The entire collection of measurements used as the basis of a conclusion is referred to as the *population*. In general, it is impossible to obtain all of the measurements for a population, so it becomes necessary to attempt to describe the population as reliably as possible by collecting a set of samples from that population. There is always potential for error in this process. For 305(b) water quality assessment, there are essentially two categories of such errors:

Type I Error: Inappropriately classifying a water body as partially or not supporting, when that water body is actually fully supporting.

Type II Error: Inappropriately classifying a water body as fully supporting, when that water body is actually partially or not supporting.

Historically, attainment of specific and general uses has been determined using a simple calculation of the percentage of samples that exceed the criteria for each water body. These criteria include dissolved oxygen, acute toxicity, bacteria, water temperature, and pH. The TNRCC based its impairment decision on the magnitude of this percentage. For example, the water body was found to be fully supporting the applicable use if the calculated exceedance rate was 10 percent or less; partially supporting if greater than 10 percent and less than or equal to 25 percent; and not supporting if greater than 25 percent. This method does not address the previously described probability for committing decision errors when analyzing the behavior of random variables like those associated with water quality.

The *binomial method* is a useful tool for estimating the probability of committing Type I and/or Type II 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.

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 is greater than 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 is equal to or less than 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 percent (0.1), and *q* is greater than or equal to 89.9 percent (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. If one sample is used to determine whether a water body is supporting or not, the probability of committing a Type I error would be simple to determine in this case—that is, 10 percent. However, the assessment of water quality data involves the collection of multiple samples and, in order to estimate the probability of committing Type I and/or Type II errors, cumulative probabilities must be determined.

The binomial method can be used to calculate the probability of collecting more than 10 percent exceedances from a water body that actually contains less than 10 percent (0.10) exceedances—that is, erroneously classifying a water body as partially supporting for each combination of number of samples (n) and number of exceedances (e). For example, the binomial method can be used to determine the cumulative probability of collecting two or more exceedances out of 9 samples when the actual exceedance

rate in a water body is 10 percent. This cumulative probability represents the Type I 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 Type I and/or Type II errors.

Based on this process of analyzing error rates using the binomial method, the TNRCC has recognized that the chance of falsely classifying a site as impaired (Type I Error) is relatively high for the historically utilized method. For example, basing decisions on the simple percentage exceedance calculation of 10 percent results in a 26.4 percent to 61.2 percent chance of falsely classifying a water body as impaired (Table 1).

Table 1. Summary of Type I and Type II Error Rates Associated with Using Simple Percentage Approach

Summary of Type I and Type II Error rates associated with using simple percentage approach to determine partial support for sample sizes from 4 to 20.

Sample Size (n)	Number of Exceedances Required (e) to Classify Water Body as Partially Supporting	Exact Binomial Type I Error Rate, Assuming 10% Actual Exceedance Rate	Exact Binomial Type II Error Rate Assuming 11% Actual Exceedance Rate
20	3	32.3	40.5
19	2	58.0	39.2
18	2	55.0	39.0
17	2	51.8	37.8
16	2	48.5	38.8
15	2	45.1	38.8
14	2	41.5	38.4
13	2	37.9	38.3
12	2	34.1	38.0
11	2	30.3	37.8
10	2	26.4	37.6
9	1	61.2	35.0
8	1	56.9	34.4
7	1	52.2	33.9
6	1	46.8	34.0
5	1	40.9	32.8
4	1	34.4	31.6

For partial support and nonsupport—defined as exceedance rates of more than 10 and 25 percent, respectively—the number of exceedances required for any given number of samples from 10 to 20 is presented in Tables 2 and 3. The number of exceedances was selected to maintain a Type I error probability below 20 percent for all standards and criteria, except acute criteria to support aquatic life, where the probability is below 50 percent. This is reflected by the error rate range for Type I error probabilities of 6.8 to 18.4 in Table 2, and 7.8 to 18.9 in Table 3.

To determine if there are primary concerns (for parameters with numeric water quality standards), the number of exceedances required for any given number of samples from 4 to 20 are shown in Table 4. These criteria were selected to maintain a Type 1 error probability below 50 percent.

For secondary concerns (for parameters where water quality standards are not adopted), the number of exceedances required for any given number of samples from 4 to 20 are shown in Table 5. These criteria were selected to maintain a Type 1 error probability below 50 percent.

Table 2. Sample Sizes and Number of Exceedances Required to Determine Partial Support of a Use

(Error rates for sample sizes greater than 20 are provided in Appendix A.)

Minimum number of exceedances chosen to maintain a less than 20% probability of falsely classifying water body as partially supporting when actually fully supporting.					
Sample Size (n)	Minimum Number of Exceedances Required (e)	Exact Binomial Type I Error Rate Assuming 10% Actual Exceedance Rate	Exact Binomial Type II Error Rate Assuming 11% Actual Exceedance Rate	Exact Binomial Type II Error Rate Assuming 25% Actual Exceedance Rate	Exact Binomial Type II Error Rate Assuming 50% Actual Exceedance Rate
20	4	13.3	41.1	22.5	0.1
19	4	11.5	41.2	26.3	0.2
18	4	9.8	40.9	30.6	0.4
17	4	8.3	40.8	35.3	0.6
16	4	6.8	40.5	40.5	1.1
15	3	18.4	39.8	23.6	0.4
14	3	15.8	39.7	28.1	0.6
13	3	13.4	39.3	33.3	1.1
12	3	11.1	39.1	39.1	1.9
11	3	8.9	38.6	45.5	3.3
10	3	7.0	38.3	52.6	5.5

Table 3. Sample Size and Number of Exceedances Required to Determine Nonsupport of a Use

(Error rates for sample sizes greater than 20 are provided in Appendix B.)

Minimum number of exceedances chosen to give a less than 20% probability of falsely classifying water body as not supporting when actually fully supporting.			
Sample Size (n)	Minimum Number of Exceedances Required (e)	Exact Binomial Type I Error Rate Assuming 25% Actual Exceedance Rate	Exact Binomial Type II Error Rate Assuming 26% Actual Exceedance Rate
20	8	10.2	41.6
19	7	17.5	41.6
18	7	13.9	41.1
17	7	10.7	40.8
16	6	18.9	40.7
15	6	14.8	40.3
14	6	11.2	40.1
13	6	8	39.5
12	5	15.8	39.1
11	5	11.5	38.7
10	5	7.8	37.7

Flow Conditions

Streams are routinely monitored under highly variable flow conditions—from extreme low flows that typically occur in late summer months following extended dry periods, to high flows that follow seasonal storm events. Water quality criteria and screening levels generally apply to flowing streams as long as flow exceeds the seven-day, two-year low flow (7Q2). *Low-flow criteria* (7Q2) are calculated from historical USGS stream flow records and are available for most classified streams in Appendix B of the TSWQS. In places where low-flow criteria are not available, they may be approximated from a downstream gaged site, or from one located in a nearby watershed of similar size.

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 matrix that follows (page 13) was developed for this guidance to explain which dissolved oxygen, toxic substances in water, and bacteria criteria apply under different flow conditions.

Table 4. Sample Size and Number of Exceedances Required to Determine Primary Concerns and Partial Support of Aquatic Life Use Acute Criteria

(Error rates for sample sizes greater than 20 are provided in Appendix C.)

Minimum number of exceedances chosen to give a less than 50% probability of falsely classifying water body as a primary concern when there is no concern, or as partially supporting the acute criteria when they are actually supporting.			
Sample Size (n)	Minimum Number of Exceedances Required (e)	Exact Binomial Type I Error Rate Assuming 10% Actual Exceedance Rate	Exact Binomial Type II Error Rate Assuming 11% Actual Exceedance Rate
20	3	32.3	40.5
19	3	29.4	40.3
18	3	26.6	40.1
17	3	23.8	40.3
16	2	48.5	38.8
15	2	45.1	38.8
14	2	41.5	38.5
13	2	37.9	38.3
12	2	34.1	38.0
11	2	30.3	37.8
10	2	26.4	37.6
9	2	22.5	37.8
8	1	56.9	34.4
7	1	52.2	33.9
6	1	46.8	33.4
5	1	40.9	32.8
4	1	34.4	31.6

Values Below Limits of Detection

Many individual values in SWQM and finished drinking water databases are reported as less than a minimum analytical limit (*nondetects*). There is no generalized way to determine the true value for an individual nondetect in the range between zero and the reported minimum analytical limit. For assessments, 50 percent of an analytical reporting limit is computed for these nondetects. This is done to include as many individual data points in the analysis as possible and to indicate the level of monitoring effort. In many areas of the state, much of the nutrient and toxicant data for individual parameters are reported as nondetects. These occurrences are particularly noteworthy, because they may indicate concentrations that are below

Table 5. Sample Size and Number of Exceedances Required to Determine Secondary Concerns (or Primary Concerns for Bacterial Indicators) and Nonsupport of Aquatic Life Use Acute Criteria

(Error rates for sample sizes greater than 20 are provided in Appendix D.)

Minimum number of exceedances chosen to give a less than 50% probability of falsely classifying water body as a secondary concern when actually there is no concern, as a primary concern for bacterial indicators, or as not supporting the acute criteria when they are actually supported.			
Sample Size (n)	Minimum Number of Exceedances Required (e)	Exact Binomial Type I Error Assuming 25% Actual Exceedance Rate	Exact Binomial Type II Error Assuming 26% Actual Exceedance Rate
20	6	38.3	41.6
19	6	33.2	41.4
18	5	48.1	41.1
17	5	42.6	41.0
16	5	37	40.8
15	5	31.3	40.5
14	4	47.9	39.9
13	4	41.6	39.6
12	4	35.1	39.4
11	4	28.7	38.7
10	3	47.4	38.3
9	3	39.9	37.8
8	3	32.1	37.0
7	3	24.3	36.0
6	2	46.6	35.2
5	2	36.7	33.7
4	2	26.2	31.2

those for concern. Values computed from 50 percent of minimum analytical limits that exceed criteria or screening levels are not counted as exceedances. However, the 50 percent value of the reporting limit for these nondetects is used in developing screening levels and in calculating summary statistics (minimum, maximum, and average). TNRCC staff are investigating the application of statistical methods for treating non-detects as part of an overall initiative to redevelop the water monitoring database and to store more complete metadata.

Determination of Appropriate Criteria For Unclassified Waters

(1) Is the water body listed in the Texas Surface Water Quality Standards (TSWQS) "Appendix D. Site-Specific Receiving Water Assessments"? Yes, go to step 2. No, go to step 3.

(2) Does the reach from which the samples were collected fall within the description given in Appendix D? Yes, apply appropriate criteria according to use specified in Appendix D. No, go to step 3.

(3) Does the TNRCC Standards Team have information which allows the aquatic life use (ALU) to be assigned? Yes, go to step 4. No, go to step 5.

(4) Apply appropriate criteria according to the flow status specified by TNRCC Standards Team. Document the criteria and decision-making process.

(5) Attempt to determine the flow status of the water body as intermittent, intermittent with perennial pools, or perennial, according to definitions given in TSWQS 307.3(a)(29/30):

An *intermittent stream* is one which has a period of zero flow for at least one week during most years. Where flow records are available, a stream with a 7Q2 flow of less than 0.1 cfs is considered intermittent.

A stream that has a period of zero flow for at least one week during most years is considered *intermittent with perennial pools* when adequate pools persist that would be expected to provide habitat for significant aquatic life use. As a rule of thumb, an adequate pool is deeper than one meter and greater than 100 meters in length, *or* where large pools cover greater than 20 percent of the streambed in a 500 meter reach.

A *perennial stream* is one which does not have a period of zero flow for at least one week during most years.

Can a determination be made whether the water body is intermittent, intermittent with perennial pools, or perennial, according to definition given in TSWQS 307.3(a)(29/30)? Yes, go to step 6. No, then water body is **not assessed** for ALU attainment using dissolved oxygen data. Use acute criteria only to assess toxics in water data relative to aquatic life use. A significant effort will be made during the assessment to determine the flow status of streams with available data. Monitoring may be needed in the years following in order to enable a flow status determination.

(6) Provide supportive information for how determination was made:

an affidavit (completed by a local resident)
flow monitoring data
biological data
other

Is water body freshwater or influenced by tidal activity? (See "Determination of Tidal Influence" section in the General Assessment Methodology.)

Determine stream order according to TSWQS 307.3(a)(56) which specifies that the smallest unbranched tributary of a drainage basin is designated a *first order stream*. Where two first order streams join, a *second order stream* is formed; and where two second order streams join, a *third order stream* is formed, etc. Stream order is determined from USGS topographic maps with a scale of 1:24,000.

If water body is intermittent:

use acute criteria only to assess toxics in water data relative to aquatic life use.

assess dissolved oxygen data relative to aquatic life use according to TSWQS 307.4(h)(4), which specifies that intermittent streams that are not specifically listed in Appendix A or D will maintain a 24-hour dissolved oxygen average concentration of 2.0 mg/L and an absolute minimum concentration of 1.5 mg/L. For intermittent streams with seasonal aquatic life uses, dissolved oxygen concentrations commensurate with the aquatic life uses will be maintained during the seasons in which the aquatic life uses occur.

Are biological data available which allow determination of appropriate seasonal aquatic life uses? Yes/No

If yes, assess using criteria appropriate to that use during the season that the use exists.

If no, assess using a 24-hour dissolved oxygen average concentration of 2.0 mg/L and an absolute minimum concentration of 1.5 mg/L until such time as biological data become available to assess seasonal uses.

If water body is intermittent with perennial pools adequate to support significant aquatic life:

assess toxics in water data relative to aquatic life use using acute and chronic criteria.

assess dissolved oxygen data relative to aquatic life use according to TSWQS 307.4(h)(4), which specifies that unclassified intermittent streams with significant aquatic life uses created by perennial pools are presumed to have a limited aquatic life use and corresponding dissolved oxygen criteria, a 24-hour average concentration of 3.0 mg/L, and an absolute minimum concentration of 2.0 mg/L.

If water body is intermittent with perennial pools that are sustained by wastewater treatment plant flows, and pools are inadequate to support significant aquatic life:

assess toxics in water data relative to aquatic life use using acute and chronic criteria.

assess dissolved oxygen data relative to aquatic life use according to TSWQS 307.4(h)(4), which specifies that unclassified intermittent streams with significant aquatic life uses created by perennial pools are presumed to have a limited aquatic life use and corresponding dissolved oxygen criteria, a 24-hour average concentration of 3.0 mg/L, and an absolute minimum concentration of 2.0 mg/L.

If water body is intermittent with perennial pools that are not sustained by wastewater treatment flows, and pools are inadequate to support significant aquatic life:

assess toxics in water data relative to aquatic life using acute criteria.

assess dissolved oxygen data relative to aquatic life use according to TSWQS 307.4(h)(4) which specifies that intermittent streams which are not specifically listed in Appendix A or D will maintain a 24-hour dissolved oxygen average concentration of 2.0 mg/L and an absolute minimum concentration of 1.5 mg/L. For intermittent streams with seasonal aquatic life uses, dissolved oxygen concentrations commensurate with the aquatic life uses will be maintained during the seasons in which the aquatic life uses occur.

If water body is freshwater and perennial; and

(a) flow data are available and flow is $\geq$7Q2:

use acute and chronic criteria to assess toxics in water relative to aquatic life use.

assess dissolved oxygen data relative to aquatic life use according to TSWQS 307.4(h)(1) which specifies that perennial streams, rivers, lakes, bays, estuaries and other appropriate perennial waters that are not specifically listed in Appendix A or D are presumed to have a high aquatic life use and corresponding dissolved oxygen criteria; a 24-hour average concentration of 5.0 mg/L; and an absolute minimum concentration of 3.0 mg/L, 5.5, and 4.5 mg/L, respectively, in spring. For streams located in north and east Texas [as defined in TSWQS 307.7(b)(3)(a)(ii)] assess dissolved oxygen data relative to aquatic life use according to Table 5 in the TSWQS .

(b) flow data are available and flow is below 7Q2:

use acute criteria only to assess toxics in water data relative to aquatic life use.

do not assess dissolved oxygen data.

(c) flow data are not available:

assess dissolved oxygen data.

If water body is tidal and perennial:

use marine acute and chronic criteria to assess toxics in water relative to aquatic life use.

use a 24-hour average concentration of 4.0 mg/L and an absolute minimum concentration of 3.0 mg/L to assess dissolved oxygen data relative to aquatic life use.

If water body is freshwater, perennial, and third order or greater:

use the column B value for human health protection to assess human health criteria relative to the fish consumption use.

If water body is freshwater, perennial, and less than third order or intermittent with perennial pools:

use 10 times the column B value for human health protection to assess human health criteria relative to the fish consumption use (see exception for spring-fed streams with a sustainable fishery).

(7) Evaluation of contact recreation use for all unclassified water bodies:

Perennial streams:

Are flow data available? Yes/No

If yes, evaluate the contact recreation use by using only bacterial indicator data associated with sample events when flow is equal to or greater than 0.10 cfs, or the 7Q2, if known.

If no, contact recreation is assessed.

Intermittent streams and intermittent streams with perennial pools:

bacterial indicator criteria apply at all times.

An exception to the previous guidance on nondetects is made when evaluating chronic toxicants (aquatic life use), human health criteria for water (fish consumption use), and primary organic substances (public water supply use). The criteria for these constituents are expressed as average values. In these cases, the smaller of the following measurements is used in calculating the average: 50 percent of the reporting limit for nondetects or 50 percent of the chronic criterion/human health criterion.

Biological monitoring, toxicity in ambient water and sediment, and tissue monitoring are ways of identifying water quality impairments and concerns for many contaminants, such as organic substances and some metals, that are too low in concentration to be measured in ambient water. Potential contamination of the aquatic environment by these substances is controlled through strict wastewater effluent limits.

Spatial Coverage

Water quality data are reviewed station by station within classified and unclassified waters to determine geographical extent of designated use support and water quality concerns. The geographic extent is estimated, based on review of existing data, spatial distribution of monitoring sites having the required minimum number of samples, known sources of pollution, influence of tributaries, land use, hydrological modifications, and best professional judgment of TNRCC and CRP assessment personnel. Streams are measured in miles, reservoirs are measured in acres, and estuaries and the Gulf of Mexico are measured in square miles. For large water bodies that have only one monitoring site, the data from that one station are not used to generate an assessment for the entire reach or area. A single monitoring site is considered to be representative of no more than 25 miles in freshwater and tidal streams and ocean shoreline. A single monitoring site in reservoirs and estuaries is considered representative of 25 percent of the total reservoir acres and estuary square miles, but not more than 5,120 acres or 8 square miles. Major hydrological features, such as the confluence of a major tributary or an instream dam, may also limit the spatial extent of an assessment based on one station. Where possible, the SWQM Station ID number will be reported for the assessment. The remaining area not covered by a single site will be reported as not assessed.

Depth of Water Quality Measurements

Surface measurements—typically collected at a depth of one foot from the water surface—are generally used for assessing the following: water temperature, chloride, sulfate, total dissolved solids, 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 and pH measurements made in profile over the entire *mixed surface layer* are evaluated. For toxic substances in water, individual *surface grab samples* or *surface-to-bottom composite samples* are evaluated. Automatic 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.

Determination of the Mixed Surface Layer

Monitoring personnel often make vertical field measurement profiles in deep freshwater streams that are mixed from the surface to the bottom. In these cases, all of the dissolved oxygen measurements made in the profile during each individual sampling event are averaged, and the average is then compared to the criterion. Individual pH measurements made in the profile are compared to the minimum/maximum criteria. Only one exceedance is counted in cases where more than one pH measurement in the profile does not meet the minimum/maximum criteria.

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. Dissolved oxygen and pH criteria apply to the entire mixed water column, or only to measurements made in the mixed surface layer if the water column is stratified.

For reservoirs, the mixed surface layer is defined as the portion of the water column from the surface to the depth at which water temperature decreases by greater than 0.5°C. Dissolved oxygen and pH criteria apply to the entire mixed water column, or only to measurements made in the mixed surface layer if the water column is stratified. In rare instances, rapid declines with depth in dissolved oxygen or pH may occur within the mixed surface layer defined by water temperature. Best professional judgment may be used to determine which dissolved oxygen and/ or pH measurements are included in the mixed surface layer. The information considered for this decision will be recorded and provided with the assessment.

Determination 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' mouths over several complete tidal cycles. In the absence of monitored 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.
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. Marine criteria developed in the TSWQS apply to all tidally influenced streams (classified and unclassified), estuaries, and the Gulf of Mexico.

Methodology for Assessing Use Support and Primary Concerns

A designated beneficial use is identified as partially supported or not supported based on the number of criteria exceedances for indicators that are protective of the use. Criteria for these indicators must be adopted in the TSWQS. At least 10 samples must be available at each site for assessment. Water bodies with designated or presumed uses that are partially supported or not supported are placed on the 303(d) list. The framework for evaluating designated use support is shown in Table 6.

Primary concerns are identified for indicators, such as dissolved oxygen, that are directly tied to support of designated uses and criteria adopted in the TSWQS. *Tier 1 primary concerns* are identified for indicators where less than 10 samples are available for assessment and some exceedances are reported. *Tier 2 primary concerns* are identified for indicators that support the designated use as determined by an adequate number of samples (10-sample minimum), but a few reported exceedances (for example, three exceedances in 20 samples) indicate a potential water quality problem.

Secondary concerns are identified for indicators, such as nutrients, that are not tied to support of a designated use with a quantitative criterion. The narrative criteria may not be supported in some cases; see the section "Narrative Concerns and Nonsupport of Narrative Criteria." Screening levels for these indicators have generally not been adopted as standards (with the exception of secondary drinking water standards). Water bodies with concerns are identified in the 305(b) report, but are not placed on the 303(d) list. The TNRCC and the CRP will target enhanced monitoring to water bodies identified with primary concerns to provide data for full use assessment. The framework for evaluation of concerns is shown in Table 6.

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 biological screening levels for habitat, macrobenthos, and fish, provided that the minimum number of samples is 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 (see Table 13).

Table 6. Framework for Evaluating Use Support and Primary Concerns

Use/Impact	Assessment Method	Minimum Number of Samples	Designated Uses			Primary Concern
			Fully Supporting	Partially Supporting	Not Supporting	
Overall Use Support	Evaluation of Designated and General Uses		All uses are fully supported.	One or more uses are partially supported and remaining uses are fully supported.	One or more uses are not supported.	Not applicable.
Aquatic Life Support	Intensively Collected 24-hour Dissolved Oxygen Measurements, Compared to the 24-hour Average and Minimum Criteria in the TSWQS	10 sets	10% or less of the time, the 24-hour average or minimum concentrations are less than the criteria (see Table 2 for number of exceedances required for a given sample size).	Greater than 10% to 25% of the time, the 24-hour average or minimum concentrations are less than the criteria (see Table 2 for number of exceedances required for a given sample size).	Greater than 25% of the time, the 24-hour average or minimum concentrations are less than the criteria (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 10% of the time, the 24-hour average or minimum concentrations are less than the criteria (see Table 4 for number of exceedances required for a given sample size).
		4-9 sets	Aquatic life use not assessed for small sample sizes.	Aquatic life use not assessed for small sample sizes.	Aquatic life use not assessed for small sample sizes.	Tier 1: Greater than 10% of the time, the 24-hour average or minimum concentrations are less than the criteria (see Table 4 for number of exceedances required for a given sample size).
	Routinely Collected Instantaneous Dissolved Oxygen Measurements (Grabs) Compared to Absolute Minima in the TSWQS	10	10% or less of the time, concentrations are less than minimum criterion (see Table 2 for number of exceedances required for a given sample size).	Greater than 10% to 25% of the time, concentrations are less than minimum criterion (see Table 2 for number of exceedances required for a given sample size).	Greater than 25% of the time, concentrations are less than minimum criterion (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 10% of the time, concentrations are less than minimum criterion (see Table 4 for number of exceedances required for a given sample size).

Table 6. Framework for Evaluating Use Support, continued

Use/Impact	Assessment Method	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Aquatic Life Support (continued)	Routinely Collected Instantaneous Dissolved Oxygen Measurements (Grabs) Compared to Absolute Minima in the TSWQS (continued)	4-9	Aquatic life use support is not assessed for small sample sizes.	Aquatic life use support is not assessed for small sample sizes.	Aquatic life use support is not assessed for small sample sizes.	Tier 1: Greater than 10% of the time, concentrations are less than minimum criterion (see Table 4 for number of exceedances required for a given sample size).
	Routinely Collected Instantaneous Dissolved Oxygen Measurements (grabs) Compared to the 24-Hour Criteria in the TSWQS	10	Aquatic life use is not assessed by comparing grab samples to the 24-hour criteria.	Aquatic life use is not assessed by comparing grab samples to the 24-hour criteria.	Aquatic life use is not assessed by comparing grab samples to the 24-hour criteria.	Tier 2: Greater than 10% of the time, concentrations are less than the 24-hour criterion in the TSWQS (see Table 4 for number of exceedances).
	Acute and Chronic Exposure to Metals and Organic Substances in Water	10	10% or less of the time, for any individual parameter, concentrations are less than the acute criterion (see Table 4 for number of exceedances required for a given sample size) and/or the average is less than or equal to the chronic criterion.	Greater than 10% to 25% of the time, for any individual parameter, concentrations exceed the acute criterion (see Table 4 for number of exceedances required for a given sample size)	Greater than 25% of the time, for any individual parameter, concentrations exceed the acute criterion (see Table 5 for number of exceedances required for a given sample size) and/or the average is greater than the chronic criterion.	Tier 2 concerns are not assessed for acute criteria.
		4-9	Aquatic life use not assessed for small sample sizes.	Aquatic life use not assessed for small sample sizes.	Aquatic life use not assessed for small sample sizes.	Tier 1: Greater than 10% of the time for any individual parameter, concentrations exceed the acute criterion (see Table 4 for number of exceedances required for a given sample size) and/or the average exceeds the chronic criterion.

Table 6. Framework for Evaluating Use Support, continued

Use/Impact	Assessment Method	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Aquatic Life Support (continued)	Acute or Chronic Ambient Water and Sediment Tests	10	10% or less of the time, conditions indicate acute or chronic toxicity (see Table 2 for number of exceedances required for a given sample size).	Greater than 10% to 25% of the time, conditions indicate acute or chronic toxicity (see Table 2 for number of exceedances required for a given sample size).	Greater than 25% of the time, conditions indicate acute or chronic toxicity (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 10% of the time, conditions indicate acute or chronic toxicity (see Table 4 for number of exceedances required for a given sample size).
		4-9	Aquatic life use not assessed for small sample sizes.	Aquatic life use not assessed for small sample sizes.	Aquatic life use not assessed for small sample sizes.	Tier 1: Greater than 10% of the time, conditions indicate acute or chronic toxicity (see Table 4 for number of exceedances required for a given sample size).
	Habitat Assessment	2	See Table 13.	See Table 13.	See Table 13.	Not applicable.
		1	Aquatic life use not assessed for one sample.	Aquatic life use not assessed for one sample.	Aquatic life use not assessed for one sample.	One sample indicates ALU support less than designated.
	Biological Assessment	2	See Table 13.	See Table 13.	See Table 13.	Not applicable.
		1	Aquatic life use not assessed for one sample.	Aquatic life use not assessed for one sample.	Aquatic life use not assessed for one sample.	One sample indicates ALU support less than designated.
Contact Recreation	<u>Bacteria Type</u> <u>Geo Avg</u> <u>Single</u> fecal coliform 200 400 E. coli 126 394 Enterococci 35 89	10	The long-term geometric average is less than the criterion and 25% of the time or less, concentrations are greater than the single sample criterion (see Table 3 for number of exceedances required for a given sample size).	Partial support is not assessed.	The long-term geometric average exceeds the criterion and/or greater than 25% of the time, concentrations are greater than the single sample criterion (see Table 3) for number of exceedances required for a given sample size).	Tier 2: Greater than 25% of the time, concentrations exceed the single sample criterion (see Table 5 for number of exceedances required for a given sample size).

Table 6. Framework for Evaluating Use Support, continued

Use/Impact	Assessment Method	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Contact Recreation (continued)	Bacteria Type / Geo Avg / Single fecal coliform 200 400 E. coli 126 394 Enterococci 35 89	4-9	Contact recreation use not assessed for small sample sizes.	Contact recreation use not assessed for small sample sizes.	Contact recreation use not assessed for small sample sizes.	Tier 1: The long-term geometric average exceeds the criterion and/or greater than 25% of the time, concentrations exceed the single sample criterion (see Table 5 for number of exceedances required for a given sample size).
Noncontact Recreation	Bacteria Type / Geo Avg / Single fecal coliform 200 400 E. coli 126 394 Enterococci 35 89	10	The long-term geometric average is less than the criterion and 25% of the time or less, concentrations are greater than the single sample criterion (see Table 3 for number of exceedances required for a given sample size).	Partial support is not assessed.	The long-term geometric average exceeds the criterion and/or greater than 25% of the time, concentrations are greater than the single sample criterion (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 25% of the time, concentrations exceed the single sample criterion (see Table 5 for number of exceedances required for a given sample size).
		4-9	Noncontact recreation use not assessed for small sample sizes.	Noncontact recreation use not assessed for small sample sizes.	Noncontact recreation use not assessed for small sample sizes.	Tier 1: The long-term geometric average exceeds the criterion and/or greater than 25% of the time, concentrations exceed the single sample criterion (see Table 5 for number of exceedances required for a given sample size).

Table 6. Framework for Evaluating Use Support, continued

Use/Impact	Assessment Method	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Noncontact Recreation (continued)	For Segment 2308 only Bacteria Type / Geo Avg / Single fecal coliform 2,000 4,000 E. coli 605 —	10	The long-term geometric average is less than the criterion and 25% of the time or less, concentrations are greater than the single sample criterion (see Table 3 for number of exceedances required for a given sample size).	Partial support is not assessed.	The long-term geometric average exceeds the criterion and/or greater than 25% of the time, concentrations are greater than the single sample criterion (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 25% of the time, concentrations exceed the single sample criterion (see Table 5 for number of exceedances required for a given sample size).
		4-9	Noncontact recreation use not assessed for small sample sizes.	Noncontact recreation use not assessed for small sample sizes.	Noncontact recreation use not assessed for small sample sizes.	Tier 1: The long-term geometric average exceeds the criterion and/or greater than 25% of the time, concentrations exceed the single sample criterion (see Table 5 for number of exceedances required for a given sample size).
Public Water Supply	**Finished Drinking Water**: Organic and Inorganic MCLs	4	Running annual average is less than the MCL.	Partial support is not assessed.	Running annual average exceeds the MCL.	Not applicable.
		4	Full use support is not assessed for this indicator based on individual concentrations.	Partial support is not assessed for this indicator based on individual concentrations.	Nonsupport is not assessed for this indicator based on individual concentrations.	Greater than 10% of the time, concentrations exceed one-half the MCL (**threatened**) (see Table 4 for number of exceedances required for a given sample size).
	Surface Water: Organic and Inorganic MCLs	10	Long-term or running annual average of at least four quarterly samples is less than or equal to the MCL.	Partial support is not assessed.	Long-term or running annual average of at least four quarterly samples exceeds the MCL.	Not applicable.

Table 6. Framework for Evaluating Use Support, continued

Use/Impact	Assessment Method	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Public Water Supply (continued)	**Surface Water**: Organic and Inorganic MCLs	4-9	The public water supply use is not assessed for small sample sizes (unless a running annual average can be determined).	Partial support is not assessed.	The public water supply use is not assessed for small sample sizes (unless a running annual average can be determined).	Average exceeds the MCL.
Fish Consumption	Consumption Advisories/ Aquatic Life Closures	-----	No fish/shellfish consumption advisories or aquatic life closures in effect.	Restricted-consumption advisory (limits on number or size of meals) in effect for the general population or a subpopulation that could be at greater risk (e.g., pregnant women, children).	Aquatic life closure (no taking of aquatic life) in effect or fish/shellfish "no-consumption" advisory in effect for one or more species for the general population or subpopulation that could be at greater risk.	Not applicable.
	Human Health Criteria in Water for Water and Fish, Freshwater Fish Only, and Tidal-Water Fish Only (Toxic Substances)	10	Average is less than or equal to human health criteria.	Partial support is not assessed.	Average exceeds human health criteria.	Not applicable.
		4-9	The fish consumption use is not assessed for small sample sizes.	Partial support is not assessed.	The fish consumption use is not assessed for small sample sizes.	Average exceeds human health criteria.

Table 6. Framework for Evaluating Use Support, continued

Use/Impact	Assessment Method	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Oyster Waters	Most recent TDH Shellfish Maps, Sanitary Surveys, and Water Quality Data	-----	Water quality data indicate good conditions and low densities of fecal coliform bacteria. Area approved for growing and harvesting shellfish.	Partial support is not assessed.	Area is restricted for the growing and harvesting of shellfish or prohibited due to water quality concerns based on recent TDH water quality survey indicating high densities of fecal coliform bacteria.	Area conditionally approved for the growing and harvesting of shellfish based on predictable high densities of fecal coliform bacteria or Area restricted due to high risk of microbial contamination when recent TDH water quality surveys indicate acceptable fecal coliform densities or prohibited area where there is no current water quality survey.
All Uses	Statistical Trend	20-60 over 5-20 years	Full use support is not assessed for this indicator.	Partial use support is not assessed for this indicator.	Nonsupport is not assessed for this indicator.	Long-term statistical trend indicates declining water quality conditions (threatened).

Dissolved Oxygen Criteria

Each classified water body in the TSWQS is assigned one of the following aquatic life uses, based on physical, chemical, and biological characteristics: *exceptional*, *high*, *intermediate, limited,* or *no significant aquatic life use*. Dissolved oxygen criteria (24-hour averages) to protect these aquatic life uses for freshwater are 6.0, 5.0, 4.0, 3.0, and 2.0 mg/L, respectively. A minimal use and dissolved oxygen screening level of 2 mg/L is used in this guidance where the TSWQS designate no significant aquatic life use. The dissolved oxygen criteria are 1 mg/L lower for exceptional, high, and intermediate aquatic life uses in tidally-influenced water bodies, due to differences between oxygen solubility in fresh and salt water.

In addition, *absolute minimum criteria* to protect the range of aquatic life uses are designated. In freshwater, these minimum criteria are 4.0, 3.0, 3.0, 2.0, and 1.5 mg/L, respectively. Absolute minima in tidal waters are nearly the same, except the criterion for the intermediate use is 2.0 mg/L, and there is no limited use or criterion.

Unclassified perennial water bodies are presumed to have a high aquatic life use and corresponding dissolved oxygen criteria. 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). Intermittent streams without perennial pools are presumed to have minimal aquatic life uses (protected by a 2.0 mg/L criterion) when water is flowing and exceeds the 7Q2. Presumed aquatic life uses for unclassified streams may be changed by the results of receiving water assessments.

A decision matrix that describes the appropriate dissolved oxygen criteria for different flow conditions is shown on page 13. An exception to this general rule is where site-specific aquatic life use and associated dissolved oxygen criteria have been assigned to a perennial unclassified water body through a receiving water assessment (see Appendix D of the TSWQS). Another exception is for perennial streams located in the eastern and southern areas of the state [described in the TSWQS, 307.7(b) (3)(a)(iii)] where a strong dependent relationship exists among summertime dissolved oxygen concentration, stream flow, and channel bed slope. Streams with significant aquatic life uses in these areas of the state may be evaluated for 24-hour dissolved oxygen concentrations when flow is greater than the 7Q2, as shown in Table 1 of the *Procedures to Implement the Texas Surface Water Quality Standards* (Implementation Procedures, RG-194), adopted by the TNRCC on November 15, 2000. The headwater flows, shown in Table 2 of the Implementation Procedures, may be used to evaluate summertime dissolved oxygen criteria (see Table 1 of the Implementation Procedures) for presumed, designated, or assigned aquatic life uses.

Most of the dissolved oxygen data collected at fixed monitoring stations are instantaneous (grab sample) measurements collected during daylight hours (0900 to 1400 hours). Tier 2 aquatic life primary concerns are identified by comparing instantaneous dissolved oxygen measurements to 24-hour criteria (see Table 8). Water bodies identified with Tier 2 aquatic life primary concerns are candidates for 24-hour sampling. The water body will be placed on the 303(d) list if impairment of the aquatic life use is indicated by sufficient 24-hour dissolved oxygen data.

Beginning in September 1997, the TNRCC and the CRP began intensive 24-hour monitoring of dissolved oxygen and other field measurements at many sites. This type of monitoring is targeted to water bodies where low instantaneous dissolved oxygen levels indicate partial or nonsupport of designated aquatic life uses. Intensive 24-hour monitoring is conducted with automated equipment that is preset to record and store field measurements at 30-minute intervals (or in some cases more frequently) over one 24-hour period. Four or more dissolved oxygen measurements may also be made manually at even intervals over one 24-hour period at a site, as long as one is made near sunrise (0500-0900 hours) to approximate the daily minimum. Dissolved oxygen values recorded over the 24-hour period are summed and divided by the number of measurements to determine the *average concentration*, which is compared to the 24-hour criterion. The lowest dissolved oxygen value from each 24-hour set is compared to the minimum criterion.

All intensive 24-hour dissolved oxygen monitoring events must be spaced over an index period representing warm-weather seasons of the year (March 15-October 15), with between one-half to two-thirds of the measurements occurring during the critical period (July 1-September 30). The *critical period* of the year is when minimum stream flows, maximum water temperatures, and minimum dissolved oxygen concentrations typically occur in Texas streams. A period of about one month must separate each 24-hour sampling event. When samples are available from outside the index period, these samples can be used to indicate nonsupport of the criterion at the discretion of TNRCC staff.

For purposes of determining compliance with 24-hour average criteria, samples collected near the surface will be considered representative of the mixed surface layer. In deep streams, reservoirs, and tidally-influenced water bodies, automatic equipment may be positioned at one-half the depth of the mixed surface layer for compliance purposes. At least ten 24-hour monitoring events (using 24-hour criteria and/or absolute minimum criteria) at each site within a five-year period are required to provide adequate data for assessment of the aquatic life use (Table 6). A Tier 1 primary concern is identified if only 4 to 9 samples are available. A Tier 2 primary concern is identified when there are 10 or more samples and the evidence is compelling (2 or more samples exceed rating criteria).

Toxic Substances in Water Criteria

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 TNRCC has developed water quality criteria in the TSWQS for 12 metals and 26 organic substances (see Tables 7 and 8). *Acute criteria* apply to all waters of the state except in small zones of initial dilution near wastewater discharge points. *Chronic criteria* apply wherever there are aquatic life uses outside of mixing zones in intermittent streams that maintain large perennial pools, and in flowing streams when the stream flow is greater than the 7Q2. Refer to the decision matrix on page 13 for a more detailed explanation of which toxic substances in water criteria apply at different flow conditions.

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. Ten or more samples are required to evaluate support of the aquatic life use (Table 6). A Tier 1 aquatic life primary concern is identified if only 4 to 9 samples are available. Tier 2 concerns are not identified for acute criteria.

For several toxic substance parameters where toxicity is defined as a function of pH or hardness, acute criteria are expressed as an equation based on this relationship. Appropriate pH and hardness values of long-term SWQM fixed station network data by segment are used to compute criteria (see Table 5 in the Implementation Procedures). Where segment-specific criteria are not available, those developed for the entire basin may be used (see Table 2 in the TSWQS). In other instances where 30 or more ambient samples are available at a site, pH and hardness values are ranked from the lowest to the highest, and the low 15th percentiles are used to compute criteria for a specific site or the entire water body. If hardness values are available for the day at the site that the toxicant was collected, criteria calculated for that day can be applied to the sample.

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. Silver data collected from a variety of water bodies throughout the United States indicate that a correlation exists between the dissolved chloride concentration and the percent free ionic silver.

Table 7. Criteria for Specific Metals in Water for Protection of Aquatic Life

(All values listed or calculated 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)	$0.973we^{(1.128(\ln(\text{hardness}))-1.6774)}$	$0.909we^{(0.7852(\ln(\text{hardness}))-3.490)}$	45.4w	10w
01030	Chromium (Tri)(d)	$0.316we^{(0.8190(\ln(\text{hardness}))+3.688)}$	$0.860we^{(0.8190(\ln(\text{hardness}))+1.561)}$	—	—
01040	Copper (d)	$0.960we^{(0.9422(\ln(\text{hardness}))-1.3844)}$	$0.960we^{(0.8545(\ln(\text{hardness}))-1.386)}$	13.5w	3.6w
00722	Cyanide (free)	45.8	10.7	5.6	5.6
01049	Lead (d)	$0.889we^{(1.273(\ln(\text{hardness}))-1.460)}$	$0.792we^{(1.273(\ln(\text{hardness}))-4.705)}$	133w	5.3w
71900	Mercury (t)	2.4	1.3	2.1	1.1
01065	Nickel (d)	$0.998we^{(0.8460(\ln(\text{hardness}))+3.3612)}$	$0.997we^{(0.8460(\ln(\text{hardness}))+1.1645)}$	118w	13.1w
01147	Selenium (t)	20	5	564	136
01075	Silver (d)(f)	0.8w	—	2w	—
01090	Zinc (d)	$0.978we^{(0.8473(\ln(\text{hardness}))+0.8604)}$	$0.986we^{(0.8473(\ln(\text{hardness}))+0.7614)}$	92.7w	84.2w

(d) - dissolved fraction
(t) - total metal
(f) - criteria corrected 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 sufficient data is available to establish a site-specific, water-effects ratio. 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 8. Criteria in Water for Specific Organic Substances for Protection of Aquatic Life

(All values listed or calculated 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	2.0	—	613.0	—
39370	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	—	—
	Endosulfan I (alpha)	0.22	0.056	0.034	0.009
	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	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

Table 8. Criteria in Water for Specific Organic Substances for Protection of Aquatic Life, continued

Parameter Code	Parameter	Freshwater Acute	Freshwater Chronic	Marine Acute	Marine Chronic
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
	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

The TNRCC 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:

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

where

Y = percent of dissolved silver in the free ionic form
Cl = dissolved chloride

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 TNRCC's SWQM database. The 50th percentile value of the dissolved chloride concentration for each segment is used (refer to the "Percentiles and Ranges"section of the TNRCC Supplementary Information Manual). When the range of chloride values exceeds 140 mg/L (the upper extent of the TNRCC data range), the percentage of silver in the free ionic form will be 8.98 percent. Site specific criteria may be derived, providing 30 or more ambient samples are available. Chloride values are ranked from the lowest to the highest, and the 50^{th} percentile is used to compute criteria for free ionic silver. The degree of aquatic life use support for toxicants in water is based on ranges for the percent of exceedances (see Table 6).

Support of the aquatic life use is also based on *toxic substance chronic criteria*. Selection of either freshwater or marine criteria for a given station is guided by the influence of tidal activity. Chronic criteria that are pH- or hardness-dependent are computed in the manner described above for acute criteria. For each parameter at each site, the average of all values (10-sample minimum) collected during a five-year period is compared against the chronic criterion to determine aquatic life use support. If the average exceeds the criterion, the use is not supported (see Table 6). A Tier 1 primary aquatic life concern is identified if the average from 4 to 9 samples exceeds the criterion.

Ambient Water and Sediment Toxicity Tests

Aquatic life use support is also evaluated based on ambient water and sediment toxicity testing. The TNRCC, in cooperation with EPA Region 6 and the CRP, routinely collect water and sediment samples for ambient toxicity testing to assess potential toxicity in water bodies, and to evaluate the effectiveness of implemented toxicity control measures. Water bodies that have shown recurrent ambient water or sediment toxicity are candidates for more intensive special studies to confirm the occurrence of toxic conditions or nonsupport of aquatic life uses, and to determine the causes

and sources of the toxicity. Laboratories conduct standard 24- to 48-hour acute and 7-day chronic toxicity tests on ambient water and sediment elutriates using *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) in freshwater. For estuarine or saline waters (ambient water salinity >2 ppt) and sediment, a standard 7-day chronic toxicity test is conducted using *Americamysis bahia* (mysids) and *Menidia beryllina* (inland silverside). The chronic embryo-larval test using *Cyprinodon variegatus* (sheepshead minnow) is conducted over 9 days.

Support of the aquatic life use using ambient toxicity data when 10 or more samples are available is based on the occurrence of toxicity in water and/or sediment for given sample sizes (see Table 6). A Tier 1 aquatic life primary concern is identified when only 4 to 9 samples are available. A Tier 2 primary concern is identified when there are 10 or more samples and the evidence is compelling (toxicity occurs in at least 2 samples).

Biological and Habitat 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, 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. A use attainability analysis should be undertaken in water bodies where the designated aquatic life use has been based on information other than biological and habitat sampling, and the use is not supported based on a preliminary biological and habitat assessment.

Fish Community Assessment

Fish community data are collected according to field methods specified in the TNRCC *Receiving Water Assessment Procedures Manual* (GI-253). These data are used to evaluate the integrity of the fish community based on the *index of biotic integrity* (IBI) (Table 9). The IBI cannot be used to assess fish community samples collected from reservoirs or tidal streams. Draft regionalized IBI metrics have been proposed by the Texas Parks and Wildlife Department *(Regionalization of the Index of Biotic Integrity for Texas Streams*, draft TPWD publication). Ultimately, these regionalized IBIs are the preferred assessment tool. However, until the draft regionalized IBIs are finalized in 2001, data will be evaluated using statewide criteria, and the draft regionalized IBIs will be used as a supplemental assessment tool. For example, the regionalized IBI may be used to catego-

Table 9. Index of Biotic Integrity Scoring and Evaluation Statewide Criteria

Category	Metric	Scoring 5	3	1
Species richness and composition	1. Total number of fish species	*	*	*
	2. Number of darter species	≥ 3	1-2	0
	3. Number of sunfish species (excluding bass)	≥ 2	1	0
	4. Number of sucker species	≥ 2	1	0
	5. Number of intolerant species	≥ 3	1-2	0
	6. Percentage of individuals as tolerants	< 5%	5-20%	> 20%
Trophic composition	7. Percentage of individuals as omnivores	< 20%	20-45%	> 45%
	8. Percentage of individuals as insectivores	> 80%	> 40-80%	≤ 40%
	9. Percentage of individuals as piscivores	> 5%	1-5%	< 1%
Fish abundance and condition	10. Number of individuals in sample	> 200	> 50-200	≤ 50-0
	11. Percentage of individuals as hybrids	0%	> 0-1%	> 1%
	12. Percentage of individuals with disease or other anomaly	≤ 2%	> 2-5%	> 5%

*First-second order streams: ≥ 7(5), 4-6(3), ≤ 3(1)
Third-fourth order streams: ≥ 10(5), 5-9(3), ≤ 4(1)
Fifth-sixth order streams: ≥ 16(5), 8-15(3), ≤ 7(1)
Seventh-eighth order streams: ≥ 22(5), 11-21(3), ≤ 10(1)

Total Score for Aquatic Life Use Subcategories

58 - 60	**Exceptional**
48 - 52	**High**
40 - 44	**Intermediate**
< 34	**Limited**

rize samples for which the IBI score obtained using the statewide metric set falls in between categories.

Benthic Macroinvertebrate Community Assessment
Benthic macroinvertebrate data are collected according to field protocols specified in the TNRCC *Receiving Water Assessment Procedures Manual* (GI-253). 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 (Table 10). 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 (Table 11).

Aquatic Life Use Support Determination Using Bioassessment Data
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 13, and should be based on both fish and benthic macroinvertebrate samples. In certain instances, it may only be possible to collect either fish or benthic macroinvertebrates. Proper justification should be submitted, detailing why only one type of community was sampled. After it has been determined that it is appropriate to use only fish or only benthic macroinvertebrates, rows in Table 13 that are marked with an asterisk may be used to interpret results. Determination of attainment for bioassessment data (column 1, Table 13) is based on the average of the total scores. Scores are derived for each of two or more bioassessment events as described in Table 9 for fish, and in Table 10 or 11 for benthic macroinvertebrates.

If only two bioassessment events are considered, then both should be conducted in the same year during the index period March 15 to October 15, with only one of the two events occurring between July 1 and September 30. If more than two bioassessment events are considered, then the period of study should be two or more years, with two events per year (minimum of four sets for two years); all events should occur between March 15 and October 15; and at between one-half to two-thirds of the events should occur between July 1 and September 30. Sample events should be separated by at least one month, and conducted during periods of moderate to low flow (but above the 7Q2). The average score should be compared to the aquatic life use point score ranges given in Table 9 for fish, and in Tables 10 or 11 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 the

samples will be evaluated for validity. An aquatic life primary concern is identified when only one sample is available for assessment and partial or nonsupport of the use is indicated.

Determination of Criteria Support for Protection of Aquatic Habitat
An evaluation of habitat quality is critical to any assessment of ecological integrity. A habitat quality evaluation is accomplished by measurement of physical habitat parameters over a defined stream reach according to established TNRCC protocols (*Receiving Water Assessment Procedures Manual*, GI-253). These habitat measurements should be conducted at the same time as biological field work. Physical habitat measurements are made at evenly- spaced transects over the defined stream reach. Measurements are made instream, along the stream channel and banks, and on 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* (Table 12). The total score obtained from the stream reach is compared to categorical ranges that relate to exceptional, high intermediate, limited, and minimal aquatic life uses. Support for water bodies identified in Appendixes A and D of the TSWQS will be assessed according to the decision matrix shown in Table 13.

Contact Recreation Use

Contact recreation is a use that is assigned to all water bodies, except for special cases (see "Noncontact Recreation Use," following). 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 Enterococci in tidal water. The preferred indicators are *E. coli* (for freshwater) and Enterococci (for tidal waters), and they should be used when fecal coliform data are also available. Most of the bacteriological data are routinely monitored at fixed stations at quarterly or monthly frequencies.

Support of the contact recreation use is based on a 10-sample minimum (see Table 6). For routinely monitored bacteria data, the following long-term 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 contact recreation use is not supported if the geometric average of the samples collected exceeds the mean criterion or if the criteria for individual samples are exceeded greater than 25 percent of the time (see Table 3 for number of exceedances required for a given sample size). A Tier 1 primary concern is identified when only 4 to 9 samples are available. A Tier 2 primary concern is identified when there are 10 or more samples and evidence is compelling.

Table 10. Metrics and Scoring Criteria for Surber Samples - Benthic Macroinvertebrates

(Davis, 1997)

	METRIC	SCORING CRITERIA		
		5	3	1
CENTRAL BIOREGION **(Ecoregions: 23,24,27,29,30 31, and 32)**	1. Total Taxa	> 32	32 - 18	< 18
	2. Diptera Taxa	> 7	7 - 4	< 4
	3. Ephemeroptera Taxa	> 4	4 - 2	< 2
	4. Intolerant Taxa	> 8	8 - 4	< 4
	5. % EPT Taxa	> 30	30.0 - 17.4	< 17.4
	6. % Chironomidae	---a	< 22.3	≥ 22.3
	7. % Tolerant Taxa	---a	< 10.0	≥ 10.0
	8. % Grazers	> 14.9	14.9 - 8.7	< 8.7
	9. % Gatherers	> 15.2	15.2 - 8.8	< 8.8
	10. % Filterers	---a	> 11.9	≤ 11.9
	11. % Dominance (3 Taxa)	< 54.6	54.6 - 67.8	> 67.8
EAST BIOREGION **(Ecoregions: 33,34, and 35)**	1. Total Taxa	> 30	30 - 17	< 17
	2. Diptera Taxa	> 10	10 - 6	< 6
	3. Ephemeroptera Taxa	---b	> 3	≤ 3
	4. Intolerant Taxa	> 4	4 - 2	< 2
	5. % EPT Taxa	> 18.9	18.9 - 10.8	< 10.8
	6. % Chironomidae	---a	< 40.2	≥ 40.2
	7. % Tolerant Taxa	< 16.0	16.0 -24.3	> 24.3
	8. % Grazers	> 9.0	9.0 - 5.2	< 5.2
	9. % Gatherers	> 12.5	12.5 - 7.3	< 7.3
	10. % Filterers	---a	> 16.3	≤ 16.3
	11. % Dominance (3 Taxa)	< 57.7	57.7 - 71.6	> 71.6
NORTH BIOREGION **(Ecoregions 25 and 26)**	1. Total Taxa	> 33	33 - 19	< 19
	2. Diptera Taxa	> 14	14 - 8	< 8
	3. Ephemeroptera Taxa	---b	> 2	≤ 2
	4. Intolerant Taxa	> 3	3 - 2	< 2
	5. % EPT Taxa	> 14.4	14.4 - 8.2	< 8.2
	6. % Chironomidae	< 36.9	36.9 - 56.2	> 56.2
	7. % Tolerant Taxa	< 14.1	14.1 - 21.5	> 21.5
	8. % Grazers	---b	> 5.4	≤ 5.4
	9. % Gatherers	---a	> 14.9	≤ 14.9
	10. % Filterers	> 12.2	12.2 - 7.1	< 7.1
	11. % Dominance (3 Taxa)	< 68.1	68.1 - 84.5	> 84.5

a - discriminatory power was less-than-optimal for this bioregion, so metric was assigned only two scoring categories

b - median value for this bioregion was less than the metric selection criterion (< 5.5 for taxa richness metrics; < 12 for percentage metrics expected to decrease with disturbance), so metric was assigned only two categories

Aquatic Life Use Point Score Ranges: Exceptional >40; High 31-40; Intermediate 21-30; Limited <21

Table 11. Metrics and Scoring Criteria for Kick Samples, Rapid Bioassessment Protocol - Benthic Macroinvertebrates

(Harrison, 1996)

	Scoring Criteria			
Metric	**4**	**3**	**2**	**1**
Taxa Richness	> 21	15-21	8-14	< 8
EPT Taxa Abundance	> 9	7-9	4-6	< 4
Biotic Index (HBI)	< 3.77	3.77-4.52	4.53-5.27	>5.27
% Chironomidae	0.79-4.10	4.11-9.48	9.49-16.19	< 0.79 or >16.19
% Dominant taxon	< 22.15	22.15-31.01	31.02-39.88	> 39.88
% Dominant FFG	< 36.50	36.50-45.30	45.31-54.12	> 54.12
% Predators	4.73-15.20	15.21-25.67	25.68-36.14	< 4.73 or >36.14
Ratio of Intolerant:Tolerant Taxa	> 4.79	3.21-4.79	1.63-3.20	< 1.63
% of Total Trichoptera as Hydropsychidae	< 25.50	25.51-50.50	50.51-75.50	> 75.50 or no trichoptera
# of Noninsect Taxa	> 5	4-5	2-3	< 2
% Collector-Gatherers	8.00-19.23	19.24-30.46	30.47-41.68	< 8.00 or >41.68
% of total number as Elmidae	0.88-10.04	10.05-20.08	20.09-30.12	< 0.88 or >30.12

Aquatic Life Use Point Score Ranges:

Exceptional: > 36
High: 29 - 36
Intermediate: 22 - 28
Limited: < 22

Table 12. Habitat Quality Index Scoring and Evaluation Criteria

Category	Metric	Scoring			
Primary Attributes	1. Available Instream Cover	4	3	2	1
	2. Bottom Substrate Stability	4	3	2	1
Secondary Attributes	3. Number of Riffles	4	3	2	1
	4. Dimensions of Largest Pool	4	3	2	1
	5. Channel Flow Status	3	2	1	0
	6. Bank Stability	3	2	1	0
	7. Channel Sinuosity	3	2	1	0
Tertiary Attributes	8. Riparian Buffer Vegetation	3	2	1	0
	9. Aesthetics of Reach	3	2	1	0

Total Score for Aquatic Life Subcategories

26 - 31	Exceptional
20 - 25	High
14 - 19	Intermediate
13 - 8	Limited
≤ 7	Minimal

Table 13. Decision Matrix for Integrated Assessments of Aquatic Life Use (ALU) Support Based on Bioassessment, Dissolved Oxygen, Toxics in Water, and Toxicity in Water Testing Data

Aquatic Life Use Support Attainment							
Bioassessment Data	**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**	**Toxics in Water, Toxicity Testing Data Not Available**	**Habitat Assessment Meets Screening Criteria**	**Habitat Assessment Does Not Meet Screening Criteria**
Benthic macroinvertebrate and fish bioassessments done and both attain designated ALU	Fully Supported*	Fully Supported	Fully Supported**	Partially Supported	Fully Supported	Fully Supported	Fully Supported
Benthic macroinvertebrate and fish bioassessments done and one of the two does not attain designated ALU	Partially Supported	Partially Supported	Partially Supported	Partially Supported	Partially Supported	Partially Supported	Partially 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	Not Supported
Only fish bioassessment done and indicates nonattainment of designated ALU*	Not Supported	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	Not Supported
Only fish bioassessment done and indicates attainment of designated ALU*	Fully Supported	Fully Supported	Fully Supported**	Partially Supported	Fully Supported	Fully Supported	Fully Supported
Only benthic macroinvertebrate bioassessment done and indicates attainment of designated ALU*	Fully Supported	Fully Supported	Fully Supported**	Partially Supported	Fully Supported	Fully Supported	Fully Supported
Bioassessment data not available	Fully Supported	Fully Supported	Not Supported	Not Supported	Not Assessed	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.

*** Site-specific dissolved oxygen criteria may be applicable (see Appendix D of the TSWQS).

Noncontact Recreation Use

A *noncontact recreation* use is assigned to water bodies where ship and barge traffic makes contact recreation unsafe (Segments 1005, 1701, 2437, 2438, 2484, and 2494), and to Rita Blanca Lake (0105), which is a waterfowl refuge. The noncontact recreation use for these water bodies is protected by the same criteria assigned to contact recreation waters—fecal coliform, *E. coli,* and Enterococci (see Table 6).

A Tier 1 noncontact recreation primary concern is identified when 4 to 9 samples are available. A Tier 2 primary concern is identified when there are 10 or more samples, and evidence is compelling.

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 noncontact recreation use in this segment. A fecal coliform criterion of 4,000 colonies/100mL applies to individual samples.

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

Public Water Supply Use

Finished Drinking Water

In the TSWQS, 219 segments are designated for the public water supply use. That use for these water bodies is protected by both the TSWQS and the TDWS. The drinking water criteria for organic chemicals are shown in Table 14 and criteria for inorganic chemicals are shown in Table 15. The criteria apply to finished (after treatment) drinking water that is sampled at the point of entry to distribution systems. Public water supply use support is based on exceedance of *maximum contaminant levels* (MCLs) for organic and inorganic drinking water standards. A running annual average of samples (minimum of 4) is computed and compared to the organic and inorganic drinking water standards.

Surface Water

The public water supply use is also assessed for surface water by evaluation of the same organic and inorganic chemical MCLs developed for finished drinking water (Tables 14 and 15). These assessments are restricted to water bodies designated in the TSWQS for public water supply use. For each parameter at each site, the average of all concentrations (10-sample minimum) collected during a five-year period and the running annual average (of at least 4 quarterly samples) are compared against the

drinking water MCL to determine public water supply use support. A primary concern is identified if the average concentration exceeds the MCL and is based on only 4 to 9 samples.

Table 14. Maximum Contaminant Levels for Organic Chemicals in Public Drinking Water Supplies

Contaminant	mg/L	Contaminant	mg/L
Alachlor	0.002	Ethylbenzene	0.7
Aldicarb	0.003	Ethylene dibromide (EDB)	0.00005
Aldicarb sulfone	0.002	Glyphosate	0.7
Alicarb sulfoxide	0.004	Heptachlor	0.0004
Atrazine	0.003	Heptachlor epoxide	0.0002
Benzene	0.005	Hexachlorobenzene	0.001
Benzo(a)pyrene	0.0002	Hexachlorocyclopentadiene	0.05
Carbofuran	0.04	Lindane	0.0002
Carbon tetrachloride	0.005	Methoxychlor	0.04
Chlordane	0.002	Monochlorobenzene	0.1
2,4-D	0.07	Oxamyl (vydate)	0.2
Dalapon	0.2	Pentachlorophenol	0.001
Dibromochloropropane (DBCP)	0.0002	Picloram	0.5
Di(2-ethylhexyl) adipate	0.4	Polychlorinated biphenyls (PCBs)	0.0005
Di(2-ethylhexyl) pthalate	0.006	Simazine	0.004
o-Dichlorobenzene	0.6	Styrene	0.1
p-Dichlorobenzene	0.075	2,3,7,8-TCDD (Dioxin)	0.00000003
1,2-Dichloroethane	0.005	Tetrachloroethylene	0.005
1,1-Dichloroethylene	0.007	Toluene	1.0
cis-1,2-Dichloroethylene	0.07	Toxaphene	0.003
trans-1,2-Dichloroethylene	0.1	2,4,5-TP (Silvex)	0.05
Dichloromethane	0.005	1,2,4-Trichlorobenzene	0.07
1,2-Dichloropropane	0.005	1,1,1-Trichloroethane	0.2
Dinoseb	0.007	1,1,2-Trichloroethane	0.005
Diquat	0.02	Trichloroethylene	0.005
Endothall	0.1	Vinyl chloride	0.002
Endrin	0.002	Xylenes (total)	10.0

Table 15. Maximum Contaminant Levels for Inorganic Chemicals in Public Drinking Water Supplies

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

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

Fish Consumption Use

Support of the fish consumption use is determined by two assessment methods. The first is by the designation of the human health criteria in the TSWQS. For each toxicant parameter at each site, the average of all values (10-sample minimum) for water samples collected during a five-year period is computed. The averages are compared to human health criteria shown in Table 16. Column A criteria are used for freshwater bodies designated for public water supply. Column B criteria are used for fresh waters that are capable of supporting sustainable fisheries and that are not designated for public water supply, and 10 times this level is used for unclassified perennial water bodies that are less than third order streams. For spring-fed streams that sustain a fishery, Column B is used. Column C criteria are used for classified and unclassified tidally-influenced water bodies. Selection of either freshwater (column B) or tidal water (column C) criteria for a given station is guided by the influence of tidal activity. A

Table 16. Human Health Criteria in Water

Parameter Code	Parameter	Column A	Column B	Column C
		Water and Fish µg/L	Freshwater Fish Only µg/L	Tidal-Water Fish Only µg/L
34215	Acrylonitrile	1.28	10.9	7.3
77825	Alachlor[6]	2	—	—
39330	Aldrin	0.00408	0.00426	0.0028
01000	Arsenic (d)	50[1]	—	—
39630	Atrazine[6]	3	1,600	1,060
01005	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)	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[7]	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

Table 16. Human Health Criteria in Water, continued

Parameter Code	Parameter	Column A	Column B	Column C
		Water and Fish µg/L	Freshwater Fish Only µg/L	Tidal-Water Fish Only µg/L
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
—	Dioxins/Furans (TCDD Equivalents)[2] Equivalency Compound 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 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	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[4]	0.0122	0.0122	0.0250
39480	Methoxychlor	2.21	2.22	1.48
82612	Metolachlor[6]	70	—	—
81595	Methyl ethyl ketone	52,917	9.94E06	6.63E06

Table 16. Human Health Criteria in Water, continued

Parameter Code	Parameter	Column A	Column B	Column C
		Water and Fish µg/L	Freshwater Fish Only µg/L	Tidal-Water Fish Only µg/L
46491	Methyl tert-butyl ether (MTBE)[6]	15.0	—	—
00620	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
61209	Perchlorate[6]	22	—	—
77045	Pyridine	88.1	13,333	8,889
01147	Selenium	50[1]	—	—
39055	Simazine[6]	4	—	—
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
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 applied.
[3] Calculations based on USEPA 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] Human health criterion not established; screening level used to assess water quality concerns.
[7] 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.

Tier 1 primary concern is identified when only four to nine samples are available. A Tier 2 primary concern is identified when there are 10 or more samples and the evidence is compelling (at least two exceedances are found).

The fish consumption use is also assessed by review of TDH-published fish tissue data, human risk assessment information, and consumption advisories and aquatic life closures. The TDH Web site (www.tdh.state.tx.us/bfds/ssd/survey.html) is a source of information concerning fish consumption advisories and aquatic life closures. The TDH should be 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 TDH are available in their latest publication, *TDH Fish Sampling Data, 1970-1997*. The TDH data are periodically updated to reflect recent sampling.

The fish consumption use is supported in water bodies where the TDH has collected tissue data and a subsequent risk assessment indicates no appreciable risk of deleterious effects due to consumption over a person's lifetime. The use is partially supported when a restricted-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). The fish consumption use is not supported when a no-consumption advisory has been issued for the general population, or for a subpopulation that could be at greater risk; or when an aquatic life closure has been issued that prohibits the taking of aquatic life from the affected water body (see Table 6).

Oyster Waters Use

The TDH has authority to administer the National Shellfish Sanitation Program for the state. This authority allows the TDH 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.

The TDH annually publishes maps that depict the classification of shellfish growing areas in Texas estuaries. These maps do not provide the current status of shellfish growing areas. Status (open or closed) of shellfish growing areas is subject to change by the TDH 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 TDH Seafood Safety Division *Classification of Shellfish Harvesting Area Maps*, dated November 1, 2001.

The mapped information is utilized to determine the degree of oyster waters use support, except for some areas classified as restricted (non-support of the oyster waters use). When the most recent TDH water quality surveys indicate acceptable fecal coliform densities, restricted areas are assessed with primary concerns if the classification is based on high risk of microbial contamination (proximity to marinas and wastewater treatment plants, stormwater runoff, drainage from areas frequented by livestock or waterfowl, etc.). Mapped information will also differ from oyster waters assessment due to the inclusion of a 1,000 foot buffer zone in the TSWQS. Application of the oyster waters use for the TNRCC's assessment is excluded within the buffer zone, which is measured from the shoreline to ordinary high tide.

Water bodies are classified as supporting or not supporting according to the classification guidance provided in Table 6. The TDH classifies shellfish growing areas into one of four categories.

Approved Area

An *approved area* is a shellfish growing area approved by the TDH 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 TDH. An approved area meets criteria except under extreme conditions.

Conditionally Approved Area

A *conditionally approved area* is determined by the TDH 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, but are identified as primary concerns.

Restricted Area

Restricted areas are shellfish growing areas classified by the TDH as threatened 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 classified as restricted for reasons other than water quality impairment are reported as not assessed.

Prohibited Area

A *prohibited area* is where there are recent TDH 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. Prohibited areas with sanitary surveys indicating impairment are assessed as not supporting the oyster waters use. Areas without recent sanitary surveys are also classified as prohibited, since no data are available for assessment. Prohibited areas where there is no sanitary survey are assessed with primary concerns. Areas that are classified as prohibited for reasons other than water quality impairment are reported as not assessed. Shellfish from a prohibited area may not be taken for cleansing by depuration or relaying.

Threatened Water Bodies

As outlined in 40 CFR section 130.2(j) and in EPA guidance, states are required to identify water quality-limited segments "where it is known that water quality does not meet applicable water quality standards, and/or is *not expected to meet* applicable water quality standards." Those water bodies *not expected to meet* applicable water quality standards are considered "threatened." As a result, water bodies that are supporting their designated uses and have no exceedances of criteria may be categorized as threatened and as a primary concern (Table 6). Threatened water bodies are identified in the 305(b) assessment but are not placed on the 303(d) list. A water body is considered threatened if:

- Information provided by TNRCC's Water Permits and Resource Management Division indicates finished drinking water concentrations are above one-half the MCL for primary drinking water standards greater than 10 percent of the time. For a water body to be classified as threatened, individual concentrations may actually exceed the MCL (that is, concentrations are not restricted to the range between 50 percent of the MCL and the MCL). A water body is considered nonsupportive of the water supply use when the annual running average (minimum of 4 samples) exceeds the MCL (see "Methodology for Assessing Use Support"). These chemicals must also represent possible source water contaminants from a surface water source.

- Other reliable, available data and information indicate an apparent declining water quality trend (that is, water quality conditions have deteriorated, compared to earlier assessments, but the waters still support uses) (Table 6). The information must demonstrate that in the next two to four years, uses or criteria will not be supported unless additional pollution controls are implemented. Threatened

water bodies, in this context, are those where specific pollutants are identified and documented as probable contributors to nonsupport of uses and/or criteria in the future.

Methodology for Assessing General Uses and Primary Concerns

Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality, rather than for protection of a specific use. Water temperature, pH, chloride, sulfate, total dissolved solids (TDS), and Enterococci are the parameters in this grouping. Enterococci criteria (other than contact recreation criteria) are assigned only to two Houston Ship Channel segments. Specific criteria for each of the other parameters are assigned to each classified segment in the TSWQS based on physical, chemical, and biological characteristics. Data from a five-year period are compared to specific segment criteria in order to determine compliance. Only surface water temperature values are evaluated. Values of pH are evaluated over the mixed surface layer. The degree of water temperature and pH criteria support is based on a 10-sample minimum and the number of exceedances for a given sample size (see Table 17). Tier 1 primary concerns are identified for sites where only 4 to 9 samples are available. Tier 2 primary concerns are identified when there are 10 or more samples and evidence is compelling (minimum of two exceedances). Water temperature, pH, chloride, sulfate, and TDS criteria developed for classified segments do not apply to unclassified water bodies.

Chloride, sulfate, and total dissolved solids criteria in the TSWQS represent annual averages of all values that were collected when streamflow equaled or exceeded the seven-day, two-year low-flow value established for each segment. Due to infrequent monitoring and absence of stream flow information at many sites, all of the chloride, sulfate, and total dissolved solids values measured during the five-year period (10-sample minimum) are averaged for all sites within the water body 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 water body. Tier 1 primary concerns are identified for water bodies where the average is based on only 4 to 9 samples, and the average exceeds the criterion. For cases where total dissolved solids 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 total dissolved solids criteria are not supported if the average value exceeds the criteria (Table 17).

An Enterococci bacterial screening level (500 colonies/100 mL) is established for two Houston Ship Channel Segments (1006 and 1007) to

Table 17. Framework for Evaluating General Use Support

Parameter	Units/Criteria	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Water temperature	°F, segment-specific	10	10% or less of the time, measurements are less than the criterion (see Table 2 for number of exceedances required for a given sample size).	Greater than 10% to 25% of the time, the criterion is exceeded (see Table 2 for number of exceedances required for a given sample size).	Greater than 25% of the time, the criterion is exceeded (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 10% of the time, the criterion is exceeded (see Table 4 for number of exceedances required for a given sample size).
		4-9	Not assessed due to small sample size.	Not assessed due to small sample size.	Not assessed due to small sample size.	Tier 1: Greater than 10% of the time, the criterion is exceeded (see Table 4 for number of exceedances required for a given sample size).
pH	Standard units, segment-specific (minimum and maximum criteria must be met)	10	10% or less of the time, measurements are outside the pH range (see Table 2 for number of exceedances required for a given sample size).	Greater than 10% to 25% of the time, values are outside the pH range (see Table 2 for number of exceedances required for a given sample size).	Greater than 25% of the time, values are outside the pH range (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 10% of the time, values are outside the pH range (see Table 4 for number of exceedances required for a given sample size).
		4-9	Not assessed due to small sample size.	Not assessed due to small sample size.	Not assessed due to small sample size.	Tier 1: Greater than 10% of the time, the criterion is exceeded (see Table 4 for number of exceedances required for a given sample size).
Chloride	mg/L, segment-specific	10	Segment average less than or equal to criterion.	Partial support is not assessed.	Segment average exceeds criterion.	—
		4-9	Not assessed due to small sample size.	Not assessed due to small sample size.	Not assessed due to small sample size.	Tier 1: Segment average exceeds criterion.

Table 17. Framework for Evaluating General Use Support, continued

Parameter	Units/Criteria	Minimum Number of Samples	Fully Supporting	Partially Supporting	Not Supporting	Primary Concern
Sulfate	mg/L, segment-specific	10	Segment average less than or equal to criterion.	Partial support is not assessed.	Segment average exceeds criterion.	—
		4-9	Not assessed due to small sample size.	Not assessed due to small sample size.	Not assessed due to small sample size.	Tier 1: Segment average exceeds criterion.
Total dissolved solids	mg/L, segment-specific	10	Segment average less than or equal to criterion.	Partial support is not assessed.	Segment average exceeds criterion.	—
		4-9	Not assessed due to small sample size.	Not assessed due to small sample size.	Not assessed due to small sample size.	Tier 1: Segment average exceeds criterion.
Enteroccoci bacteria	500 colonies/ 100 mL	10	10% or less of the time, measurements are less than the criterion (see Table 2 for number of exceedances required for a given sample size).	Greater than 10% to 25% of the time, the criterion is exceeded (see Table 2 for number of exceedances required for a given sample size).	Greater than 25% of the time, the criterion is exceeded (see Table 3 for number of exceedances required for a given sample size).	Tier 2: Greater than 10% of the time, the criterion is exceeded (see Table 4 for number of exceedances required for a given sample size).
		4-9	Not assessed due to small sample size	Not assessed due to small sample size	Not assessed due to small sample size	Tier 1: Greater than 10% of the time, the criterion is exceeded (see Table 4 for number of exceedances required for a given sample size).

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. The degree of Enterococci criteria support is based on a 10-sample minimum and the number of exceedances for a given sample size (see Table 17). Tier 1 primary concerns are identified for sites where only 4 to 9 samples are available. Tier 2 primary concerns are identified when there are 10 or more samples and evidence is compelling (minimum of two exceedances).

Methodology for Assessing Secondary Concerns

In most cases, secondary concerns identify elevated concentrations that exceed screening levels for indicators for which water quality standards have not been adopted. Water bodies identified with secondary concerns are identified in the 305(b) report, but are not placed on the 303(d) list. Water bodies with secondary concerns are scheduled for increased monitoring and additional parameter coverages.

Water quality criteria for nutrients and chlorophyll *a* in water have not been developed for Texas by the TNRCC. Sediment criteria have been developed by the EPA for only a few parameters, but the criteria have not been adopted. Criteria for some toxicants in fish tissue were developed from human health criteria in the TSWQS. In the absence of established criteria, the TNRCC, the CRP, and the National Oceanic and Atmospheric Administration (NOAA) developed screening levels for these three water quality indicator groups in order to identify areas where elevated concentrations cause secondary concerns. The screening levels do not represent adopted state criteria. Waters are classified as having no concerns or concerns based on comparisons of water quality data to screening levels (10-sample minimum) (Table 18). The number of exceedances to identify a concern is based on a sliding scale for given sample sizes.

Water quality criteria have been developed for dissolved minerals in finished drinking water. In this assessment, the secondary finished drinking water criteria for chloride, sulfate, and TDS are evaluated in both finished drinking water and surface water. Exceedance of the criteria does not generally impair the public water supply use. Sometimes, generally high levels of dissolved minerals (chloride, sulfate, and TDS) are found in drinking water. Often, the elevated dissolved mineral concentrations originate from natural sources (brine water seeps, flow over salt-bearing strata). Elevated concentrations of dissolved minerals may impart a “salty” taste to water that can be removed from the supply source by water treatment at additional cost. In these cases, the public water supply use is considered fully supported, but the elevated concentrations are identified as secondary concerns. The geographical extent of secondary concern

within each water body follows the same basis as that for determining use support. Water bodies with concerns are candidates for targeted monitoring in subsequent years and further evaluation to determine if designated uses are affected.

Nutrients and Chlorophyll a Screening Levels

The screening levels listed for nutrients and chlorophyll *a* in Table 18 were statistically derived from long-term SWQM monitoring data (September 1990 - August 2000). The 85th percentile values for each parameter in freshwater streams, tidal streams, reservoirs, and estuaries are shown in Table 18. A secondary concern is identified if the screening level is exceeded greater than 25 percent of the time, based on the number of exceedances for a given sample size (Table 18).

Sediment Quality Screening Levels

Criteria have not been adopted for the wide array of contaminants in sediment. The EPA has developed preliminary *equilibrium partitioning sediment guidelines* (ESQs) for divalent metals and numerous non-ionic organic substances. Sediment screening levels developed by the TNRCC (85^{th} percentiles) from long-term SWQM data and by NOAA are used to evaluate sediment concerns. *Probable effects levels* (PELs) developed by NOAA are used to identify compounds which are likely to be elevated to toxic concentrations. Freshwater and marine PELs are based on benthic macroinvertebrate community metrics and toxicity tests. The PEL—as the geometric average of the 50^{th} percentile of impacted, toxic samples and the 85^{th} percentile of non-impacted samples—is the level above which adverse biological effects are frequently expected. In order to compute sediment 85^{th} percentiles, the SWQM database was first screened for specific metals and organic substances with at least 10 observations statewide within four types of water bodies: freshwater streams, reservoirs, tidally influenced streams, and estuaries. This screen resulted in the selection of 11 specific metals and 133 specific organic substances (40 pesticides, 30 volatile organics, and 63 semivolatile organics). The 85th percentile values for each parameter in the four different water body types are shown in Tables 19 and 20. The sediment 85^{th} percentiles are based on long-term data and are revised annually. At least 10 sediment samples at each site are required for assessment of sediment concerns based on 85^{th} percentile and PEL screening levels. Identification of a secondary concern is determined if the 85^{th} percentiles and PELs are exceeded greater than 25 percent of the time based on the number of exceedances for a given sample size (see Table 18).

Table 18. Framework for Identifying Secondary Concerns

Category	Parameter/Screening Levels	Minimum Number of Samples	No Concern	Concern
Nutrients				
Freshwater Streams	NH_3-N - 0.17 mg/L NO_2-N + NO_3-N - 2.76 mg/L OP - 0.5 mg/L TP - 0.8 mg/L Chl *a* - 11.6 µg/L	10	For any one parameter, the screening level is exceeded 25% or less of the time (see Table 5 for number of exceedances for a given sample size).	For any one parameter, the screening level is exceeded greater than 25% of the time (see Table 5 for number of exceedances for a given sample size).
Reservoirs	NH_3-N - 0.106 mg/L NO_2-N + NO_3-N - 0.32 mg/L OP - 0.05 mg/L TP - 0.18 mg/L Chl *a* - 21.4 µg/L	10	For any one parameter, the screening level is exceeded 25% or less of the time (see Table 5 for number of exceedances for a given sample size).	For any one parameter, the screening level is exceeded greater than 25% of the time (see Table 5 for number of exceedances for a given sample size).
Tidal Streams	NH_3-N - 0.58 mg/L NO_2-N + NO_3-N - 1.83 mg/L OP - 0.55 mg/L TP - 0.71 mg/L Chl *a* - 19.2 µg/L	10	For any one parameter, the screening level is exceeded 25% or less of the time (see Table 5 for number of exceedances for a given sample size).	For any one parameter, the screening level is exceeded greater than 25% of the time (see Table 5 for number of exceedances for a given sample size).
Estuaries	NH_3-N - 0.10 mg/L NO_2-N + NO_3-N - 0.26 mg/L OP - 0.16 mg/L TP - 0.22 mg/L Chl *a* - 11.5 µg/L	10	For any one parameter, the screening level is exceeded 25% or less of the time (see Table 5 for number of exceedances for a given sample size).	For any one parameter, the screening level is exceeded greater than 25% of the time (see Table 5 for number of exceedances for a given sample size).

Table 18. Framework for Identifying Secondary Concerns, continued

Category	Parameter/Screening Levels	Minimum Number of Samples	No Concern	Concern
Toxicants in Sediment	12 Metals and 131 Organic Substances (85th Percentiles and PELs); see Tables 17 and 18	10	For any one parameter, the screening level is exceeded 25% or less of the time (see Table 5 for number of exceedances for a given sample size).	For any one parameter, the screening level is exceeded greater than 25% of the time (see Table 5 for number of exceedances for a given sample size).
Toxicants in Fish Tissue	7 Metals and 31 Organic Substances; see Tables 19 and 20	10	For any one parameter, the screening level is exceeded 25% or less of the time (see Table 5 for number of exceedances for a given sample size).	For any one parameter, the screening level is exceeded greater than 25% of the time (see Table 5 for number of exceedances for a given sample size).
Public Water Supply	Finished Water Secondary Drinking Water Standards	4	Average less than or equal to criteria.	Average exceeds criteria.
	Surface Water Secondary Drinking Water Standards	10	Average less than or equal to criteria.	Average exceeds criteria.
	Increased Costs for Demineralization of Surface Water Only	-----	Demineralization is not used in the treatment process.	Demineralization used to treat water to make it palatable.
	MTBE, 240 μg/L perchlorate, 22 μg/L	10	Average less than or equal to the criteria.	Average exceeds the criteria.
Narrative Criteria	Nutrients, sediment contaminants, fish tissue contaminants, other narrative criteria	-----	Information available indicates attainment of screening levels and narrative criteria.	Information available indicates a concern; however, it is insufficient to determine impairment of uses or criteria.

Fish Tissue Screening Levels

The screening levels for concentrations of toxicants in fish tissue were developed from human health criteria in the TSWQS, except for the metals arsenic, cadmium, chromium, copper, mercury and selenium. Screening levels for these metals are based on TDH screening levels that are slightly lower than the levels used to issue consumption advisories. The human health criteria in the standards 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 following procedures and assumptions were used to calculate allowable fish tissue concentrations.

For noncarcinogens: $RTC = \frac{RfD \times WT}{FC}$

For carcinogens: $RTC = \frac{(RL)/(q1^*) \times WT}{FC}$

Definitions:

RTC = *Reference tissue concentration* (as mg of toxicant/kg of fish tissue), which is the allowable concentration of the toxicant in edible fish tissue.

RfD = *Reference dose* (as mg of toxicant/kg human body weight/day), which is the allowable exposure of the toxicant (through ingestion of fish) on a daily basis. Reference doses were obtained from the USEPA Integrated Risk Information System (IRIS), which is an updated computer database for assessing human health effects of toxicants.

WT = *Weight* of an average human adult (70 kg).

FC = Average amount of *fish consumed* per person (as kg of fish per day). This amount was 0.010 kg/day for fresh waters, and 0.015 kg/day for marine waters.

RL = *Risk level* for carcinogens (= 1/100,000). This is the potential risk of cancer for each person exposed at the allowable dose over a 70-year period.

q1* = *Cancer potency slope factor* (as the reciprocal of mg/kg/ day). This factor is the relationship (slope) of cancer risk and dose, and it is indicative of a chemical's potential to cause cancer in humans. Values for q1* are extrapolated from data on cancer rates in laboratory ani-

mals that are exposed at very high dose rates. The q1* values were obtained from the EPA IRIS database.

Additional procedures and assumptions:

(1) The ratio of average body weights was used to convert data on laboratory test animals to human scale. When the weight of test animals was not specified, the average weights were considered to be 0.35 kg for rats, 0.03 kg for mice, and 70 kg for humans.

(2) If the concentration of a substance in fish tissue used for these calculations was greater than the applicable U.S. Food and Drug Administration action level for edible fish and shellfish tissue, then the acceptable concentration in fish tissue was lowered to the Action Level for calculation of criteria.

Using this approach, screening levels were developed for lead and 31 organic substances (see Tables 21 and 22). Screening levels developed by the TDH are used for the other six metals. Five years of data are screened using these levels. Identification of secondary concerns is determined when the screening levels are exceeded greater than 25 percent of the time based on the number of exceedances for a given sample size.

Public Water Supply Concerns

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 standards in the TDWS. Secondary MCLs that are evaluated are limited to chloride (300 mg/L), sulfate (300 mg/L), and total dissolved solids (1,000 mg/L) (see Table 18). These criteria were developed to ensure that water supply utilities can treat and deliver water that is free of objectionable tastes and odor for reasonable costs to consumers.

Public water supply concerns are also evaluated in surface water bodies that are designated for the public water supply use in the TSWQS by comparing chloride, sulfate, and total dissolved solids concentrations in surface water to the secondary drinking water criteria. Samples (minimum of 10) from all sites within a water body are averaged for the comparisons (see Table 18).

Some organic compounds (MTBE and perchlorate) have potential human health impacts even though no drinking water or surface water criteria have been developed. When data are available for surface waters designated or currently used for public water supply and no TSWQS has been established, secondary concerns will be identified if the average concentra-

tions exceed human health screening guidelines (established by the TNRCC) for drinking water. Human health screening levels are 240 μg/L for MTBE and 22 μg/L for perchlorate (Table 18).

Implementation of advanced treatment may be required for water supplies with elevated chloride, sulfate, and total dissolved solids concentrations. Public water supply systems that experience increased costs for demineralization treatment are identified as concerns for dissolved solids in the surface water body (see Table 18).

Narrative Concerns and Nonsupport of Narrative Criteria

In addition to numeric screening levels, water quality concerns and nonsupport are also identified by *narrative criteria*. Narrative criteria include:

- Concentrations of taste- and odor-producing substances.
- Floating debris and suspended solids.
- Settleable solids (erosion from land surface, banks, and bottom scour).
- Aesthetically attractive conditions.
- Waste discharges that cause substantial and persistent changes from ambient conditions or turbidity or color.
- Foaming of a persistent nature.
- Oil, grease, or related residue that produce a visible film of oil or globules of grease on the water surface.
- Toxic surface waters that are harmful to humans through ingestion of water, consumption of aquatic organisms, or contact with the skin, or to terrestrial or aquatic life.
- Nutrients from permitted discharges or other controllable sources that cause excessive growth of aquatic vegetation that impairs an existing, attainable, or designated use.

The analysis and identification of narrative concerns is inherently less objective and consistent than that for numeric screening levels. Therefore, narrative standards are assessed using narrative criteria for which related numeric data exist (for example, excessive aquatic plant growths associated with instream nutrient concentrations). All water bodies are automatically evaluated to determine if they also fail to support narrative criteria if they exhibit concerns identified by numeric screening criteria for nutrients, contaminated sediment, contaminated fish tissue, and public water supply concerns.

Table 19. Screening Levels for Metals in Sediment

(All values in mg/kg dry weight)

Parameter Code	Parameter	Probable Effect Level (PEL)		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
01003	Arsenic	17.0	41.6	7.00	8.99	32.7	9.61
01008	Barium	--	--	204.0	244.0	347.0	483.0
01028	Cadmium	3.53	4.21	0.55	0.75	0.73	0.663
01029	Chromium	90.0	160.4	21.7	49.0	51.3	36.9
01043	Copper	197.0	108.2	14.5	37.2	26.8	19.9
01052	Lead	91.3	112.18	20	72.3	34.8	21.9
71921	Mercury	0.486	0.696	0.125	0.31	0.169	0.23
01068	Nickel	35.9	42.8	15.5	23.8	33.5	21.4
01148	Selenium	--	--	1.21	1.24	2.46	1.7
01078	Silver	--	1.77	0.52	1.17	0.87	0.6
01093	Zinc	315.0	271.0	64.1	200.0	143.0	107.0

Table 20. Screening Levels for Organic Substances in Sediment

(All values in µg/kg dry weight)

Parameter Code	Parameter	Probable Effect Level (PEL)		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
Pesticides							
39731	2,4-D			38.5	75.0	330.0	220.0
39741	2,4,5-T			8.95	13.0	34.5	190.0
39761	2,4,5-TP (silvex)			7.0	10.5	65.0	190.0
39333	Aldrin			5.74	21.0	34.05	13.0
39076	*alpha*-Hexachlorocyclohexane			6..01	16.4	32.95	12.0
34257	*beta*-Hexachlorocyclohexane			6.1	30.0	34.05	15.0
34262	*delta*-Hexachlorocyclohexane			6.1	30.0	34.05	15.0
39783	*gamma*-Hexachlorocyclohexane (lindane)	1.38	0.99	5.74	16.4	23.45	10.0
39351	Chlordane, total	8.9	4.79	30.0	190.0	172.5	60.0
81404	Chloropyrifos (dursban)			43.9	78.0	172.5	50.0
39363	DDD, total			11.2	65.0	35.9	25.0
39368	DDE, total			13.35	30.0	35.9	24.0
39373	DDT, total	4450.0	51.7	11.45	37.0	34.75	25.0
82400	Demeton			100.0	100.0	203.0	100.0
39571	Diazinon			45.75	77.65	160.5	50.0
79799	Dicofol (kelthane)			25.0	31.0	20.0	1050.0
39383	Dieldrin	6.67	4.3	6.01	15.0	26.68	13.1
73030	Diuron			----	----	----	----

Table 20. Screening Levels for Organic Substances in Sediment, continued

Parameter Code	Parameter	PEL		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
34364	Endosulfan I (alpha)			1.3	----	----	----
34359	Endosulfan II (beta)			1.3	----	----	----
34354	Endosulfan sulfate			7.55	48.5	34.05	23.5
39393	Endrin	62.4	--	9.85	28.65	34.05	24.0
39581	Guthion			62.5	87.15	172.5	75.0
39413	Heptachlor			5.72	17.5	26.68	13.0
39423	Heptachlor epoxide	2.74	–	7.05	50.0	27.8	14.95
39701	Hexachlorobenzene			473.55	752.7	840.0	415.0
39531	Malathion			44.95	77.65	166.5	50.0
39481	Methoxychlor			12.75	75.0	59.0	30.3
79800	Mirex			2.5	25.0	7.6	25.0
39541	Parathion			43.9	72.0	158.8	50.0
39514	PCB-1016			32.0	350.0	220.0	115.0
39491	PCB-1221			32.0	350.0	340.65	115.0
39495	PCB-1232			32.0	350.0	220.0	115.0
39499	PCB-1242			30.0	350.0	247.4	115.0
39503	PCB-1248			30.0	1000.0	220.0	120.0
39507	PCB-1254			33.2	1000.0	220.0	115.0
39511	PCB-1260			33.2	1000.0	220.0	120.0
39519	PCB, total	277.0	188.79	72.5	190.0	234.5	130.0
39118	Pentachlorobenzene			452.95	1200.0	1.25	170.0
39403	Toxaphene			105.5	550.0	695.0	620.0

Table 20. Screening Levels for Organic Substances in Sediment, continued

Parameter Code	Parameter	PEL		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
Volatile Organic Substances							
34218	Acrylonitrile			1100.0	1500.0	2650.0	1700.0
34237	Benzene			250.0	300.0	500.0	335.0
34290	Bromoform			250.0	300.0	550.0	335.0
88802	Bromomethane			480.0	750.0	1100.0	850.0
34299	Carbon tetrachloride			250.0	300.0	450.0	335.0
34304	Chlorobenzene			250.0	312.5	500.0	335.0
34309	Chlorodibromomethane			250.0	300.0	450.0	335.0
34314	Chloroethane			550.0	750.0	1300.0	850.0
34579	2-Chloroethyl vinyl ether			1900.0	3000.0	5300.0	3800.0
34318	Chloroform			300.0	300.0	450.0	335.0
88835	Chloromethane			480.0	750.0	1100.0	850.0
34330	Dichlorobromomethane			250.0	300.0	500.0	325.0
88805	1,2-Dibromomethane			220.0	350.0	665.0	390.0
34499	1,1-Dichloroethane			250.0	300.0	450.0	335.0
34534	1,2-Dichloroethane			250.0	300.0	450.0	335.0
34504	1,1-Dichloroethylene			235.0	312.5	450.0	335.0
34549	1,2-trans-Dichloroethylene			250.0	312.5	500.0	380.0
34544	1,2-Dichloropropane			250.0	300.0	450.0	335.0
34702	cis-1,3-Dichloropropylene			250.0	300.0	500.0	335.0
34697	trans-1,3-Dichloropropylene			250.0	312.5	500.0	335.0
34374	Ethylbenzene			250.0	340.0	550.0	335.0

Table 20. Screening Levels for Organic Substances in Sediment, continued

Parameter Code	Parameter	PEL		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
34426	Methylene chloride			350.0	315.0	500.0	390.0
34478	Tetrachloroethylene			250.0	390.0	550.0	335.0
34519	1,1,2,2-tetrachloroethane			250.0	300.0	550.0	335.0
34483	Toluene			300.0	312.5	500.0	335.0
34509	1,1,1-trichloroethane			250.0	300.0	450.0	335.0
34514	1,1,2-trichloroethane			250.0	300.0	450.0	335.0
34487	Trichloroethylene			245.0	315.0	500.0	335.0
45510	Xylenes, total			650.0	937.5	1600.0	1000.0
34495	Vinyl chloride			550.0	750.0	1100.0	850.0
Semivolatile Organic Substances							
34208	Acenaphthene	–	88.9	750.0	1709.0	2400.0	1050.0
34203	Acenaphthylene	–	127.87	750.0	1709.0	2400.0	1050.0
34223	Anthracene	–	245.0	767.0	1800.0	2400.0	1050.0
39121	Benzidine			1050.0	4600.0	2725.65	1430.0
34529	Benzo(a)anthracene	385.0	692.53	750.0	1800.0	2400.0	1100.0
34250	Benzo(a)pyrene	782.0	763.22	750.0	1800.0	2400.0	1200.0
34233	Benzo(b)fluoranthene			750.0	1800.0	2400.0	1200.0
34524	Benzo(ghi)perylene			750.0	1800.0	2400.0	1100.0
34245	Benzo(k)fluoranthene			750.0	1800.0	2400.0	1200.0
34639	4-Bromophenyl phenyl ether			750.0	1800.0	2400.0	1050.0
88811	Cresols, total			1648.2	2215.0	3274.9	1500.0
34281	Bis(2-chloroethoxy)methane			750.0	1709.0	2400.0	1050.0

Table 20. Screening Levels for Organic Substances in Sediment, continued

Parameter Code	Parameter	PEL		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
34276	Bis(2-chloroethyl)ether			750.0	1709.0	2400.0	1050.0
34286	Bis(2-chloroisopropyl)ether			750.0	1709.0	2400.0	1050.0
34584	2-Chloronaphthalene			950.0	1970.45	2790.5	950.0
34589	2-Chlorophenol			1007.8	1950.0	2400.0	1500.0
34644	4-Chlorophenyl phenyl ether			750.0	1800.0	2400.0	1050.0
34323	Chrysene	862.0	845.98	750.0	1800.0	2400.0	1200.0
34559	Dibenz(a,h)anthracene	–	134.61	750.0	1800.0	2400.0	1050.0
34295	n-Butyl benzyl phthalate			776.45	1800.0	2400.0	1050.0
39112	Di-n-butyl phthalate			900.0	2800.0	2400.0	1100.0
34599	Di-n-octyl phthalate			776.45	1800.0	2400.0	1050.0
34539	1,2-Dichlorobenzene			670.0	1399.0	2400.0	1050.0
34569	1,3-Dichlorobenzene			662.35	1530.0	2400.0	1050.0
34574	1,4-Dichlorobenzene			700.0	1389.5	2400.0	1021.45
34634	3,3'-Dichlorobenzidine			1100.0	2900.0	3900.65	1423.5
34604	2,4-Dichlorophenol			1200.0	1950.0	3125.0	1732.15
34339	Diethyl phthalate			750.0	1800.0	2400.0	1050.0
34609	2,4-Dimethylphenol			1100.0	1950.0	3125.0	1732.15
34344	Dimethyl phthalate			776.45	1709.0	3150.0	1100.0
34660	4,6-Dinitro-o-cresol			1890.0	4100.0	3850.0	3000.0
34619	2,4-Dinitrophenol			2150.0	6650.0	5451.0	3450.0
34614	2,4-Dinitrotoluene			800.0	1800.0	3150.0	1100.0
34629	2,6-Dinitrotoluene			750.0	1709.0	2400.0	1050.0

Table 20. Screening Levels for Organic Substances in Sediment, continued

Parameter Code	Parameter	PEL		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
34349	1,2-Diphenylhydrazine			750.0	1709.0	1950.0	1050.0
39102	Bis(2-Ethylhexyl)phthalate			900.0	2300.0	2400.0	1200.0
34379	Fluoranthene	2355.0	1493.54	767.00	2176.9	2400.0	1200.0
34384	Fluorene	–	144.35	750.0	1800.0	2400.0	1050.0
39705	Hexachlorobutadiene			767.00	1800.0	3150.0	1257.4
34389	Hexachlorocyclopentadiene			1300.0	1920.0	3150.0	1563.9
34399	Hexachloroethane			767.0	1709.0	2400.0	1050.0
73120	Hexachlorophene			490.0	4055.0	3150.0	885.0
34406	Indeno(1,2,3-cd)pyrene			750.0	1800.0	2400.0	1100.0
34411	Isophorone			750.0	1709.0	2400.0	1050.0
34455	3-Methyl-4-chlorophenol			1400.0	2850.0	7500.0	1750.0
34445	Naphthalene	–	390.64	670.0	1399.5	2400.0	1050.0
34450	Nitrobenzene			750.0	1709.0	2400.0	1050.0
34594	2-Nitrophenol			1150.0	1950.0	3125.0	1732.15
34649	4-Nitrophenol			2150.0	6650.0	3900.65	3000.0
88817	N-Nitrosodiethylamine			600.0	1800.0	2400.0	750.0
34441	N-Nitrosodimethylamine			850.0	1800.0	2400.0	1050.0
73159	N-Nitrosodi-n-butylamine			700.0	2300.0	2400.0	950.0
34431	N-Nitrosodi-n-propylamine			750.0	1709	1950.0	1050.0
34436	N-Nitrosodiphenylamine			750.0	1350.0	1950.0	950.0
39061	Pentachlorophenol			1650.0	3850.0	3850.0	3128.0
34464	Phenanthrene	515.0	543.53	767.0	1800.0	2400.0	1100.0

Table 20. Screening Levels for Organic Substances in Sediment, continued

Parameter Code	Parameter	PEL		85th Percentile by Water Body Type			
		Freshwater	Marine	Freshwater Stream	Tidal Stream	Reservoir	Estuary
34695	Phenol			1007.8	1950.0	2400.0	1500.0
34472	Pyrene	875.0	1397.6	750.0	2100.0	2400.0	1257.4
88823	Pyridine			700.0	1800.0	3900.65	1100.0
88826	1,2,4,5-tetrachlorobenzene			670.0	2300.0	2400.0	950.0
34554	1,2,4-trichlorobenzene			600.0	1399.5	2400.0	1050.0
78401	2,4,5-trichlorophenol			1150.0	2050.0	2725.65	1650.0
34624	2,4,6-trichlorophenol			1052.9	1950.0	2400.0	1563.9
Other Sediment Parameters							
00557 00561	Oil and grease			1700.00	10800.0	7180.0	3200.0

Table 21. Screening Levels for Metals in Tissue

(All values listed as mg/kg Wet Weight)

Parameter Code	Parameter	Freshwater	Tidal Water
01004	Arsenic *	3.0	3.0
71940	Cadmium *	0.5	0.5
71939	Chromium *	100.0	100.0
71937	Copper *	40.0	40.0
71936	Lead	1.25	8.333
71930	Mercury*	0.7	0.7
01149	Selenium *	2.0	2.0

* Texas Department of Health screening level

Table 22. Screening Levels for Organic Substances in Tissue

(All Values in mg/kg Wet Weight)

Parameter Code	Parameter	Freshwater	Tidal Water
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
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

Table 22. Screening Levels for Organic Substances in Tissue, continued

Parameter Code	Parameter	Freshwater	Tidal Water
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	0.3150	----
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

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

Monitoring Strategy to Strengthen Assessments

The new water quality assessment methods contained in this document provide a thorough description of the level of confidence in identifiying concerns and impairments. A binomial method is established to specify the number of exceedances of criteria or screening levels required to deter-

mine partial and nonsupport of designated uses and criteria, and to identify concerns. This statistical approach defines the level of confidence for listing a water body on the 303(d) list. It is also used to identify concerns with small data sets and focus more monitoring resources on possible problems to determine if the uses or criteria are supported.

This information will be used to plan monitoring that will subsequently strengthen the assessment and lead to appropriate water quality management initiatives to restore and maintain water quality. Table 23 illustrates monitoring responses to the water quality status reported in the assessment.

In addition to emphasizing impaired water bodies and water bodies with identified concerns, the TNRCC maintains and coordinates a routine monitoring network. General commitments for the monitoring program include:

- Conducting a comprehensive assessment of all state waters.
- Using a wide range of indicators to provide assessment information, including physico-chemical measurement; chemical constituents in water, sediment, and tissue; biological and habitat measurements; and ambient toxicity.
- Collecting all data under an approved QA program (TNRCC-approved QAPP or data acquired and quality approved by agency staff).

The program works to ensure consistency and share data with other monitoring organizations, including all TNRCC water programs; federal monitoring programs of the EPA, the IBWC, and the USGS; state programs at TPWD and TDH; and river authorities and local cooperators in the CRP program.

The assessment activities that result in the 305(b) and 303(d) reports are long-term planning activities that are implemented through the Water Quality Management Plan. The emergency response and complaint programs are TNRCC's means for addressing water quality problems in the shorter term. There are, however, emerging monitoring and water quality issues that the program will investigate. Recent examples include MTBE and perchlorate in surface water, and the need for low-level metals collection and analysis methods.

The implementation of coordinated statewide monitoring is a priority of the TNRCC and the CRP. It ensures reduced duplication of effort, improves spatial coverage of monitoring sites, and improves consistency of parametric coverages. An annual meeting is held in each major river basin, hosted by the CRP planning agency, during the spring of each year. The purpose of the meeting is to develop a coordinated basin-wide monitoring

Table 23. Targeted and Surveillance Monitoring Objectives

Impaired Waters and Concerns		
Assessment Status	**General Monitoring Objective**	**Priority**
Use Not Supported **On** the 303(d) List	Sample until adequate data set is available to define geographic extent and severity of the impairment. or Conduct Use Attainability Analysis and develop a more appropriate standard. or Some water bodies may have a TMDL scheduled or underway which includes a comprehensive monitoring program.	1st
Use Partially Supported **On** the 303(d) List	Same as above	2nd
Primary Concern (for water quality criteria) **Tier 1** (< 10 samples)	Sample until an adequate data set is available for assessment.	3rd
Primary Concern (for water quality criteria) **Tier 2** (≥10 samples)	Verify the current assessment status and continue monitoring. When DO grabs identify concern, determine if 24-hour mean criterion is supported.	4th
Concern Identified for Threatened Water Quality or Declining Trend	Verify the current assessment status and continue monitoring. Investigate other water quality causes and sources related to the parameter of concern.	5th
Secondary Concern (narrative criteria, i.e., nutrients and sediment) **Tier 2** (≥10 samples)	Verify the current assessment status and continue monitoring. Investigate other water quality causes and sources related to the parameter of concern.	6th

Use Supported or Not Assessed		
General Monitoring Objective	**Monitoring Approach**	**Prioritizing Monitoring Resources**
For Water Bodies and Parameters Where Uses Are Supported - Track current status, expand assessment parameters	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	For conventionals, local interest determines priority at this time
	Toxics, ambient toxicity, and biological monitoring in areas of risk	For toxics, etc., local interest determines priority at this time
For Water Bodies and Parameters That Are Not Assessed - Determine use support	Conventional parameters on high use water bodies and water bodies of local interest	For conventionals, local interest determines priority at this time
Determine Statewide Percentages for Use Support and Concerns - Reports to the Texas legislature and EPA	Comprehensive probability-based or watershed-integrator monitoring plan	To be developed for the 2003 schedule; 10-30% of total resources

Table 23. Targeted and Surveillance Monitoring Objectives, continued

Use Supported or Not Assessed		
General Monitoring Objective	**Monitoring Approach**	**Prioritizing Monitoring Resources**
Determine Water Quality Trend for a Water Body	Develop a water body- and parameter-specific plan, or continue some of the monitoring already underway	Local interest determines priority at this time
Develop Ecoregion-Specific Background Data	Develop ecoregion specific monitoring plan	Plan will be developed with TPWD by the Biological Workgroup
Determine Sources of Pollutants	Develop watershed and parameter specific plan	Local interest determines priority at this time; or part of TMDL-initiated investigation
Determine if Existing Point Source Controls are Effective	Conduct compliance monitoring of effluents and receiving waters	Plan is developed from results of the assessment, compliance history, and relative risk to the environment
Verify Effectiveness of BMPs	Develop watershed and parameter specific plan	As required by implementation plans
Determine Loads for a TMDL	Develop watershed and parameter specific plan	As required by TMDL priorities or schedule

schedule (plan), reduce duplication of monitoring efforts, enhance spatial coverage of sampling sites, and ensure consistency in sampling, analysis, and data reporting protocols. All water quality monitoring groups that collect SWQM data and commit to comply with TNRCC requirements for collecting quality-assured data are invited to participate in the meetings. The merits of maintaining or relocating existing sites and changing parametric coverages are discussed in relation to the historical baseline sampling, identification of use impairments and water quality concerns from the 305(b) assessment, local knowledge of water quality problems, permit activities, special studies, and TMDL monitoring projects. Special attention is focused on spatial gaps in station locations and inadequacy of parametric coverages. New sites are added, existing sites may be relocated, and parametric coverages may be changed based on the discussions at the meetings. Additional information pertaining to coordinating monitoring across river basins is available in the *Clean Rivers Program Guidance and Reference Guide, FY 2000-2001* (TNRCC).

Basin-wide monitoring schedules are developed and submitted to the TNRCC, where they are aggregated to produce a coordinated statewide SWQM schedule provided to EPA. Beginning in 2002, the statewide schedule will be made available at the TNRCC Web site (www.tnrcc.state.tx.us/water/quality/data/coopmonitoring.html).

During the monitoring planning cycle for 2002, a considerable effort has been directed toward impaired water bodies. Monitoring has been scheduled to confirm nonsupport of 24-hour dissolved oxygen criteria for all water bodies identified as impaired based on grab sampling. Over the next two years, this emphasis will continue. The 2002 assessment will identify Tier 1 and 2 primary concerns, as well as secondary concerns. Monitoring resources will be directed to these new categories in order to identify potential and confirmed water quality problems.

Methodology for Assignment of Causes and Sources of 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).

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 24). *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 25).

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 24. List of Causes/Stressors

Code	Cause/Stressor	Code	Cause/Stressor
0000	Cause Unknown	1000	pH
0100	Unknown Toxicity	1100	Siltation
0200	Pesticides	1200	Organic Enrichment/ Low Dissolved Oxygen
			1220 Low Dissolved Oxygen
0300	Priority Organics	1300	Salinity/TDS/Chloride/Sulfate
0400	Nonpriority Organics	1400	Thermal Modifications
0410	PCBs	1500	Flow Alterations
0420	Dioxins	1600	Habitat Alterations
0500	Metals	1700	Pathogens
	0510 Arsenic	1800	Radiation
	0520 Cadmium	1900	Oil and Grease
	0530 Copper	2000	Taste and Odor
	0540 Chromium	2100	Suspended Solids
	0550 Lead	2200	Noxious Aquatic Plants
	0560 Mercury	2400	Total Toxics
	0570 Selenium	2500	Turbidity
0600	Ammonia	2600	Exotic Species
0700	Chlorine	2800	Excessive Algal Growth
0800	Other Inorganics	2900	Inappropriate Littoral Vegetation
0900	Nutrients		
	0910 Phosphorus		
	0920 Nitrogen		
	0930 Other		

Table 25. List of Sources

Code	Source Category
0100	Industrial Point Sources
	0110 Major Industrial Point Sources
	0120 Minor Industrial Point Sources
0200	Municipal Point Sources
	0210 Major Municipal Point Sources--dry and/or wet weather discharges
	0212 Major Municipal Point Sources--dry weather discharges
	0214 Major Municipal Point Sources--wet weather discharges
	0220 Minor Municipal Point Sources---dry and/or wet weather discharges
	0222 Minor Municipal Point Sources--dry weather discharges
	0224 Minor Municipal Point Sources--wet weather discharges
0400	Combined Sewer Overflow
0500	Collection System Failure
0900	Domestic Wastewater Lagoon
1000	Agriculture
	1050 Crop-Related Sources
	1100 Nonirrigated Crop Production
	1200 Irrigated Crop Production
	1300 Speciality Crop Production (e.g., horticulture, citrus, nuts, fruits)
	1350 Grazing-Related Sources
	1400 Pasture Grazing--riparian and/or upland
	1410 Pasture Grazing--riparian
	1420 Pasture Grazing--upland
	1500 Range Grazing--riparian and/or upland
	1510 Range Grazing--riparian
	1520 Range Grazing--upland
	1600 Intensive Animal Feeding Operations
	1620 Concentrated Animal Feeding Operations (CAFOs); permitted point sources
	1640 Confined Animal Feeding Operations Nonpoint Sources
	1700 Aquaculture

Table 25. List of Sources, continued

Code	Source Category
2000	Silviculture
	2100 Harvesting, Restoration, Residue Management
	2200 Forest Management (e.g., pumped drainage, fertilization, pesticide application)
	2300 Logging Road Construction/Maintenance
	2400 Silvicultural Point Sources
3000	Construction
	3100 Highway/Road/Bridge Construction
	3200 Land Development
4000	Urban Runoff/Storm Sewers
	4100 Nonindustrial Permitted Sources
	4200 Industrial Permitted Sources
	4300 Other Urban Runoff
	4400 Illicit Connections/Illegal Hook-ups/Dry Weather Flows
	4500 Highway/Roadway/Bridge Runoff
	4600 Erosion and Sedimentation
5000	Resources Extraction
	5100 Surface Mining
	5200 Subsurface Mining
	5300 Placer Mining
	5400 Dredge Mining
	5500 Petroleum Activities
	5700 Mill Tailings
	5800 Acid Mine Drainage
	5900 Abandoned Mining
	5950 Inactive Mining
6000	Land Disposal
	6100 Sludge
	6200 Wastewater
	6300 Landfills
	6400 Industrial Land Treatment

Table 25. List of Sources, continued

Code	Source Category
6000, cont.	6500 On-Site Wastewater Systems (septic tanks)
	6600 Hazardous Waste
	6700 Septage Disposal
7000	Hydromodification
	7100 Channelization
	7200 Dredging
	7300 Dam Construction
	7350 Upstream Impoundment
	7400 Flow Regulations/Modification
7550	Habitat Modification (other than hydromodification)
	7600 Removal of Riparian Vegetation
	7700 Bank or Shoreline Modification/Destabilization
	7800 Drainage/Filling or Wetlands
7900	Marinas and Recreation Boating
	7910 In-Water Releases
	7920 On-land Releases
8050	Erosion from Derelict Land
8100	Atmospheric Deposition
8200	Waste Storage/Storage Tank Leaks (above ground)
8250	Leaking Underground Storage Tanks
8300	Highway Maintenance and Runoff
8400	Spills (accidental)
8500	Contaminated Sediments
8520	Debris and Bottom Deposits
8530	Internal Nutrient Cycling (primary lakes)
8540	Sediment Resuspension
8600	Natural Sources
8700	Recreation and Tourism Activities
	8710 Releases From Boats
	8750 Golf Courses

Table 25. List of Sources, continued

Code	Source Category
8900	Salt Storage Sites
8910	Groundwater Loadings
8920	Groundwater Withdrawal
8950	Other
9000	Unknown Source
	9001 Unknown Point Source 9002 Unknown Nonpoint Source
9050	Sources Outside State Jurisdiction or Borders

Appendixes

Appendix A. Sample Sizes and Number of Exceedances Required to Determine Partial Support of a Use

(continued from Table 2, page 9)

Sample Size (n)	Number of Exceedances	Type I Error Rate (%)	Sample Size (n)	Number of Exceedances	Type I Error Rate (%)
21	4	15.2	61	9	15.2
22	4	17.2	62	9	16.3
23	4	19.3	63	9	17.5
24	5	8.5	64	9	18.6
25	5	9.8	65	9	19.9
26	5	11.2	66	10	12.0
27	5	12.6	67	10	12.9
28	5	14.2	68	10	13.8
29	5	15.8	69	10	14.8
30	5	17.5	70	10	15.8
31	5	19.3	71	10	16.9
32	6	9.4	72	10	18.0
33	6	10.6	73	10	19.1
34	6	11.8	74	10	20.2
35	6	13.2	75	11	12.6
36	6	14.5	76	11	13.5
37	6	16.0	77	11	14.4
38	6	17.5	78	11	15.4
39	6	19.0	79	11	16.3
40	7	9.9	80	11	17.3
41	7	11.0	81	11	18.4
42	7	12.1	82	11	19.4
43	7	13.3	83	12	12.3
44	7	14.6	84	12	13.1
45	7	15.8	85	12	14.0
46	7	17.2	86	12	14.9
47	7	18.6	87	12	15.8
48	7	20.0	88	12	16.7
49	8	11.2	89	12	17.7
50	8	12.2	90	12	18.6
51	8	13.3	91	12	19.6
52	8	14.4	92	13	12.8
53	8	15.6	93	13	13.5
54	8	16.8	94	13	14.4
55	8	18.0	95	13	15.2
56	8	19.3	96	13	16.1
57	9	11.2	97	13	17.0
58	9	12.1	98	13	17.9
59	9	13.1	99	13	18.8
60	9	14.2	100	13	19.8

Appendix B. Sample Sizes and Number of Exceedances Required to Determine Nonsupport of a Use

(continued from Table 3, page 10)

Sample Size (n)	Number of Exceedances	Type I Error Rate (%)	Sample Size (n)	Number of Exceedances	Type I Error Rate (%)
21	8	13.0	61	19	16.8
22	8	16.1	62	19	18.8
23	8	19.6	63	20	13.8
24	9	12.1	64	20	15.6
25	9	14.9	65	20	17.5
26	9	18.0	66	20	19.5
27	10	11.3	67	21	14.5
28	10	13.8	68	21	16.3
29	10	16.6	69	21	18.2
30	10	19.6	70	21	20.2
31	11	12.8	71	22	15.2
32	11	15.3	72	22	17.0
33	11	18.1	73	22	18.8
34	12	11.9	74	23	14.2
35	12	14.2	75	23	15.8
36	12	16.7	76	23	17.6
37	12	19.4	77	23	19.4
38	13	13.2	78	24	14.8
39	13	15.4	79	24	16.4
40	13	17.9	80	24	18.2
41	13	20.5	81	24	20.0
42	14	14.3	82	25	15.4
43	14	16.6	83	25	17.0
44	14	19.0	84	25	18.7
45	15	13.3	85	26	14.4
46	15	15.3	86	26	15.9
47	15	17.6	87	26	17.6
48	15	20.0	88	26	19.3
49	16	14.2	89	27	14.9
50	16	16.3	90	27	16.5
51	16	18.5	91	27	18.1
52	17	13.2	92	27	19.8
53	17	15.1	93	28	15.4
54	17	17.2	94	28	17.0
55	17	19.4	95	28	18.6
56	18	14.1	96	28	20.3
57	18	16.0	97	29	15.9
58	18	18.0	98	29	17.5
59	18	20.2	99	29	19.1
60	19	14.8	100	30	14.9

Appendix C. Sample Sizes and Number of Exceedances Required to Determine Primary Concerns and Partial Support of Aquatic Life Use Acute Criteria

(continued from Table 4, page 11)

Sample Size (n)	Number of Exceedances	Type I Error Rate (%)	Sample Size (n)	Number of Exceedances	Type I Error Rate (%)
21	3	35.1	61	7	41.0
22	3	38.0	62	7	42.7
23	3	40.8	63	7	44.4
24	3	43.6	64	7	46.1
25	3	46.3	65	7	47.7
26	3	48.9	66	7	49.4
27	4	28.2	67	8	35.4
28	4	30.5	68	8	37.0
29	4	32.9	69	8	38.5
30	4	35.2	70	8	40.1
31	4	37.6	71	8	41.7
32	4	40.0	72	8	43.2
33	4	42.3	73	8	44.8
34	4	44.6	74	8	46.4
35	4	46.9	75	8	47.9
36	4	49.1	76	8	49.4
37	5	30.9	77	9	36.3
38	5	33.0	78	9	37.8
39	5	35.0	79	9	39.3
40	5	37.1	80	9	40.7
41	5	39.1	81	9	42.2
42	5	41.2	82	9	43.7
43	5	43.2	83	9	45.1
44	5	45.3	84	9	46.6
45	5	47.3	85	9	48.0
46	5	49.3	86	9	49.5
47	6	32.8	87	10	37.1
48	6	34.7	88	10	38.5
49	6	36.5	89	10	39.8
50	6	38.4	90	10	41.2
51	6	40.2	91	10	42.6
52	6	42.1	92	10	44.0
53	6	43.9	93	10	45.4
54	6	45.7	94	10	46.8
55	6	47.5	95	10	48.1
56	6	49.3	96	10	49.5
57	7	34.3	97	11	37.7
58	7	36.0	98	11	39.0
59	7	37.7	99	11	40.4
60	7	39.3	100	11	41.7

Appendix D. Sample Size and Number of Exceedances Required to Determine Secondary Concerns (or Primary Concerns for Bacterial Indicators) and Nonsupport of Aquatic Life Use Acute Criteria

(continued from Table 5, page 12)

Sample Size (n)	Number of Exceedances	Type I Error Rate (%)	Sample Size (n)	Number of Exceedances	Type I Error Rate
21	6	43.3	61	16	46.1
22	6	48.3	62	16	49.0
23	7	34.6	63	17	40.5
24	7	39.2	64	17	43.3
25	7	43.9	65	17	46.2
26	7	48.5	66	17	49.0
27	8	35.7	67	18	40.7
28	8	40.0	68	18	43.5
29	8	44.3	69	18	46.3
30	8	48.6	70	18	49.1
31	9	36.6	71	19	41.0
32	9	40.6	72	19	43.7
33	9	44.7	73	19	46.4
34	9	48.7	74	19	49.1
35	10	37.4	75	20	41.2
36	10	41.2	76	20	43.9
37	10	45.0	77	20	46.5
38	10	48.7	78	20	49.1
39	11	38.0	79	21	41.5
40	11	41.6	80	21	44.0
41	11	45.2	81	21	46.6
42	11	48.8	82	21	49.1
43	12	38.5	83	22	41.7
44	12	42.0	84	22	44.2
45	12	45.4	85	22	46.7
46	12	48.8	86	22	49.2
47	13	39.0	87	23	41.8
48	13	42.3	88	23	44.3
49	13	45.6	89	23	46.7
50	13	48.9	90	23	49.2
51	14	39.4	91	24	42.0
52	14	42.6	92	24	44.4
53	14	45.8	93	24	46.8
54	14	48.9	94	24	49.2
55	15	39.8	95	25	42.2
56	15	42.9	96	25	44.5
57	15	45.9	97	25	46.9
58	15	49.0	98	25	49.2
59	16	40.2	99	26	42.3
60	16	43.1	100	26	44.6