Procedures to Implement the Texas Surface Water Quality Standards

Prepared by
Water Quality Division

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Abbreviations

Abbreviation	Full Name
ACR	acute-to-chronic ratio
AU	assessment unit
BAF	bioaccumulation factor
BAT	best available technology
BCF	bioconcentration factor
BMP	best management practice
BOD	biochemical oxygen demand
BPJ	best professional judgment
CASRN	Chemical Abstracts Service Registry Number
CBOD	carbonaceous biochemical oxygen demand
CFR	Code of Federal Regulations
CIU	categorical industrial user
CPP	Continuing Planning Process
CRQL	contract required quantitation level
CSTR	continuously stirred tank reactor
CV	coefficient of variation
CWA	Clean Water Act
DO	dissolved oxygen
EPA	Environmental Protection Agency
FR	Federal Register
GIS	geographic information system
HM	harmonic mean flow
HUC	hydrological unit code
IBWC	International Boundary and Water Commission
IU	industrial user
LTA	long-term average
MAL	minimum analytical level
MCL	maximum contaminant level
MDL	method detection limit
MGD	million gallons per day
ML	minimum level
MOA	memorandum of agreement

Abbreviation	Full Name
MQL	minimum quantitation level
MS4	municipal separate storm sewer system
MSDS	material safety data sheet
MZ	mixing zone
NCR	noncontact recreation
NH_3-N	ammonia-nitrogen
NOE	Notice of Enforcement
NOEC	no observable effects concentration
NPDES	National Pollutant Discharge Elimination System
1Q2	one-day, two-year low-flow
ONRW	outstanding national resource water
PCR	primary contact recreation
PMSD	percent minimum significant difference
QSAR	quantitative structure-activity relationship
RP	reasonable potential
RWA	receiving water assessment
SCR	secondary contact recreation
7Q2	seven-day, two-year low-flow
SIU	significant industrial user
SM	*Standard Methods*
SMAV	species mean acute value
SOD	sediment oxygen demand
SPIF	supplemental permit information form
SWMP	storm water management plan
SWP3	storm water pollution prevention plan
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TAC	Texas Administrative Code
TBD	to be determined
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TEAC	Texas Environmental Advisory Council
TEF	toxic equivalency factor
TEQ	toxic equivalence
TIE	toxicity identification evaluation
TMDL	total maximum daily load

Abbreviation	Full Name
TN	total nitrogen
TNRCC	Texas Natural Resource Conservation Commission
TP	total phosphorus
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TRE	toxicity reduction evaluation
TSS	total suspended solids
TWDB	Texas Water Development Board
UAA	use-attainability analysis
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WER	water-effect ratio
WET	whole effluent toxicity
WLA	waste load allocation
WLE	waste load evaluation
WQMP	Water Quality Management Plan
ZID	zone of initial dilution

Introduction

The Texas Commission on Environmental Quality (TCEQ) is responsible for maintaining and enhancing water quality in the state. The Texas Surface Water Quality Standards, which are the legal standards for the quality of surface water in Texas, are described in Title 30 of the Texas Administrative Code (TAC) Chapter 307.[1]

The TCEQ applies these Standards when issuing permits for wastewater discharges or other authorized discharges to the surface waters of the state. Wastewater permits are issued under a program called the Texas Pollutant Discharge Elimination System—TPDES.

Who should read this document? This document explains procedures the TCEQ uses when applying the Standards to permits issued under the TPDES program. This information should be of interest to regulated facilities that discharge wastewater (for example, domestic sewage treatment plants and industrial plants), to environmental professionals who help such facilities obtain their permits, and to other environmental professionals interested in wastewater permitting. The TCEQ will update this guidance document as needed to reflect changes in the Standards and in agency policy and procedures. This document should be interpreted as guidance and not as a replacement to the rules.

Document approval. This document was approved by the TCEQ on [new date]. It was also subject to Environmental Protection Agency (EPA) review and approval in accordance with the memorandum of agreement (MOA) between the TCEQ and EPA concerning the TPDES program. In a letter dated [new date], EPA approved this document.

For more information concerning revisions to the Standards and to this document, visit the Texas Surface Water Quality Standards page **(www.tceq.state.tx.us/nav/eq/eq_swqs.html)** and follow the Link: "Future Revisions of the Texas Surface Water Quality Standards."

Application review. The TCEQ believes that a consistent approach to application review is important. A permit applicant may provide information throughout the technical review to assist TCEQ staff in site-specific assessment and draft permit development. All preliminary determinations by TCEQ staff in the development of a permit (for example, instream uses, impact analysis, antidegradation, effluent limits, and all other specifications of the permit) are subject to additional review

[1] On [new date], the TCEQ adopted the most recent revision to Chapter 307, Texas Surface Water Quality Standards.

and revision through the public hearing process. Case-by-case permitting decisions are subject to EPA review and approval in accordance with the MOA between the TCEQ and EPA concerning the TPDES program.

For more information. Implementing the Standards in the TPDES program is just one aspect of the TCEQ's overall program for water quality management. A series of documents, the Continuing Planning Process (CPP), details the agency's policies and procedures to protect and maintain water quality, in fulfillment of the state's responsibilities under federal law. For more information about the overall program, visit the "Continuing Planning Process" page **(www.tceq.state.tx.us/implementation/water/planning/CPPMain.html)**.

A list of abbreviations used throughout this document is provided in the front of this document on page 9.

References in this document to tables or appendices should be understood to mean tables or appendices in this document unless another document is specified, such as the Standards.

Determining Water Quality Uses and Criteria

Classified Waters

Classified waters are those water bodies that are designated as segments in Appendix A of the Standards. Classified segments have designated uses (such as recreation, aquatic life, and water supply) and criteria associated with those uses (such as dissolved minerals, dissolved oxygen, pH, bacteria, and temperature). The designated uses and associated criteria are listed in Appendix A of the Standards and are used to evaluate wastewater permit applications.

Unclassified Waters

Unclassified waters are those smaller water bodies that are not designated as segments in Appendix A of the Standards. Certain unclassified water bodies are listed in Appendix D of the Standards. These are water bodies where sufficient information has been gathered to assign an aquatic life use and associated dissolved oxygen criterion. Water bodies listed in Appendix D are not designated as classified segments. Unclassified water bodies not included in Appendix D are assigned presumed aquatic life uses (as described in § 307.4(h) of the Standards) during reviews of wastewater permit applications.

In addition to aquatic life uses, unclassified waters can be assigned uses for primary, secondary, or noncontact recreation and domestic water supply. Basic uses such as navigation, agricultural water supply, and industrial water supply are normally assumed for all waters. Presumed recreational uses and bacteria criteria for unclassified water bodies, including those in Appendix D, are described in § 307.4(j) of the Standards.

Presumed Aquatic Life Uses

The characteristics and associated dissolved oxygen criteria for exceptional, high, intermediate, and limited aquatic life use subcategories are contained in Table 1 below. This table also includes associated dissolved oxygen criteria for a minimal aquatic life use subcategory, which applies to intermittent streams without perennial pools.

Table 1. Aquatic Life Use Subcategories

AQUATIC LIFE USE SUBCATEGORY		Exceptional	High	Intermediate	Limited	Minimal
DISSOLVED OXYGEN CRITERIA (mg/L)	Freshwater mean/ minimum	6.0/4.0	5.0/3.0	4.0/3.0	3.0/2.0	2.0/1.5
	Freshwater in Spring mean/ minimum	6.0/5.0	5.5/4.5	5.0/4.0	4.0/3.0	—
	Saltwater mean/ minimum	5.0/4.0	4.0/3.0	3.0/2.0	—	—
AQUATIC LIFE ATTRIBUTES	Habitat Characteristics	Outstanding natural variability	Highly diverse	Moderately diverse	Uniform	—
	Species Assemblage	Exceptional or unusual	Usual association of regionally expected species	Some expected species	Most regionally expected species absent	—
	Sensitive Species	Abundant	Present	Very low in abundance	Absent	—
	Diversity	Exceptionally high	High	Moderate	Low	—
	Species Richness	Exceptionally high	High	Moderate	Low	—
	Trophic Structure	Balanced	Balanced to slightly imbalanced	Moderately imbalanced	Severely imbalanced	—

NOTE: Information in this table is taken from Table 3 in § 307.7(b)(3)(A) of the Standards.

Perennial Waters

As stated in § 307.4(h)(3) of the Standards, unclassified perennial streams that are not listed in Appendix D of the Standards, rivers, lakes, bays, estuaries, and other appropriate perennial waters are presumed to have a high aquatic life use and corresponding dissolved oxygen criterion. Higher uses will be maintained where they are attainable.

Intermittent Streams

Intermittent streams are defined as having either

- a period of zero flow for at least one week during most years or
- a seven-day, two-year low-flow (7Q2) less than 0.1 ft^3/s (where flow records are available).

According to § 307.4(h)(4) of the Standards, unclassified intermittent streams that are not specifically listed in Appendix A or D of the Standards are considered to have a minimal aquatic life use, except as indicated below in this paragraph, and will maintain a 24-hour mean

dissolved oxygen concentration of 2.0 mg/L and an absolute minimum dissolved oxygen concentration of 1.5 mg/L. For intermittent streams with seasonal aquatic life uses, dissolved oxygen concentrations commensurate with those aquatic life uses will be maintained during the seasons in which the aquatic life uses occur.

Intermittent Streams with Perennial Pools

Unclassified intermittent streams with perennial pools are presumed to have a limited aquatic life use and corresponding dissolved oxygen criterion (*See* Table 1). Higher uses will be maintained where they are attainable.

At this time, determination of what constitutes a seasonal aquatic life use and perennial pool designation is done on a case-by-case basis using available data and best professional judgment. The TCEQ will continue to develop improved procedures to address the issues of seasonal aquatic life use and perennial pools.

Playa Lakes

The applicability of the Standards and the appropriate aquatic life use designation for playa lakes is discussed in the Playa Lake Policy Statement that was signed by the agency's executive director on October 20, 1997 (*See* Appendix A on page 209 of this document).

Assigned Aquatic Life Uses

Aquatic life uses and corresponding dissolved oxygen (DO) criteria are assigned to waters that have the potential to be affected by permitted wastewater discharges. The DO criteria are used to evaluate the results of DO modeling performed to determine the effluent limits needed to protect the uses. (For more information, see the chapter of this document entitled "Modeling Dissolved Oxygen" on page 83.)

Staff uses Table 2 below to estimate how far downstream to assign uses for discharges to streams or rivers. The distances in the table are based on default dissolved oxygen modeling of a single discharge and represent twice the distance to the predicted bottom of the dissolved oxygen sag. Uses are assigned farther downstream when site-specific stream data indicate that the impact from a discharge extends a greater distance than indicated in Table 2.

Table 2. Estimated Extent of Downstream DO Impact from Discharge

Permitted Flow (MGD)	Estimated Impact Distance (miles)
≤ 0.05	0.60
> 0.05 to ≤ 0.10	0.75
> 0.10 to ≤ 0.20	1.0
> 0.20 to ≤ 0.50	1.1
> 0.50 to ≤ 1.0	2.0
> 1.0 to ≤ 2.0	2.7
> 2.0 to ≤ 3.5	2.9
> 3.5 to ≤ 5.0	3.2
> 5.0 to ≤ 7.5	5.0
> 7.5 to ≤ 10	6.0
> 10 to ≤ 15	7.7
> 15 to ≤ 20	9.2
> 20 to ≤ 40	15.3

Uses and associated criteria for unclassified waters are either in Appendix D of the Standards or have to be assigned when those waters have the potential to be affected by permitted wastewater discharges (see § 307.4(l) of the Standards). Assignments of aquatic life use categories are based on characteristics shown in Table 1 on page 16. Please note the following:

- Site-specific modification of the aquatic life criteria in Table 1 may be considered when sufficient information is available to justify such modifications. Site-specific modifications are evaluated in accordance with guidance for regional development of criteria or other procedures used by TCEQ (*See* the chapter of this document entitled "Site-Specific Standards and Variances" on page 191).

- The attribute characteristics in Table 1 will be further clarified, modified, and "calibrated" as more region-specific data become available.

All permit applicants are requested to provide information about the receiving water as part of the permit application. Determining general stream flow characteristics (perennial, intermittent, or intermittent with perennial pools) is of major importance in assigning uses to unclassified streams. Permittees with discharges to small unclassified streams are encouraged to develop and submit additional documentation concerning the general stream type and stream flows at their discharge site.

TCEQ staff evaluates available information and determine appropriate uses and criteria for each permit action for discharge into surface water in the state. For sites where available information indicates that the presumed uses and criteria in the Standards may be inappropriate, additional data may be obtained by the TCEQ or the applicant in the form of a receiving water assessment (RWA). Guidelines for collecting the additional data and evaluating aquatic life uses for RWAs are described in the most recent versions of the TCEQ's *Surface Water Quality Monitoring Procedures*, RG-415 and RG-416. These documents are available on the agency's Web site (www.tceq.state.tx.us); follow the link for "Publications."

TCEQ staff considers hydrological conditions, appropriate assessment location, and applicability when determining the aquatic life uses for water bodies that receive or may receive a permitted wastewater discharge.

- TCEQ staff determines aquatic life use for the same set of hydrological conditions (normally stream low-flow and high temperatures, or critical conditions) that are used to analyze the impact of permitted discharges. These determinations may consider seasonal uses and associated hydrological conditions other than critical conditions. Permit limits are established as necessary to protect seasonal uses in both intermittent and perennial streams.

- TCEQ staff determines which part of a stream to assess depending on whether the discharge already exists or is not yet occurring.

    - For existing dischargers seeking permit renewals or amendments, TCEQ staff will give more weight to physical, hydrological, chemical, and biological conditions <u>upstream</u> of or in an area unaffected by an existing discharge. Staff will also consider differences in stream morphometry downstream of the discharge when determining appropriate aquatic life uses.

    - For new dischargers or facilities that have not yet discharged, TCEQ staff will give more weight to physical, hydrological, chemical, and biological conditions <u>downstream</u> of the proposed discharge point.

- For freshwater streams, the aquatic life use attributes are evaluated primarily from the use of an index of biotic integrity as described in the most recent version of TCEQ's *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data*, RG-416. Other water body types are evaluated on a case-by-case basis.

- The uses assigned to unclassified waters at a particular discharge site are not automatically assumed to be appropriate for other discharge sites in the same water body.

Unclassified waters with sufficient information obtained under these procedures will be considered for inclusion in Appendix D during the triennial review of the Standards.

When an attainable aquatic life use for a particular unclassified water body might be lower than the presumed aquatic life use, a use-attainability analysis (UAA) is conducted (*See* the section of this document entitled "Site-Specific Standards for Aquatic Life Use" on page 195).

TCEQ staff may review the preliminary determinations of use and the criteria associated with those uses throughout the permit application review if, new information becomes available and/or if there are errors in the previous evaluations. The applicant is given an opportunity to discuss the preliminary determinations of use and provide additional information after receiving the draft permit for review. The Notice of Application and Preliminary Decision indicates any preliminary additional uses assigned to the unclassified receiving waters.

Evaluating Impacts on Water Quality

General Information

New permit applications, permit renewals, and permit amendments are reviewed to ensure that permitted effluent limits will maintain instream criteria for dissolved oxygen and other parameters such as bacteria, phosphorus, nitrogen, turbidity, dissolved solids, temperature, and toxic pollutants. The assessment of appropriate aquatic life uses and dissolved oxygen criteria is conducted as discussed in the previous chapter, "Determining Water Quality Uses and Criteria" (see page 14).

TCEQ staff review all available information from sources that may include (but are not limited to) the permit application, stream surveys, routine monitoring information, waste load evaluations (WLEs), or total maximum daily loads (TMDLs). Additional information may also be acquired from the TCEQ's regional staff, the applicant, adjacent land owners, river authorities, or governmental entities.

All proposed permit actions that would increase pollution are also evaluated using the procedures discussed in the chapter of this document entitled "Antidegradation" on page 55.

The impact of discharges on endangered and threatened species is considered in accordance with the memorandum of agreement (MOA) between the TCEQ and the EPA and with the biological opinion from the U.S. Fish and Wildlife Service (USFWS). For more information, see the section of this document entitled "Federally Endangered and Threatened Species" on page 21.

Waste load evaluation recommendations and TMDLs are incorporated into permit limits for discharges into segments with completed WLEs or calculated TMDLs. For receiving waters without specific WLEs or TMDLs, oxygen deficit models or other appropriate analyses are conducted to determine permit limits. See the chapter of this document entitled "Modeling Dissolved Oxygen" on page 83.

Throughout any permit hearing process, TCEQ may continue to evaluate water quality impacts of permitted discharges and revise permit effluent limits based on these evaluations. Such evaluations and revisions may also be subject to EPA review and approval.

Minimum and Seasonal Criteria for Dissolved Oxygen

Instantaneous minimum dissolved oxygen criteria (from Table 1 of this document—see page 16) and seasonal dissolved oxygen criteria are also considered. When determining seasonal permit limits, TCEQ staff generally use either a low-flow frequency or a seasonal 7Q2 and associated temperatures to estimate critical conditions in a particular month or season. For more detailed information, see the discussion on critical conditions used in modeling on page 85 of the "Modeling Dissolved Oxygen" chapter.

Federally Endangered and Threatened Species

The TCEQ reviews permit applications to determine whether discharges could potentially have any adverse effect on an aquatic or aquatic-dependent federally endangered or threatened species, including proposed species. The TCEQ may also consider potential adverse affects to state-listed species and will coordinate with Texas Parks and Wildlife Department (TPWD) as needed. Information that is considered during the review includes the following:

- the MOA between the TCEQ and the EPA concerning the TPDES program, available on the agency's Web site (www.tceq.state.tx.us);[2]

- the USFWS biological opinion (dated September 14, 1998) associated with assumption of the TPDES program by the State of Texas; and

- an update to that biological opinion (dated October 21, 1998).

The USFWS biological opinion includes a list of the United States Geological Survey (USGS) hydrological unit codes (HUCs) that cover the watersheds that should be considered in determining whether a listed species could be affected. These HUCs have been matched to both the counties and the classified segments into which the watersheds drain. Subsequent information from the USFWS has identified some specific water bodies where species of critical concern are known to occur. USFWS is informally notified, by way of a supplemental permit information form (SPIF), of all permit applications declared administratively complete.

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[2] Go to the TCEQ Web site and follow these links:
"Permits, Registrations"
"Water Quality Permits"
"Water Quality Permits for Cities and Other Developed Areas"
"Wastewater Pretreatment: Requirements and Options"
"TPDES Permit: Pretreatment Requirements"
"What Is the 'Texas Pollutant Discharge Elimination System (TPDES)'?"
"Authorization"
"Memorandum of Agreement between the TNRCC (TCEQ) and USEPA Region 6"

Screening Process

After permit applications are declared administratively complete, TCEQ staff screen them as follows:

1. The first classified segment that the discharge enters is determined.

2. The list of segments in Appendix B on page 211 (taken from Appendix A of the USFWS biological opinion and subsequent updates) is consulted to determine whether there is a potential for the listed species to occur anywhere within the watershed of the segment or whether the listed species is known to be only in a particular water body.

3. If the species has a potential of occurring anywhere within the watershed of the segment, TCEQ staff may compare the location of the discharge against the HUCs listed in the biological opinion to more accurately determine whether the discharge may impact listed species.

   Note that TCEQ staff also screen applications from petroleum facilities south of Copano Bay (Segment 2472) to determine whether these discharges could potentially have any adverse effect on the piping plover, a species of high priority.

4. If the application screening indicates that the discharge has a potential to affect a listed species, USFWS is formally notified via either the SPIF or the Notice of Application and Preliminary Decision.

5. TCEQ staff performs further reviews of discharges that are formally reported to USFWS in step 4 to determine whether additional or more stringent permit limits are necessary. In making this determination, the location of the discharge within the county, the distance from the segment or water body in question, the size of the discharge, and the type of species (for example, fish, amphibian, invertebrate, or plant) are all considered.

Additional Permit Limits

The TCEQ may require additional permit limits for discharges that TCEQ staff determine have a high potential to adversely affect listed species of critical concern. Examples of such discharges include:

- discharges directly to watersheds in which listed species occur.
- discharges whose dissolved oxygen sag extends into watersheds where listed species occur.

These types of discharges are issued permits that, if necessary, require dechlorination and contain a daily average ammonia-nitrogen limit of 3.0

mg/L or less. Additional permit limits may be imposed based on USFWS concerns and other issues as they arise.

Edwards Aquifer

Discharges within and across the contributing and recharge zones of the southern section of the Edwards Aquifer are reviewed to determine whether there will be any effects on threatened and endangered fish, amphibian, invertebrate, or plant species occurring down-gradient from the discharge. The review may include input from TCEQ staff knowledgeable in groundwater and hydrogeology.

Table 3 lists the classified segments that cross the contributing and recharge zones of the southern section of the Edwards Aquifer. This list of segments corresponds to the true geological zones that cover the entire watersheds containing those segments. This list is not identical to the segments covered in 30 TAC Chapter 213 (in Medina, Bexar, Comal, Kinney, Uvalde, Hays, Travis, and Williamson Counties) or to those segments having an assigned aquifer protection use in Appendix A of the Standards.

Table 3. Segments that Cross the Contributing and Recharge Zones of the Southern Section of the Edwards Aquifer

Segment Number	Segment Name
1427	Onion Creek
1430	Barton Creek
1804	Guadalupe River Below Comal River
1805	Canyon Lake
1806	Guadalupe River Above Canyon Lake
1808	Lower San Marcos River (above City of Martindale)
1809	Lower Blanco River
1810	Plum Creek
1811	Comal River
1812	Guadalupe River Below Canyon Dam
1813	Upper Blanco River
1814	Upper San Marcos River
1815	Cypress Creek
1816	Johnson Creek
1817	North Fork Guadalupe River
1818	South Fork Guadalupe River
1903	Medina River Below Medina Diversion Lake
1904	Medina Lake

Segment Number	Segment Name
1905	Medina River Above Medina Lake
1906	Lower Leon Creek
1907	Upper Leon Creek
1908	Upper Cibolo Creek
1909	Medina Diversion Lake
1910	Salado Creek
2111	Upper Sabinal River
2112	Upper Nueces River (upper portion)
2113	Upper Frio River
2114	Hondo Creek
2115	Seco Creek

Bacteria

Recreational Uses and Criteria

E. coli criteria have been established in freshwater as follows for primary contact recreation (PCR), secondary contact recreation (SCR) 1 and 2, and noncontact recreation (NCR).

E. Coli Criteria for Freshwater

Use	Geometric Mean (colonies/100 ml)	Single Sample (colonies/100 ml)
PCR	126	399
SCR 1	630	—
SCR 2	1,030	—
NCR	2,060	—

Enterococci criteria have been established in saltwater as shown in the following table.

Enterococci Criteria for Saltwater

Use	Geometric Mean (colonies/100 ml)	Single Sample (colonies/100 ml)
PCR	35	104
SCR1	175	—
NCR	350	—

Assigning Recreational Uses

Assigning recreational uses to classified and unclassified water bodies is defined in § 307.4(j) of the Texas Surface Water Quality Standards. The following tables provide a summary of how (1) presumed and designated uses are assigned and applied; (2) how uses less stringent that presumed or designated uses are assigned; and (3) when site-specific information or a RUAA is required.

Summary of assigning recreational uses to classified water bodies

Use	Assigning uses	RUAA Required	Rule Change Required
PCR	Designated use unless otherwise specified in Appendix A of § 307.10	No	No
SCR1	Standards change is required	Yes	Yes
SCR2	Standards change is required	Yes	Yes
NCR	Standards change is required	Yes	Yes

Summary of assigning recreational uses to unclassified water bodies

Use	Assigning uses	RUAA Required	Rule Change Required
PCR	Presumed use if greater than or equal to 0.5 meter average depth or substantial pools with depths of one meter or greater	No	No
SCR1	Presumed use if less than 0.5 meter average depth, no substantial pools greater than 1 meter, and no existing PCR activities	No. Only a reasonable level of inquiry (equivalent to a Basic RUAA) is required.	No. Public notification will be provided through a regulatory action and the assigned use will be subject to public comment and EPA approval.
	If presumed use is PCR, then a standards change is required	Yes	Yes
SCR2	Standards change is required	Yes	Yes
NCR	Standards change is required	Yes	Yes

Wastewater Permitting

Wastewater discharge permits for Publically Owned Treatment Works (POTWs) will include effluent limits and monitoring requirements in accordance with 30 TAC § 309.3(h). Effluent limits and monitoring requirements for bacteria associated with industrial discharges will be evaluated on a case-by-case basis in order to meet instream water quality standards. Any rules that are approved in the future regarding bacteria limits in wastewater permits will supersede the provisions in this section.

Freshwater—*E. coli* is the indicator bacteria in effluent limits for wastewater discharges into freshwater. This includes those freshwaters that are identified in Appendix A of the water quality standards as high saline inland water bodies.

Saltwater—Enterococci is used as the indicator bacteria in effluent limits for wastewater discharges into saltwater.

Nutrients

Introduction

The TCEQ has included numerical criteria for nutrients in major reservoirs in the Standards. The criteria are based on historical chlorophyll *a* data from the main body of selected reservoirs. The TCEQ plans to develop nutrient criteria for streams and rivers, estuaries, and wetlands and evaluate them for inclusion in a future Standards revision.

In addition to numerical criteria for reservoirs, the following rules also address the issue of controlling nutrients in wastewater discharges:

- General narrative criteria for nutrients in the Standards (§ 307.4)
- Antidegradation provisions of the Standards (§ 307.5)
- Watershed rules (30 TAC Chapter 311)
- Edwards Aquifer rules (30 TAC Chapter 213)

General Screening Approach for Nutrient Impacts

Applicability

The TCEQ evaluates applications for new or expanding domestic discharges to reservoirs, streams, and rivers to determine if an effluent limit is needed for total phosphorus (TP) or, in appropriate situations, total nitrogen (TN) to prevent violation of numerical nutrient criteria and/or preclude excessive growth of aquatic vegetation. Permit renewals and industrial discharges may be evaluated for potentially significant concentrations of TP (and if appropriate, TN) on a case-by-case basis.

The nutrient screening procedures in this section constitute the basis for the antidegradation review(s) for nutrients (see the chapter of this document entitled "Antidegradation" on page 55.) Additional factors for the antidegradation review(s) can be considered as appropriate to further address potential nutrient impacts of concern to sensitive water bodies.

General Procedure

The following general procedure is also shown by flow chart in Figure 1 on page 28. Discharges >0.25 MGD into or near a reservoir that has been assigned numerical nutrient criteria in the Standards are first screened to evaluate main pool effects. Additional screening is performed regardless of flow size to evaluate local effects in the reservoir and in the tributary stream or river under the narrative provisions of the Standards.

Discharges into or near a reservoir that has not been assigned numerical nutrient criteria in the Standards are screened to evaluate local effects in the reservoir and in the tributary stream or river under the narrative provisions of the Standards.

Discharges into a stream or river but outside the distance of concern to a reservoir are screened to evaluate local effects in the stream or river.

Assessing Numerical Nutrient Criteria—Main Pool Effects

For discharges >0.25 MGD to reservoirs that have numerical nutrient criteria, a detailed evaluation is performed using a completely-mixed, steady-state reservoir model to assess the effect of a proposed discharge on phosphorus levels in the main pool of the reservoir. Additionally, the effect of the TP change on chlorophyll *a* in the reservoir is estimated. Screening procedures are provided to evaluate model results and to determine if an effluent limit on TP is needed. The procedures for this evaluation are in the section entitled "Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria" on page 30.

Assessing Narrative Nutrient Provisions—Local Effects

To assess the local effects of discharges under the narrative nutrient provisions of the Standards, the TCEQ evaluates site-specific screening factors to assess eutrophication potential rated in terms of low, moderate, or high. Qualitative and quantitative guidelines are provided; screening factors may have one or the other or both. In some situations, only some of the suggested factors may be needed for the evaluation; and sufficient data may not always be available to address every factor. The procedures for this evaluation are in the sections entitled "Nutrient Screening for Local Effects in Reservoirs" on page 38 and "Nutrient Screening in Streams and Rivers" on page 44.

The individual screening factors establish the basis for an overall "weight-of-evidence" assessment to identify the need for a nutrient effluent limit. An effluent limit for TP is typically indicated when a significant number of screening factors are rated as moderate and high. However, the importance and weight of individual screening factors can vary from one site to another. If an effluent limit for TP is indicated, then screening factors and levels of concern can also be considered in determining the specific concentration limit for TP. Initial assessments can be improved and reconsidered in light of additional site-specific data and/or more extensive models and evaluations.

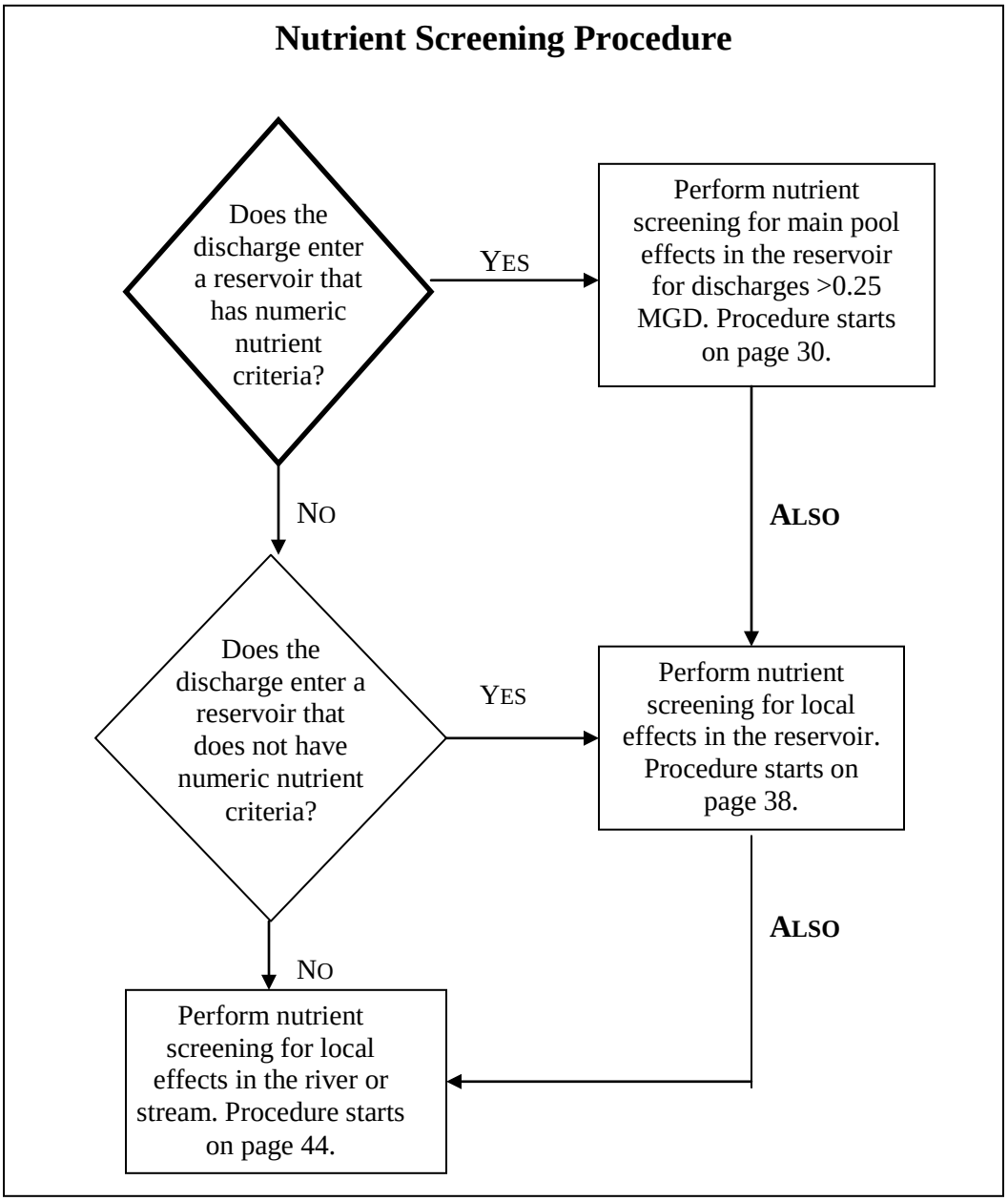

Figure 1. Flow chart showing the nutrient screening procedure.

Effluent Limits for Total Phosphorus

When screening indicates that a reduction of effluent TP is needed, an effluent limit is recommended based on reasonably achievable technology-based limits, with consideration of the sensitivity of the site. Typical effluent limits for TP, as a daily average concentration, generally fall into the following ranges:

Permitted Flow (MGD)	Typical TP Limit (mg/L)
< 0.5	1.0
0.5 – 3.0	1.0 to 0.5
> 3.0	0.5

Higher or lower limits may be recommended based on site-specific mitigating factors.

Regulatory Factors that Prescribe Nutrient Controls in Discharge Permits

Additional screening is unnecessary when the following site-specific regulatory factors explicitly establish an effluent limit for TP or other requirements:

- A TP limit, or a prohibition on wastewater discharges, is established in a watershed rule (30 TAC Chapter 311) or in the Edwards Aquifer rules (30 TAC Chapter 213).

- A water body is listed as impaired in the current Texas § 303(d) List due to excessive nutrients such as TP and potential nutrient additions are evaluated using the provisions in the section of this document entitled "Protecting Impaired Water Under Tier 1" (see page 57).

- A TMDL or TMDL Implementation Plan specifies TP limits for wastewater discharges.

Focus on Phosphorus Instead of Nitrogen

Considerations for nutrient impacts focus on TP rather than nitrogen for the following reasons:

- substantially less data on total nitrogen have been collected in Texas reservoirs, streams, and rivers.

- phosphorus is a primary nutrient in freshwaters, although nitrogen can be limiting during parts of the year.

- nitrogen can be fixed directly from the atmosphere by most of the noxious forms of blue-green algae.

- available waste treatment technologies make reducing phosphorus more effective than reducing nitrogen as a means of limiting algal production.

Effluent limits for total nitrogen can be considered in certain situations when existing or projected nitrogen levels would result in:

- growth of nuisance aquatic vegetation.

- a substantial increase in nitrate-nitrogen that could adversely affect public drinking water supplies (with a nitrate-nitrogen criterion of 10 mg/L).

- potential eutrophication of unusually sensitive tidal waters, such as around seagrass beds.

Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria

General Approach

Numerical nutrient criteria in the Standards are expressed as the long-term average concentration of chlorophyll *a* in the main pool of a reservoir. These criteria are based on historical data to ensure that existing reservoir water quality is maintained.

Domestic wastewater discharges >0.25 MGD (and in some cases industrial wastewater discharges) into the watersheds of reservoirs with numerical nutrient criteria are evaluated to ensure that potential increases in nutrients and chlorophyll *a* in the main pool are relatively small and that water quality standards will be attained.

Applicability

Evaluations are conducted for permit applications that propose to increase permitted discharge flow into the watersheds of reservoirs with numerical nutrient criteria. Evaluations are conducted for the following permitted discharge sizes within the listed distance from the normal pool elevation of the reservoir:

Permitted flow (MGD)	Distance from reservoir (stream miles)
>0.25 – < 1	≤ 5
1 – 3	≤ 10
> 3	≤ 20*

*** Very large discharges at greater distances may be evaluated.**

Screening Model for TP

The first screening is based on the relative change in TP concentration in the main pool of the reservoir that would occur solely from the proposed discharge. (The screening could also be applied to TN.) The change in TP is estimated by applying a steady-state, completely-mixed model to the reservoir using long-term estimates of reservoir retention time and reservoir volume at the normal operating pool elevation. The equations used in the following screening procedure represent one example of an appropriate steady-state model.[3]

The TCEQ will consider more sophisticated models if they are submitted for review. If a more sophisticated model is used, predicted changes in chlorophyll *a* may be evaluated directly rather than evaluating predicted changes in TP.

The screening procedure comprises six steps as follows. An example is provided on page 34.

(1) For discharges that are over one mile from the normal operating pool elevation of the reservoir, estimate the loss of TP in the tributary stream or river as follows:

Equation 1:

$$f_{TP,x} = e^{\{-k_p[x/(11318Q_T^{0.5})]\}}$$

[3] For a discussion of model formulations and settling velocity, see Kenneth Reckow. 1979. Empirical Lake Models for Phosphorus: Development, Applications, Limitations and Uncertainty. In: *Perspectives in Lake Ecosystem Modeling*. Donald Scavia and Andrew Robertson (eds.). Ann Arbor Science.

where: $f_{TP,x}$ = fraction of TP **remaining** at a distance x downstream of the discharge

k_P = TP decay rate at an assumed annual mean temperature of 20ºC. Assume to be 0.14/day unless an alternative rate is shown to be more appropriate.

x = distance along the stream to the normal pool elevation of the reservoir (m)

11318 = Combination of default velocity coefficient of 0.131 $(1/m \cdot s)^{1/2}$ and conversion factor of 86,400 s/day $(s^{1/2}/(m^{1/2} \cdot day))$

Q_T = permitted discharge flow **plus** harmonic mean flow upstream of the discharge (m^3/s)

For discharge points that are less than or equal to one mile from the normal operating pool elevation of the reservoir, assume no loss of TP in the tributary stream or river (that is, set $f_{TP,x} = 1$).

(2) Estimate the concentration of TP that is delivered to the reservoir from the discharge using Equation 2:

Equation 2:

$$TP_d = f_{TP,x} \times TP_e$$

where: TP_d = concentration of TP delivered to the reservoir from the discharge (mg/L)

$f_{TP,x}$ = fraction of TP **remaining** at a distance x downstream of the discharge, calculated using Equation 1

TP_e = concentration of TP in the effluent (mg/L), assumed to be 3.5 mg/L if no effluent data are available.

(3) Estimate the annual average loading of TP in the entire reservoir due to the discharge using Equation 3:

Equation 3:

$$TP_L = 1{,}381{,}525 \times Q_P \times TP_d$$

where: TP_L = annual average loading of TP in the entire reservoir due to the discharge (g/yr)

Q_P = permitted discharge flow (MGD)

TP_d = concentration of TP from the discharge delivered to the reservoir (mg/L), calculated using Equation 2

(4) Estimate the areal loading rate to the reservoir using Equation 4:

Equation 4:

$$w' = \frac{TP_L}{4{,}047 \times A_R}$$

where:

w' = TP areal loading rate (g/m^2·yr)

TP_L = annual average loading of TP in the entire reservoir due to the discharge (g/yr), calculated using Equation 3

A_R = surface area of reservoir (acres) from Table F-2 in Appendix F

(5) Estimate the annual average concentration of TP in the entire reservoir due to the discharge using Equation 5:

Equation 5:

$$TP_R = \frac{w'}{v_s + 0.3048z/\tau}$$

where:

TP_R = annual average TP in the entire reservoir due to the discharge (mg/L)

w' = TP areal loading rate (g/m^2·yr), calculated using Equation 4

v_s = settling velocity (m/yr). For TP, assume 13 m/yr

z = mean depth (ft), see Appendix F, Table F-2 (divide volume by surface area to get mean depth)

τ = retention time (yrs), see Appendix F, Table F-2

(6) Finally, compare the change in TP in the main body of the reservoir to the reservoir's mean TP concentration using Equation 6:

Equation 6:

$$\%\ change = \frac{100 \times TP_R}{TP_A}$$

where:

% *change* = percent change in TP relative to the mean TP of the reservoir

TP_R = annual average TP in the entire reservoir due to the discharge (mg/L), calculated using Equation 5

TP_A = mean TP concentration of the reservoir (see Appendix F, Table F-1; these are long-term means of TP in the main pool of each reservoir)

Assessing the Results of Main Pool Screening

If TP is estimated to change by 10% or less, a TP limit is not needed and chlorophyll *a* screening is not performed. If TP is estimated to change by more than 10 percent, then a TP limit or monitoring may be needed, depending on the results of the chlorophyll *a* screening (see next section).

Example Calculation:
An applicant proposes to locate a new 2.0 MGD discharge on South Yegua Creek 3 miles upstream of Somerville Lake, Seg. 1212. Would chlorophyll *a* screening be performed, based on the estimated change in TP?

(1) Estimate the fraction of TP from the discharge that reaches Somerville Lake using Equation 1. Assume South Yegua Creek is intermittent with perennial pools with a harmonic mean flow of 0.1 cfs. Watch out for unit conversions!

$$f_{TP,x} = e^{\{-0.14[4827/(11318\times(0.08764+0.00283)^{0.5})]\}} = 0.82$$

(2) Estimate the concentration of TP from the discharge that reaches Somerville Lake using Equation 2. Assume an effluent TP concentration of 3.5 mg/L.

$$TP_d = 0.82 \times 3.5 = 2.87 \text{ mg/L}$$

(3) Estimate the annual average loading of TP from the discharge to Somerville Lake in its entirety using Equation 3.

$$TP_L = 1{,}381{,}525 \times 2.0 \times 2.87 = 7{,}929{,}482 \text{ g/yr}$$

(4) Estimate the areal loading rate from the discharge to Somerville Lake using Equation 4. (Reservoir characteristics are in Table F-2 in App. F.)

$$w' = \frac{7{,}929{,}482}{4{,}047 \times 11{,}555} = 0.17 \text{ g/m}^2\cdot\text{yr}$$

(5) Estimate the annual average TP concentration from the discharge in Somerville Lake using Equation 5.

$$TP_R = \frac{0.17}{13 + 0.3048 \times (147{,}104/11{,}555)/0.65} = 0.0090 \text{ mg/L}$$

(6) Compare the change in TP due to the discharge to the mean TP concentration in Somerville Lake using Equation 6.

$$\%\ change = \frac{100 \times 0.009}{0.082} = 10.9\ \%$$

Chlorophyll *a* screening is necessary based on the TP screening. This example is continued with chlorophyll *a* calculations on page 37, local effects screening for Somerville Lake on page 45, and local effects screening for South Yegua Creek on page 53.

Estimating Change in Chlorophyll a

If the projected change in TP over the entire reservoir is greater than 10%, the relative potential increase in chlorophyll *a* that may result from the estimated increase in TP is approximated. This evaluation is approximate because of the high variability in the relationship of TP to chlorophyll *a*. However, the evaluation provides additional information on the need for a TP limit or monitoring.

The potential increase in chlorophyll *a* can be estimated from the projected increase in TP by the following regression equation[4] for Texas reservoirs, as shown in Figure 2 and Equation 7 below:

Equation 7: $\ln(Chl\ a, \mu g/L) = 0.9312 \ln(TP, mg/L) + 5.14$

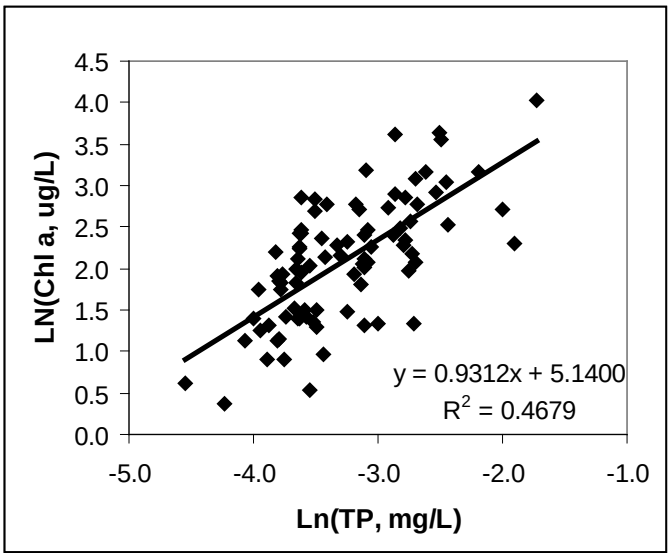

Figure 2. Relationship of mean chlorophyll *a* concentration to mean total phosphorous concentration in reservoirs.

The relationship of TP to chlorophyll *a* is statistically significant but highly variable from one reservoir to another and the regression may not accurately predict small changes in chlorophyll *a* assimilative capacity. Nevertheless, the screening is useful to ensure that criteria for chlorophyll *a* will be maintained. Alternative evaluations to predict the effect of phosphorus increases on chlorophyll *a* in specific reservoirs can also be considered.

[4] The regression is based on the long-term means of TP and chlorophyll *a* for the individual reservoirs in Table F-1 of Appendix F, with selected outliers removed (as noted in a January 23, 2009 letter from Larry Hauck at the Texas Institute for Applied Environmental Research). The r-squared for the regression is 0.47.

For ease of calculation, Equation 7 can be expressed as follows:

Equation 8: $Chl\ a\ (\mu g/L) = 170.7\ TP\ (mg/L)^{0.9312}$

The potential change in chlorophyll *a* in the entire reservoir is then evaluated using the following procedure.

(1) Use Equation 8 to calculate the reservoir chlorophyll *a* value that corresponds to the mean TP concentration in Table F-1 in Appendix F:

Equation 8a: $Chl_{AP} = 170.7\ TP_A^{0.9312}$

(2) Use Equation 8 to calculate the reservoir chlorophyll *a* value that corresponds to the sum of the mean TP concentration (from Table F-1) and the annual average TP in the entire reservoir due to the discharge (TP_R, from Equation 5):

Equation 8b: $Chl_{AR} = 170.7\ (TP_A + TP_R)^{0.9312}$

(3) Use Equation 9 to estimate the predicted change in chlorophyll *a* in the reservoir due to the discharge:

Equation 9: $Chl_R = Chl_{AR} - Chl_{AP}$

where:

Chl_R = chlorophyll *a* added by the discharge (µg/L)

Chl_{AR} = chlorophyll *a* (µg/L) predicted in the reservoir due to the discharge at permitted flow, calculated using Equation 8a

Chl_{AP} = chlorophyll *a* (µg/L) predicted in the reservoir at ambient TP concentration (see Appendix F, Table F-1), calculated using Equation 8b

(4) Use Equation 10 to compare the predicted change in chlorophyll *a* in the reservoir (due to the discharge) to the assimilative capacity of the reservoir, which is estimated to be the chlorophyll *a* criterion minus the ambient chlorophyll *a* concentration:

Equation 10: $$\%\ change = \frac{100\,[Chl_R]}{Chl_C - Chl_A}$$

where:

% *change* = percent change in chlorophyll *a* relative to the assimilative capacity of the reservoir

Chl_R = annual average chlorophyll *a* in the entire reservoir due to the discharge (mg/L), calculated using Equation 9

Chl_C = chlorophyll *a* criterion for the reservoir from Appendix F of the Standards.

Chl_A = mean chlorophyll *a* concentration of the reservoir (see Appendix F, Table F-1; these are long-term means of chlorophyll *a* in the main pool of each reservoir)

If the projected decrease in the estimated assimilative capacity of chlorophyll *a* is >20%, then a limit for TP is indicated. If the projected decrease is 10-20%, then monitoring for TP is indicated. If the projected decrease is <10%, then neither a TP limit nor monitoring is indicated.

Determining the Appropriate TP Limit

Use the typical effluent limit for TP based on permitted flow (see the table on page 29) in the screening procedure to estimate how much TP in the reservoir will change due to the discharge. The limit may need to be adjusted if the estimated change in reservoir TP is still >10% and the estimated change in chlorophyll *a* assimilative capacity is still >20%.

Example Calculation:
This example is a continuation of the scenario presented on page 34. An applicant proposes to locate a new 2.0 MGD discharge on South Yegua Creek 3 miles upstream of Somerville Lake, Seg. 1212. Would a TP limit or monitoring likely be recommended to address main pool effects in Somerville Lake, based on the estimated change in chlorophyll *a*?

(1) Use Equation 8a to estimate the concentration of chlorophyll *a* in Somerville Lake based on the ambient TP concentration for Somerville Lake.

$$Chl_{AP} = 170.7\ TP_A^{0.9312} = 170.7 \times 0.082^{0.9312} = 16.6\ \mu g/L$$

(2) Use Equation 8b to estimate the concentration of chlorophyll *a* in Somerville Lake based on the sum of the ambient TP concentration for Somerville Lake and the increase in TP concentration predicted by the previous screening calculations.

$$Chl_{AR} = 170.7\ (TP_A + TP_R)^{0.9312} = 170.7 \times (0.082 + 0.0090)^{0.9312} = 18.3\ \mu g/L$$

(3) Use Equation 9 to estimate the change in chlorophyll *a* concentration in Somerville Lake Somerville Lake in its entirety.

$$Chl_R = Chl_{AR} - Chl_{AP} = 18.3\ \mu g/L - 16.6\ \mu g/L = 1.7\ \mu g/L$$

(4) Use Equation 10 to compare the estimated increase in chlorophyll *a* to the assimilative capacity of Somerville Lake.

$$\%\ change = \frac{100\,[Chl_R]}{Chl_C - Chl_A} = \frac{100 \times [1.7\,\mu g/L]}{[47.64 - 35.16]\,\mu g/L} = 13.6\%$$

Nutrient Screening for Local Effects in Reservoirs

General Approach

To assess local effects in reservoirs from a discharge under the narrative nutrient provisions of the Standards, the TCEQ first evaluates the discharge using the general guidelines in this section. If the general guidelines indicate that a TP limit should be considered, then the TCEQ conducts a more comprehensive review using site-specific screening factors. Eutrophication potential is rated as a low, moderate, or high level of concern for each factor. Some screening factors can be rated on either qualitative or quantitative information, depending on data availability. Not every factor is appropriate or definable at a particular site.

Applicability

These screening procedures focus on larger reservoirs, such as those used for public water supplies. They can also be applied to smaller perennial impoundments (no smaller than about 10 surface acres in size), but some of the site-specific screening factors might not apply. Smaller impoundments, ponds, and perennial pools are addressed in the nutrient screening procedures for streams and rivers (see page 44). Evaluations are conducted for the following permitted discharge sizes within the listed distance from the normal pool elevation of the reservoir:

Permitted flow (MGD)	Evaluation Distance (stream miles)
< 0.25	< 5
0.25 to < 1.0	< 10
≥ 1.0*	< 20

*** Very large discharges may be evaluated on a case-by-case basis.**

A separate analysis is conducted to compare the potential impact of the discharge with numerical criteria for nutrients in the main pool of the reservoir (see the previous section of this document entitled "Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria" on page 30).

General Guidelines for Considering TP Limits

TP limits are potentially indicated in the following situations:

- for new or expanding discharges ≥ 1 MGD into or near reservoirs;
- for new or expanding discharges ≥ 0.25 MGD into or near shallow, restricted coves of reservoirs; and

- where explicitly required by watershed rules or other specific regulatory requirements.

Other situations where receiving streams appear to be especially sensitive to nutrient increases can also be considered. Smaller proposed discharges (such as those between 0.1 to 0.25 MGD) can also be of concern and will be evaluated for TP limits if the discharge location is into a sensitive area with very low dispersion.

Site-Specific Screening Factors

For cases where the general guidelines indicate that a limit on TP should be considered further, site-specific screening factors are applied to assess the potential need for a TP limit to control eutrophication. These screening factors include the following:

A. size of discharge
B. distance from reservoir
C. sensitivity to nutrient enrichment—water clarity
D. sensitivity to growth of aquatic vegetation—observations
E. sensitivity to growth of aquatic vegetation—shading and sunlight in narrow backwaters and small coves
F. consistency with similar permits
I. local dispersion and mixing
J. impact on the main pool of the reservoir
K. existence of listed concern for nutrients or aquatic vegetation in the TCEQ's integrated report (§ 305(b))

The level of concern (low, moderate, or high) for each of these factors is described in the following sections.

A. SIZE OF DISCHARGE

The size of a discharge into or near a reservoir affects phosphorus loading and the concern for potential impacts, as indicated in the following table. A higher level of concern may be assigned to discharges into sensitive areas.

Level of Concern	Permitted Flow (MGD)
Low	< 0.25
Moderate	0.25 to < 1.0
High	≥ 1.0

B. DISTANCE FROM RESERVOIR

The level of concern is based on the size of the discharge and its distance from the normal operating pool of the reservoir.

Size of Discharge (MGD)	Level of Concern (stream miles)		
	Low	Moderate	High
< 0.25	> 3	3 to > 1	≤ 1
0.25 to < 1.0	> 7	7 to > 3	≤ 3
≥ 1.0*	> 15	15 to > 7	≤ 7

*** Very large discharges may be evaluated on a case-by-case basis.**

C. SENSITIVITY TO NUTRIENT ENRICHMENT – WATER CLARITY

Reservoirs with higher transparency allow more light to penetrate, which increases the tendency for algal growth. In addition, the aesthetic impact of phytoplankton algal blooms tends to be greater in reservoirs that generally have low turbidity. A qualitative screening approach is used when other data are not readily available. A quantitative screening approach that uses mean secchi depth as a measure of water clarity may be used if adequate secchi data are available.

Option 1: Qualitative analysis: Relative clarity is assessed using general observations and knowledge by individuals who are familiar with the reservoir or similar reservoirs in the area.

Level of Concern	Discharge Environment
Low	Turbid from suspended particles or color (tannins)
Moderate	Some visible turbidity but without heavy murkiness
High	A "clear water" reservoir with high transparency

Option 2: Quantitative analysis: Relative clarity is assessed using the mean of long-term secchi data (if available) in the main pool of the reservoir or at sampling sites near the proposed discharge. Levels of concern based on clarity are as follows:

Level of Concern	Secchi (m)*
Low	≤ 0.75
Moderate	0.76 to 1.27
High	≥ 1.28

***Secchi ranges for each impact level are derived by dividing the mean secchi values in Table F-1 of this document into thirds.**

D. Sensitivity to growth of aquatic vegetation—observations

When site-specific observations are available with respect to aquatic vegetation in areas of the water body with existing wastewater discharges, the applicable levels of concern are as follows:

Level of Concern	Observed Aquatic Vegetation
Low	Little attached, floating, or suspended aquatic vegetation
Moderate	Limited patches of attached, floating, or suspended vegetation
High	Heavy patches of vegetation in areas with nutrient input

E. Sensitivity to Growth of Aquatic Vegetation—Shading and Sunlight in Narrow Backwaters and Small Coves

The sensitivity of narrow backwaters and small coves to various kinds of aquatic vegetation can be affected by the extent to which sunlight reaches the water's surface. The amount of available sunlight is related to the amount of tree canopy cover during warm seasons.

Level of Concern	Canopy Cover and Shading During Warm Months
Low	Extensive canopy cover shades most of water surface
Moderate	Substantial canopy cover, but shading is only partial and not equivalent to "deep woods"
High	Canopy cover diffuses light to some extent, but substantial light reaches water surface

F. Consistency with other permits

An assessment is conducted to determine whether TP limits have been required for other wastewater permits with similar characteristics and locations in this area.

Level of Concern	TP Limits in Other Permits in the Area?
Low	Similar permits usually do not have effluent limits for TP
Moderate	There are some similar permits with TP limits, but applicability is site-specific and not "across-the-board"
High	Discharges with similar characteristics usually have a TP limit

G. LOCAL DISPERSION AND MIXING

The local impacts of a discharge to a reservoir depend greatly on the extent to which the discharge is dispersed and mixed at the discharge site. Both qualitative and quantitative options for this analysis are described below. The qualitative option is based on the general physical characteristics of the discharge site. The quantitative option uses either a completely-mixed model or a QUAL-TX stream model to determine the extent to which phosphorus concentrations are potentially elevated by the discharge (ΔTP).

Option 1: Qualitative analysis: Discharges to the main body of the reservoir or to large, deep open coves are of low potential concern with respect to dispersion and mixing. Discharges into smaller coves, shallow areas, inundated creeks, and canals are of moderate concern. Discharges are of high concern into narrow, slow moving areas of a reservoir, whether riverine transition zones or wetlands.

Level of Concern	Discharge Environment
Low	Large, open coves or main body of reservoirs
Moderate	Coves with restricted circulation
High	Narrow, backwater transition zones

Option 2: Quantitative analysis:

A: Discharges to the main body of the reservoir or to large deep open coves (relative to the size of the discharge) are assessed as having a low level of concern with respect to dispersion and mixing. For this scenario, the assessment is still qualitative, and no quantitative analysis is performed.

B: Discharges into coves with restricted circulation are evaluated to assess the projected increase in **local** TP concentration (ΔTP) that will be added by the discharge at permitted flow. A steady-state, completely-mixed model is used to determine ΔTP as described in the section entitled "Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria" on page 30.

Default cell size for the model is 10 acres, although smaller cell sizes may be used to address physical barriers at smaller distances. Surface area and average depth are determined from best available map information. Tributary inflows at 7Q2 are used in the calculation of detention time for the cell volume. (Note: if a completely-mixed, steady-state model for dissolved oxygen is also used at a site, the morphometry for the TP model will correspond to the DO model.)

C: Discharges into narrow, backwater transition zones that are within the normal operating pool of the reservoir are screened using the same QUAL-TX model that is used for dissolved oxygen (if available for that site). The QUAL-TX results are evaluated by assessing the instream proportion of effluent at a distance of 300 feet from the point where the discharge enters the transition zone within the normal operating pool.

The ΔTP is calculated by first either assuming an effluent concentration of 3.5 mg/L TP or by using effluent TP data (if available) and then multiplying the effluent TP by the instream proportion of effluent. For discharges that are greater than one stream mile from the normal operating pool, the loss of phosphorus over stream distance can be calculated as described in the section entitled "Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria" on page 30.

For discharges to restricted coves and backwater transition zones (cases B and C above), levels of concern for the predicted ΔTP are as follows:

Level of Concern	Predicted ΔTP (mg/L)
Low	< 0.05
Moderate	0.05 to < 0.25
High	≥ 0.25

H. IMPACT ON THE MAIN POOL OF THE RESERVOIR

Although this screening factor is not a local effect, it is useful for evaluating discharge impacts to reservoirs with no numeric nutrient criteria when:

- the reservoirs are larger than 100 surface acres; and
- there are major discharges that are large enough to potentially cause a significant change to phosphorus concentrations in the main pool of the reservoir.

A steady-state, completely-mixed model is used to determine ΔTP in the main pool, as described in the section entitled "Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria" on page 30. (Note that ΔTP is equal to TP_R, which is calculated in step 5 of the screening procedure.) Using the results of that modeling procedure, the following levels of concern are assigned to various predicted changes in TP concentration:

Level of Concern	Predicted ΔTP (mg/L)
Low	< 0.0001
Moderate	0.0001 to < 0.001
High	≥ 0.001

I. EXISTENCE OF LISTED CONCERN FOR NUTRIENTS OR AQUATIC VEGETATION IN THE TCEQ'S INTEGRATED REPORT (§ 305(B))

The latest TCEQ § 305(b) report (integrated report) is reviewed to see if the water body is listed as a concern for nutrients or aquatic vegetation.

Level of Concern	Listed as a Concern for Nutrients or Aquatic Vegetation in Integrated Report?
Low	No concern for nutrients or aquatic vegetation in latest integrated report.
Moderate	Concern for nutrients or aquatic vegetation in latest integrated report due to exceedance of the 85th percentile.
High	Concern for nutrients or aquatic vegetation in latest integrated report due to documented problem with one or both of these.

Assessing the Results of Site-Specific Screening Factors

Once the individual screening factors have been rated, they provide the basis for a "weight-of-evidence" assessment to identify the need for a nutrient effluent limit. An effluent limit for TP is probably needed when a substantial number of screening factors are rated moderate and high. If the overall assessment determines that the discharge is at a moderate level of concern, a limit might be indicated if one or more of the factors are particularly elevated. A monitoring requirement may be appropriate if a TP effluent limit is not required.

Alternatively, numeric values can be assigned to each level of concern (for example, Low=1, Moderate=3, High=5) and the values averaged. If the average is <2, a TP limit is probably not needed. If the average is > 4, a TP limit is probably needed. If the average is 2-4, either TP monitoring or a TP limit is possible depending on the specifics of the case. Note that the importance and weight of the individual screening factors can vary from one site to another.

If an effluent limit for TP is indicated, the screening factors and levels of concern are used to help determine the specific effluent limit for TP. Initial assessments can be improved and reconsidered in light of additional site-specific data and more extensive models and evaluations.

Example of local effects screening for a reservoir:
This example is a continuation of the scenario presented on page 34. An applicant proposes to locate a new 2.0 MGD discharge 3 miles upstream of Somerville Lake, Segment 1212, on South Yegua Creek. Would a TP limit likely be needed to address local effects in Somerville Lake?

A. Size of discharge: 2.0 MGD – high

B. Distance from reservoir: 3 miles – high

C. Sensitivity to nutrient enrichment – water clarity:
Option 1, qualitative analysis: Information unavailable
Option 2, quantitative analysis: Mean secchi (see Table F-1) = 0.68 m – low

D. Sensitivity to growth of aquatic vegetation – observations:
Small patches of floating algae mats were found along the shoreline and in the cove where South Yegua Creek enters Somerville Lake - moderate

E. Sensitivity to growth of aquatic vegetation – shading and sunlight in narrow backwaters and small coves: Based on aerial photos from August 2004, the backwater of South Yegua Creek has minimal canopy cover – high

F. Consistency with other permits: No other permits that discharge to Somerville Lake have TP limits – low

G. Local dispersion and mixing:
Option 1, qualitative analysis: Narrow, backwater transition zone – high
Option 2, quantitative analysis, case C: Model analysis not performed at this time.

H. Impact on main pool of the reservoir: N/A - evaluated separately using screening for reservoirs with numerical criteria.

I. Existence of concern for nutrients or aquatic vegetation on the 305(b) list: The South Yegua Creek arm of Somerville Lake is not listed in the 2008 305(b) report as a concern for water quality based on screening levels of nutrients or aquatic vegetation - low

Final assessment: The screening values ranked as low (4), moderate (1), and high (4), so the overall ranking is moderate (mean = 3.0). TP monitoring is already being included in the permit based on the previous screening for the entire reservoir. Based on the local effects screening, no additional limitations on TP would likely be recommended.

Nutrient Screening for Streams and Rivers

General Approach

To assess local effects in streams and rivers from discharges under the narrative nutrient provisions of the Standards, the TCEQ first evaluates the discharge using the general guidelines. If the general guidelines in this section indicate that a TP limit should be considered, then the TCEQ conducts a more comprehensive review using site-specific screening factors. Eutrophication potential is rated as a low, moderate, or high level of concern for each factor. Some screening factors can be rated on either qualitative or quantitative information, depending on data availability. Not every factor is always appropriate or definable at a particular site.

Applicability

These screening procedures are primarily intended for freshwater streams and rivers. Perennial impoundments greater than 10 surface acres along streams can be individually evaluated using screening factors for reservoirs, as described in previous sections.

If a stream or river changes characteristics downstream of the discharge such that eutrophication impacts might be greater in downstream areas, then screening procedures are also applicable to those downstream reaches. As a rough guide, nutrient screening procedures are typically applied for the following permitted discharge sizes within the following distance of the discharge point:

Permitted flow (MGD)	Evaluation Distance (stream miles)
< 0.25	< 3
0.25 to < 1.0	< 7
≥ 1.0*	< 15

*** Very large discharges may be evaluated on a case-by-case basis.**

General Guidelines for Assigning TP Limits

TP limits are potentially indicated in the following situations:

- for new or expanding discharges with permitted flow ≥ 0.25 MGD to perennial, shallow, relatively clear streams with rocky bottoms or other substrates that promote the growth of attached vegetation;

- for new or expanding discharges with permitted flow ≥ 0.25 MGD to streams with long, shallow, relatively clear perennial impoundments; and

- where explicitly required by watershed rules or other specific regulatory requirements.

Other situations where receiving streams appear to be especially sensitive to nutrient increases can also be considered. Smaller proposed discharges (such as those between 0.1 to 0.25 MGD) can also be of concern and will be evaluated for TP limits if the discharge location is into a sensitive area with very low dispersion/dilution.

Site-Specific Screening Factors

For cases where a limit on TP should be considered further, site-specific screening factors are applied to assess the potential need for a TP limit to control instream vegetation growth. These screening factors include the following:

A. size of discharge
B. instream dilution
C. sensitivity to growth of attached algae—type of bottom
D. sensitivity to growth of attached vegetation—depth
E. sensitivity to nutrient enrichment—water clarity
F. sensitivity to growth of aquatic vegetation—observations
G. sensitivity to growth of aquatic vegetation—shading and sunlight
H. streamflow sustainability
I. impoundments and pools
J. consistency with other permits
K. existence of listed concern for nutrients or aquatic vegetation in the TCEQ's integrated report (§ 305(b))

The level of concern (low, moderate, or high) for each of these factors is described in the following sections. Calculations are based on 7Q2 stream flows unless otherwise indicated.

A. SIZE OF DISCHARGE

The permitted size of the discharge affects the downstream extent of impact and the amount of nutrient loading to deeper, slower moving areas such as pools and small impoundments.

Level of Concern	Permitted Flow (MGD)
Low	< 0.25
Moderate	0.25 to < 1.0
High	≥ 1.0

B. INSTREAM DILUTION

The potential impact of nutrients from discharges to streams and rivers is substantially affected by the dilution and resulting instream concentration during dry-weather flows. The percent effluent instream at the discharge and at downstream points is calculated at permitted discharge flow and 7Q2 streamflow.

Level of Concern	Percent Effluent
Low	< 10
Moderate	10 to < 25
High	≥ 25

The percent of effluent instream can be obtained either from the effluent percentages calculated for critical conditions or from modeling results for dissolved oxygen.

C. SENSITIVITY TO GROWTH OF ATTACHED ALGAE – TYPE OF BOTTOM

In shallow, clear streams, the tendency for the stream to have nuisance levels of attached algae depends in part upon a stable stream bottom upon which attached algae may grow.

Level of Concern	Bottom Substrate
Low	Mud or sand
Moderate	Rocky cobble, gravel, usually with riffle areas
High	Larger rocks and boulders, rock slabs

D. SENSITIVITY TO GROWTH OF ATTACHED VEGETATION – DEPTH

The growth of attached vegetation tends to be facilitated by the extent of shallow areas. Levels of concern associated with the potential for eutrophication are as follows:

Level of Concern	Depth Characteristics
Low	Relatively steep banks and deep channels across stream
Moderate	Gently sloping sides with some shallow areas
High	Substantial shallow areas near banks and in stream channel

E. SENSITIVITY TO NUTRIENT ENRICHMENT—WATER CLARITY

Relative clarity is assessed using general observations and knowledge by individuals who are familiar with the stream or river.

Level of Concern	Discharge Environment
Low	Turbid from suspended particles or color (tannins), bottom may not be visible
Moderate	Some visible turbidity but without heavy murkiness, bottom sometimes visible
High	Relatively clear water, bottom usually visible

F. SENSITIVITY TO GROWTH OF AQUATIC VEGETATION—OBSERVATIONS

When site-specific observations are available with respect to aquatic vegetation in areas of the water body with existing wastewater discharges, the levels of concern for nutrient impacts are as follows:

Level of Concern	Observed Aquatic Vegetation
Low	Little attached, floating, or suspended aquatic vegetation
Moderate	Limited patches of attached, floating, or suspended vegetation
High	Heavy patches of vegetation in areas with nutrient input

G. SENSITIVITY TO GROWTH OF AQUATIC VEGETATION—SHADING AND SUNLIGHT

The sensitivity of streams to various kinds of aquatic vegetation can be affected by the extent to which sunlight can reach the water's surface. The amount of available sunlight is related to the amount of tree canopy cover during warm seasons.

Level of Concern	Canopy Cover and Shading During Warm Months
Low	Extensive canopy cover shades most of stream surface
Moderate	Substantial canopy cover, but shading is only partial and not equivalent to "deep woods"
High	Canopy cover diffuses light to some extent, but substantial light reaches stream surface

H. Streamflow Sustainability

Growth of aquatic vegetation and the potential impact of nutrients are enhanced by flow characteristics that sustain permanent aquatic environments.

Level of Concern	Stream Type
Low	Intermittent
Moderate	Intermittent with perennial pools
High	Perennial

I. Impoundments and Pools

Perennial impoundments that are greater than 10 surface acres can be individually evaluated with screening factors that are applied to reservoirs (see previous section that starts on page 38). The presence of smaller riverine impoundments and perennial pools can also increase the level of concern for eutrophication impacts.

Level of Concern	Extent of Pools and Impoundments
Low	No impoundments > 300 feet in length and no reach with extensive smaller pools
Moderate	No impoundments > 300 feet in length, but substantial smaller pools over > 20% of affected reach
High	At least one impoundment > 300 feet in length

J. Consistency with Other Permits

An assessment is conducted to determine whether TP limits have been required for other wastewater permits with similar characteristics and locations in this area.

Level of Concern	TP Limits in Other Permits in the Area?
Low	Similar permits usually do not have effluent limits for TP
Moderate	There are some similar permits with TP limits, but applicability is site-specific and not “across-the-board”
High	Discharges with similar characteristics usually have a TP limit

K. EXISTENCE OF LISTED CONCERN FOR NUTRIENTS OR AQUATIC VEGETATION IN THE TCEQ'S INTEGRATED REPORT (§ 305(B))

The latest TCEQ § 305(b) report ("integrated report") is reviewed to see if the water body is listed as a concern for nutrients or aquatic vegetation.

Level of Concern	Listed as a Concern for Nutrients or Aquatic Vegetation in Integrated Report?
Low	No concern for nutrients or aquatic vegetation in latest integrated report.
Moderate	Concern for nutrients or aquatic vegetation in latest integrated report due to exceedance of the 85th percentile.
High	Concern for nutrients or aquatic vegetation in latest integrated report due to documented problem with one or both of these.

Assessing the Results of Site-Specific Screening Factors

Once the individual screening factors have been rated, they provide the basis for a "weight-of-evidence" assessment to identify the need for a nutrient effluent limit. An effluent limit for TP is probably needed when a substantial number of screening factors are rated moderate and high. If the overall assessment determines that the discharge is at a moderate level of concern, a limit might be indicated if one or more of the factors was particularly elevated. A monitoring requirement may be appropriate if a TP effluent limit is not required.

Alternatively, numeric values can be assigned to each level of concern (for example, Low=1, Moderate=3, High=5) and the values averaged. If the average is <2, a TP limit is probably not needed. If the average is > 4, a TP limit is probably needed. If the average is 2-4, either TP monitoring or a TP limit is possible, depending on the specifics of the case. Note that the importance and weight of the individual screening factors can vary from one site to another.

If an effluent limit for TP is indicated, the screening factors and levels of concern are used to help determine the specific effluent limit for TP. Initial assessments can be improved and reconsidered in light of additional site-specific data, more extensive models, and evaluations.

Nutrient Screening for Estuaries

Limits for total phosphorus are generally not considered for discharges to tidal rivers or estuaries because vegetation growth in tidal waters is typically controlled by nitrogen rather than by phosphorus. At sensitive sites such as those with seagrasses nearby, limits on nutrients are considered for new or increased discharges.

Other Applicable Rules

In addition to effluent limits based on dissolved oxygen, bacteria, nutrients, and other appropriate criteria, the draft permit also includes all treatment requirements of applicable rules such as:

- 30 TAC Chapter 309—"Domestic Wastewater Effluent Limitation and Plant Siting"
- 30 TAC Chapter 311—"Watershed Protection"
- 30 TAC Chapter 213—"Edwards Aquifer"
- 30 TAC Chapter 319—"General Regulations Incorporated Into Permits."

These rules are available on the agency's Web site (www.tceq.state.tx.us); follow the link for "Rules."

Example of local effects screening for a river:
This example is a continuation of the scenario presented on page 34. An applicant proposes to locate a new 2.0 MGD discharge 3 miles upstream of Somerville Lake, Segment 1212, on South Yegua Creek. Assume South Yegua Creek is intermittent with perennial pools. Would a TP limit likely be needed to address local effects in the creek?

A. Size of discharge: 2.0 MGD – high

B. Instream dilution: South Yegua Creek is intermittent with perennial pools, so the percent effluent is 100% - high

C. Sensitivity to growth of attached algae – type of bottom: Mud or sand - low

D. Sensitivity to growth of attached vegetation – depth: The banks of South Yegua Creek are not steep in most areas; some shallow areas are present - moderate

E. Sensitivity to nutrient enrichment – water clarity: The water is brown in color and highly turbid, and the stream bottom is not visible - low

F. Sensitivity to growth of aquatic vegetation – observations: Patches of attached aquatic vegetation are growing in the shallow pool areas; however, such vegetation is absent in the deeper pool areas - moderate

G. Sensitivity to growth of aquatic vegetation – shading and sunlight: Based on aerial photos from August 2004, South Yegua Creek has minimal canopy cover - high

H. Streamflow sustainability: South Yegua Creek is intermittent with perennial pools - moderate

I. Impoundments and pools: South Yegua Creek is intermittent with perennial pools - moderate

J. Consistency with other permits: No other permits that discharge to tributaries of Segment 1212 have TP limits - low

K. Existence of concern for nutrients or aquatic vegetation on the 305(b) list: South Yegua Creek is not listed in the 2008 305(b) report as a concern for water quality based on screening levels of nutrients or aquatic vegetation - low

Final Assessment: The screening values ranked as low (4), moderate (4), and high (3), so the overall ranking is on the low side of moderate (mean = 2.8). TP monitoring is already being included in the permit based on the previous screening for the entire reservoir. Based on the local effects screening for South Yegua Creek, no additional limitations on TP would likely be recommended.

Antidegradation

Policy

The antidegradation policy and framework for the antidegradation implementation procedures are specified in section § 307.5 of the Standards. This chapter provides additional guidance for antidegradation implementation. The antidegradation policy affords three tiers of protection to the water in the state.

- The first level (Tier 1) stipulates that existing uses and water quality sufficient to protect existing uses will be maintained.

- The second level (Tier 2) stipulates that activities subject to regulatory action will not be allowed if they would cause degradation of waters that exceed fishable/swimmable quality. Exceptions to this stipulation can be made if it can be shown to the TCEQ's satisfaction that the lowering of water quality is necessary for important economic or social development.

- The third level (Tier 3) stipulates that the quality of outstanding national resource waters will be maintained and protected.

General Applicability

The antidegradation policy applies to actions regulated under state and federal authority that would increase pollution of water in the state. The antidegradation implementation procedures in this document apply to any increase in pollution authorized by TPDES wastewater discharge permits or by other state and federal permitting and regulatory activities.

Increases in pollution are determined by: (1) information on effluent characteristics that are provided in the application for the TPDES permit, the draft permit, and/or in other available sources; and (2) final effluent limits for flow, loading, and concentration in the previous permit compared with the proposed permit. Permits that are consistent with an approved WLE or TMDL under the antidegradation policy do not receive a separate antidegradation review for the applicable parameters unless the discharge may cause impacts on the receiving water that were not addressed by the WLE or TMDL.

Tier 1—Protecting Uses

Antidegradation reviews under Tier 1 ensure that existing water quality uses are not impaired by increases in pollution loading. Numerical and narrative criteria necessary to protect existing uses will be maintained. TPDES permit amendments or new permits that allow increased pollution loading are subject to review under Tier 1 of the antidegradation policy, and all pollution that could cause an impairment of existing uses is included in the evaluation.

Existing uses and criteria for unclassified waters are established as discussed in the section in this document entitled "Assigned Aquatic Life Uses" on page 16. Applicable uses, and the numerical and narrative criteria needed to support those uses, are established in the Standards. Uses that may be applicable to individual water bodies include:

- aquatic life categories
- primary and secondary contact recreation and noncontact recreation
- sustainable and incidental fisheries
- public drinking water supply
- aquifer protection
- oyster waters.

Additional uses may be applicable such as:

- navigation
- agricultural water supply
- industrial water supply
- seagrass propagation
- wetland water quality functions.

Numerical criteria may be applicable to individual water bodies:

- dissolved oxygen
- total dissolved solids
- sulfate
- chloride
- pH
- temperature
- bacterial indicators of recreational suitability
- nutrient indicators (chlorophyll *a*)
- toxic pollutants to protect aquatic life and human health.

Narrative criteria may be applicable to individual water bodies for:

- radioactive materials
- nutrients (phosphorus, nitrogen)
- temperature
- salinity

- dissolved oxygen necessary to protect aquatic life
- habitat necessary to protect aquatic life
- aquatic recreation
- toxic pollutants to protect aquatic life, human health, terrestrial wildlife, livestock, and domestic animals.

Narrative criteria may also apply for aesthetic parameters such as:

- taste and odor
- suspended solids
- turbidity
- foam and froth
- oil and grease.

The review of water quality impacts from a proposed permit action is conducted in accordance with the procedures established in other chapters of this document including "Determining Water Quality Uses and Criteria" on page 14, "Evaluating Impacts on Water Quality" on page 20, and "Toxic Pollutants" on page 130.

Protecting Impaired Waters under Tier 1

The procedures in this section address proposed wastewater discharges to water bodies listed on the Clean Water Act § 303(d) List as not meeting instream water quality standards. The procedures are intended to assist in establishing permit requirements until a TMDL is completed. Provisions in 40 CFR Parts 122, 123, 124, and 131 are also applicable.

Definitions

Listed water body refers to a portion of a water body that does not meet water quality standards and is listed in the current § 303(d) List. This portion of a water body is called an assessment unit (AU), and it is the smallest geographic area of a water body that is assessed.

Listed pollutant refers to a pollutant or pollutants that cause the failure of a listed water body to attain water quality standards. For a listing due to a failure to attain dissolved oxygen criteria, the pollutants of concern include oxygen-demanding organic substances and ammonia-nitrogen.

An existing or proposed discharge is considered to be a **discharge to a listed water body** if (1) the discharge is directly to a listed water body, or (2) the discharge is in close enough proximity to potentially impact the listed area.

General Provisions

Permits for discharges to listed water bodies will not allow:

- an increase in the loading of a listed pollutant that will cause or contribute to the violation of water quality standards; and

- other conditions that will cause or contribute to the violation of water quality standards.

Subsequent references to increased loadings of listed pollutants will also include consideration of other conditions that will cause or contribute to the violation of water quality standards.

Permit applications are reviewed by the TCEQ to identify discharges into the watersheds of listed AUs.

Applicability to Specific Parameters

Substances that Deplete Instream Dissolved Oxygen

Effluent limits will be established to avoid an increase in BOD loading (carbonaceous or nitrogenous) unless it is demonstrated that: (1) water quality standards for dissolved oxygen will be attained in the area affected by the discharge; or (2) the proposed discharge will not lower instream concentrations of dissolved oxygen in any areas that are not meeting dissolved oxygen standards. Evaluation and modeling of dissolved oxygen impacts are conducted as discussed in the chapter in this document entitled "Modeling Dissolved Oxygen" (see page 83).

Toxic Pollutants

Effluent limits will be established to avoid an increase in the permitted loading of a listed toxic pollutant unless: (1) it is demonstrated that water quality standards for the listed pollutant will be attained in the area affected by the discharge; or (2) water quality standards for the listed pollutant will be attained at the "end-of-pipe." Demonstrations of standards attainment may include instream monitoring of listed pollutants.

However, no increase in loading will be allowed: (1) for toxic pollutants listed for drinking water concerns; (2) for toxic pollutants that accumulate in bottom sediments, fish tissue, or deep layers of water (typically indicated by a bioconcentration factor (BCF) equal to or greater than 1,000); or (3) where fishing advisories are present.

Dissolved Salts—TDS, Chloride, Sulfate

Effluent limits will continue to be established as discussed in the chapter of this document entitled "Screening Procedures and Permit Limits for Total Dissolved Solids" (see page 174). The current procedures preclude additional TDS loadings when they would cause further increases in ambient TDS concentrations that are already at or above standards.

Bacteria

Effluent limits are established to avoid an increase in permitted loading unless: (1) it can be demonstrated that water quality standards for the listed pollutant will be attained in the area affected by the discharge, or (2) water quality standards for the listed pollutant will be attained at the "end-of-pipe."

Listings Based on Narrative Standards

A proposed increase in loading of a pollutant that would cause or contribute to the existing violation of water quality standards will not be allowed.

Procedures for Discharges to Listed Water Bodies

Requirements for discharges to listed water bodies apply to:

- discharges that are directly to a listed water body
- discharges to adjacent water bodies that are within a reasonable distance of and may affect a listed water body.

Application procedures, requirements for effluent screening by permittees, and review of the application for administrative completeness are the same as for discharges to unlisted water bodies. Effluent screening for permit applications is conducted in accordance with the sampling requirements in current application forms.

During review of permit applications, the TCEQ identifies discharges to listed water bodies and summarizes the listing in the modeling memo. For discharges that potentially increase the loading of a listed pollutant, the permit is developed in accordance with the requirements discussed beginning on page 57. The Wastewater Permitting Section will determine, when drafting the proposed permit, whether an increase in loading is anticipated.

Information on evaluating storm water discharges is contained in the section of this document entitled "Antidegradation Review of Storm Water Permits" on page 189.

Interim compliance periods and temporary variances will not allow an increase in loading of a listed pollutant that contributes to the violation of water quality standards.

For discharges that withdraw from and discharge to the same listed water body, an increase in permitted flow does not cause an "increase in loading" if it is demonstrated that the facility does not add listed pollutants to the discharge or cause other conditions that contribute to the violation of water quality standards.

Additional permit requirements will be imposed as necessary to address potential water quality impacts from listed pollutants.

The permit's fact sheet or statement of basis/technical summary (which is publicly available) notes that the discharge is to a listed water body and the reasons why the water body is listed.

Applicability of Pollution Reduction Programs

Pollution prevention programs of the TCEQ may focus on watersheds of listed water bodies where such programs can potentially reduce the loading of listed pollutants.

Additional pretreatment requirements may be considered for discharges from publicly owned treatment works to listed water bodies where industrial users of the wastewater system contribute listed pollutants.

Examples of Permitting to Listed Water Bodies

- A proposed discharge is projected to increase the concentration of a listed pollutant in the area of the water body that is not attaining standards for that pollutant. The additional loading will not be permitted.

- An increase in discharge flow is proposed, and the discharge contains significant concentrations of a listed pollutant (for example, a listed toxic pollutant is present at a concentration at or above the minimum analytical level—MAL). The additional flow may be permitted if permit limits are established that preclude an increase in loading of the listed pollutant by reducing its concentration.

- For some pollutants, additional loading will not adversely affect water quality if no instream dilution is allowed, so that standards are attained at the "end-of-pipe." This provision does not apply when a listed pollutant accumulates in bottom sediments, fish tissue, or deep layers of water. Such accumulation is typically indicated by a bioconcentration factor (BCF) equal to or greater than 1,000 or by an advisory for fish consumption.

- For discharges that withdraw from and discharge to the same listed water body, an increase in discharge flow can be allowed if it is demonstrated that the facility is simply "passing through" the pollutant of concern, so that it does not add more of the listed pollutant to the discharge effluent or cause other conditions that contribute to the violation of water quality standards.

- For discharges that are well upstream from a listed area, some pollutants, such as BOD, might be shown to completely dissipate by the time the discharge flow reaches the listed area.

Tier 2—Protecting High-Quality Waters

Applicability

Antidegradation reviews under Tier 2 ensure that where water quality exceeds the normal range of fishable/swimmable criteria, such water quality will be maintained unless lowering it is necessary for important economic or social development. The second tier of the antidegradation policy generally applies to water bodies that have existing, designated, or presumed uses of primary and secondary contact recreation and intermediate, high, or exceptional aquatic life waters. (Note that Tier 1 of the antidegradation policy applies to all water bodies, including those that are eligible for Tier 2 review.) TPDES permit amendments and new permits that allow an increase in loading are subject to review under Tier 2 of the antidegradation policy.

For Tier 2 reviews, the parameters of concern for individual water bodies may include:

- dissolved oxygen
- total dissolved solids
- sulfate
- chloride
- pH
- temperature
- toxic pollutants
- bacterial indicators of recreational suitability
- radioactive materials

- nutrients (phosphorus, nitrogen)
- taste and odor
- suspended solids
- turbidity
- foam and froth
- oil and grease
- any other constituents that could lower water quality.

Conditions that are usually not subject to an antidegradation review under Tier 2 include the following:

- Increases in pollutant loading at a specific discharge point that result from consolidating existing wastewater from other discharge points, so that overall loadings to a particular water body are not increased.

- A new or increased loading in an individual discharge that is either:

  - authorized in a waste load evaluation (WLE) or total maximum daily load (TMDL) that has been certified as an update to the Water Quality Management Plan (WQMP); or

  - authorized by a TPDES general permit,

  provided that a Tier 2 review was previously conducted on the WLE, TMDL, or general permit.

- A new or increased discharge authorized by a temporary or emergency order.

- New data on effluent composition indicates that a pollutant that was either (1) not previously tested for or (2) not previously detected above the agency-specified minimum analytical level (MAL) is now detected above the current MAL, and there is no proposal to increase the loading of the pollutant.

Evaluating the Potential for Degradation of Water Quality

The effect of a proposed discharge is compared to baseline water quality conditions in order to assess the potential for degradation of water quality. The applicable date for establishing baseline water quality conditions is November 28, 1975, in accordance with 40 CFR Part 131 (EPA standards regulation). Baseline conditions are estimated from existing conditions, as indicated by the latest edition of the Texas Water Quality Inventory or other available information, unless there is information indicating that degradation in ambient water quality has occurred in the receiving waters since November 28, 1975.

Analyses to assess the impact of a proposed discharge on water quality include procedures that are established in other chapters of this document, such as "Determining Water Quality Uses and Criteria" on page 14, "Evaluating Impacts on Water Quality" on page 20, and "Toxic Pollutants" on page 130.

Proposed increases in loading are initially screened to determine whether sufficient potential for degradation exists to require further analysis. This initial screening procedure does not define degradation. It is intended only as general guidance to indicate when an increase in loading is small enough to preclude the need for additional evaluation. The following guidelines are used for initial screening of existing and new discharges.

Existing Discharges

Increases in permitted loading of less than 10% over the loading allowed by the existing discharge permit are usually not considered to constitute potential degradation if: (1) the increase will attain all water quality standards, (2) the aquatic ecosystem in the area is not unusually sensitive to the pollutant of concern, and (3) the discharge is not relatively large.

The cumulative effect of repeated small increases in successive permit actions or from multiple discharges may require additional screening evaluation, even though the current permit application may be for a less than 10% increase in loading for any constituents of concern.

Increases in permitted loading of 10% or greater are not automatically presumed to constitute degradation, but will receive further evaluation.

New Discharges

New discharges that use less than 10% of the existing assimilative capacity of the water body at the edge of the mixing zone are usually not considered to constitute potential degradation as long as the aquatic ecosystem in the area is not unusually sensitive to the pollutant of concern. New discharges that use 10% or greater of the existing assimilative capacity are not automatically presumed to constitute potential degradation but will receive further evaluation. For constituents that have numerical criteria in the water quality standards, the following equation may be used to estimate changes in assimilative capacity:

$$\%\ change = \frac{100\,[C_P - C_A]}{C_C - C_A}$$

where: $\%\ change$ = the percent change to the assimilative capacity

C_P = the predicted concentration at the edge of the mixing zone

C_A = the ambient concentration at the edge of the mixing zone

C_C = the numerical criterion for the constituent of concern

This screening procedure is not applicable to dissolved oxygen, pH, or temperature. The screening procedure for nutrients is explained in a previous chapter of this document in the section entitled "Nutrients" beginning on page 26. Predicted concentrations at the edge of the mixing zone are calculated at applicable critical conditions using estimated effluent concentrations, which are based on available information, categorical limits, or other information. See the subsection of this document entitled "Procedure for Developing Permit Limits" on page 148 for more information on how the ambient concentration at the edge of the mixing zone is determined.

Additional Screening

If needed, additional screening is conducted to assess the potential for degradation. If proposed loadings exceed additional screening guidelines, then further evaluation is needed. The additional screening guidelines do not define degradation. The cumulative effect of repeated small increases in successive permit actions may require additional screening evaluation.

Examples Where Degradation Is Unlikely to Occur

The following examples are usually not considered to constitute degradation except where site-specific biological, chemical, or physical conditions in a water body create additional sensitivity or concern, or where background concentrations are adversely elevated:

- Increased **TSS** loading—if effluent concentrations are maintained at 20 mg/L or less.

- Increased **temperature** loading—if the "end-of-pipe" temperatures are not expected to be significantly higher than applicable instream temperature criteria.

- Increased loading of recreational indicator **bacteria**—if the applicable instream criteria are maintained in the effluent at the "end-of-pipe".

- Increased loading of **oxygen-demanding materials**—if the dissolved oxygen in the "sag zone" is lowered by less than 0.5 mg/L from baseline instream concentrations, and if the potentially affected aquatic organisms are not unusually sensitive to changes in dissolved oxygen.

- Increased loading of constituents that affect **pH**—if the instream criteria for pH in the nearest downstream segment are attained in the effluent at the "end-of-pipe".

- Increased loading of **TDS, chloride, or sulfate** in freshwater—if the instream criteria are attained in the effluent at the edge of the mixing zone at critical conditions.

- Increased loading of **total phosphorus, nitrate, or total nitrogen**—if it can be reasonably demonstrated that detrimental increases to the growth of algae or aquatic vegetation will not occur.

- Increased loading of **toxic pollutants** that are:
  - below concentrations that require an effluent limit based on water quality criteria or require monitoring and reporting as a permit condition.

  - not bioaccumulative (that is, the bioconcentration factor is less than 1,000).

  - not a potential cause of concern to a public drinking water supply.

  - not discharged in an area where there are aquatic organisms of unusual sensitivity to the specific toxicant of concern.

Examples Where Degradation Is Likely to Occur

The following examples are intended to provide general guidelines as to when degradation becomes likely. The examples do not define degradation, nor do they address all pollutants and situations that can cause degradation. Final determinations are case-specific and can depend on the characteristics of the water body and local aquatic communities. Lower increases in loading may constitute degradation in some circumstances, and higher loadings may not constitute degradation in other situations. Examples where degradation is likely to occur include:

- Increased loading of **oxygen-demanding substances** that is projected to decrease dissolved oxygen by more than 0.5 mg/L for a substantial distance in a water body that has exceptional quality aquatic life and a relatively unique and potentially sensitive community of aquatic organisms.

- Increased loading of **bioaccumulative pollutants** (that is, the bioconcentration factor is greater than 1,000) that use more than 10% of the assimilative capacity at the edge of the human health mixing zone, or a substantial increase in the loading of a toxic pollutant that would directly affect an important or unusually sensitive aquatic organism.

- Increased loading of **phosphorus and/or nitrogen** into a reservoir that supplies public drinking water, if the loading would result in significant elevations in algae or potentially detrimental aquatic vegetation over a substantial area.

- A new discharge that is made directly into a tidal wetland or estuary and that would be expected to detrimentally affect **emergent or submerged vegetation** over a substantial area.

- Increased loading of **TSS** that would produce a visible turbidity plume extending past the designated aquatic life mixing zone.

Evaluation of Alternatives and Economic Justification

When initial and additional screening under Tier 2 preliminarily indicates that the proposed discharge is expected to degrade water quality, then the applicant is notified so that the following information can be provided to TCEQ by the applicant:

- Any additional information about the nature of the discharge and the receiving waters that could affect the evaluation of whether degradation is expected.

- An analysis of alternatives to the proposed discharge that could eliminate or reduce the anticipated degradation, and an assessment of cost and feasibility for reasonable alternatives.

- An evaluation of whether the proposed discharge will provide important economic and social development in the area where the affected waters are located, considering factors such as:

  - Employment
  - Increased production that improves local economy
  - Improved community tax base
  - Housing
  - Correction of an environmental or public health problem.

Agency Review of Degradation

When degradation is anticipated, the TCEQ reviews the preliminary determination of potential degradation, the evaluation of alternatives, and economic and social justification. The TCEQ then determines whether a lowering of water quality is expected from the proposed discharge. If it is, the TCEQ then determines whether the lowering of water quality is necessary for important economic or social development and whether reasonable alternatives to the lowering of water quality are unavailable. The TCEQ may also refer questions concerning an antidegradation review to the State Office of Administrative Hearings for further review and consideration for an administrative hearing. Any proposed TPDES permit that allows degradation is subject to EPA review and approval.

Tier 3—Outstanding National Resource Waters

Outstanding national resource waters (ONRWs) are defined in § 307.5(b)(3) of the Standards as high-quality waters within or adjacent to national parks and wildlife refuges, state parks, wild and scenic rivers designated by law, and other designated areas of exceptional recreational or ecological significance. In accordance with § 307.5(b)(3) of the Standards, the quality of such waters will be maintained and protected. No increase in pollution that could cause degradation of water quality is allowed into ONRWs.

ONRWs are specifically designated in § 307.5 of the Standards. Any designation of an ONRW should include a geographic description of the ONRW and of the applicable watershed to which the restrictions on increased loadings apply. Currently there are no designated ONRWs in Texas.

Watershed Protection Rules

Additional protection of specific, sensitive watersheds is provided by requirements for wastewater discharge permits in 30 TAC Chapter 311. Requirements for discharges in specified watersheds can include phosphorus limits, advanced treatment of carbonaceous biochemical oxygen demand (CBOD) and ammonia-nitrogen, and prohibitions of discharge except by irrigation. Water bodies and their adjacent watersheds that are addressed in 30 TAC Chapter 311 include:

Segment	Water Body/Watershed	Subchapter of 30 TAC 311
0807	Lake Worth	G
0809	Eagle Mountain Reservoir	G
0811	Bridgeport Reservoir	G
0818	Cedar Creek Reservoir	G
0828	Lake Arlington	G
0830	Benbrook Lake	G
0836	Richland-Chambers Reservoir	G
1002	Lake Houston	D
1403	Lake Austin	A
1404	Lake Travis	A
1405	Marble Falls Lake	F
1406	Lake Lyndon B. Johnson	F
1407	Inks Lake	B
1408	Lake Buchanan	B
1427	Onion Creek	E
1428	Colorado River Below Town Lake/ Lady Bird Lake	E
1434	Colorado River Above La Grange (portion above City of Smithville)	E
2425	Clear Lake	C

In addition to the above rules, additional protection is provided to the recharge and contributing zones of the Edwards Aquifer in 30 TAC Chapter 213.

Public Notice

The Notice of Application and Preliminary Decision (public notice) concerning a proposed permit or permit amendment includes any preliminary additional uses assigned to unclassified receiving waters. If the proposed discharge is to a water body listed as impaired on the current § 303(d) List, this fact is noted in the permit's fact sheet, statement of basis/technical summary, or other publicly available information.

When the proposed permit affects receiving waters whose quality is exceptional, high, or intermediate, the public notice also indicates whether a lowering of water quality is anticipated. Information in the public notice about uses and antidegradation is indicated as preliminary and is subject to additional review and revision before approval of the permit by the TCEQ. A summary of anticipated impacts and the criteria for preliminary determinations of whether degradation will occur is publicly available in the permit file.

The public notice provides opportunity to comment and to submit additional information on the determination of existing uses and criteria, anticipated impacts of the discharge, baseline conditions, the necessity of the discharge for important economic or social development if degradation of water quality is expected under Tier 2, and any other applicable aspects of the antidegradation policy.

Mixing Zones and Critical Conditions

General Information

This chapter describes how the TCEQ assigns mixing zones (MZs) and zones of initial dilution (ZIDs) and determines their associated critical mixing conditions for discharges into different types of water bodies.

Mixing zones are defined in permits for:

- domestic discharges with a flow of 1 million gallons per day (MGD) or greater (or with numerical criteria and/or whole effluent toxicity tests specifically expressed as permit limitations).

- industrial discharges (excepting those that consist entirely of storm water runoff).

A mixing zone may not encompass an intake for a domestic drinking water supply that includes an organized treatment system as defined in 30 TAC Chapter 290—Public Drinking Water.

Thermal mixing zones and thermal impacts may be separately considered by the TCEQ in accordance with (1) the general criteria for temperature in the Texas Surface Water Quality Standards in § 307.4(f), or (2) provisions concerning thermal discharges in federal Clean Water Act § 316. Evaluations and permit conditions will ensure that temperature in the state shall be maintained so as to not interfere with the reasonable use of surface waters; or so as to assure the protection and propagation of balanced, indigenous populations of shellfish, fish, and wildlife.

Mixing Zones and ZIDs for Aquatic Life Protection

Mixing zone size and shape may be varied in individual permits to account for differences in:

- stream flow
- bay, estuary, and reservoir morphometry
- effluent flow
- stream geometry
- ecological sensitivity at the discharge site
- zone of passage concerns
- discharge structures

ZIDs are specified for different receiving water types in § 307.8(b)(2) of the Standards and are not usually specified in individual permits. Complete mixing of effluent and receiving waters is assumed at mixing zone boundaries unless available information shows otherwise.

Intermittent Streams and Ditches

No mixing zone is assigned to discharges to intermittent streams or ditches or to intermittent streams with perennial pools.

Perennial Streams, Ditches, and Rivers

Mixing zones for discharges into perennial streams, ditches, or rivers are expressed in the permit in terms of longitudinal stream distance. The typical mixing zone extends 300 feet downstream and 100 feet upstream from the discharge point. Mixing zones may not preclude passage of free swimming or drifting aquatic organisms to the extent that aquatic life use is significantly affected.

ZIDs may not exceed a size of 60 feet downstream and 20 feet upstream from the point of discharge and may not encompass more than 25% of the volume of the stream flow at or above the seven-day, two-year low-flow (7Q2). ZIDs cannot extend across perennial streams, ditches, or rivers or impair migration of aquatic organisms.

Lakes and Reservoirs

Mixing zones for discharges into lakes and reservoirs are normally expressed in the permit as a radius that extends over the receiving water in all directions from the point of discharge. The typical mixing zone radius is no greater than 100 feet but does not exceed one-half the width of the receiving water at the discharge point.

ZIDs may not exceed a 25-foot radius in all directions (or equivalent volume or area for discharges through diffuser systems) from the point of discharge and are normally assigned a value that is one-fourth the radius of the mixing zone. This is generally equivalent to 6.3% of the mixing zone surface area.

Bays, Estuaries, and Wide Tidal Rivers

Mixing zones for discharges into bays, estuaries, and wide tidal rivers (≥ 400 feet across) are expressed in the permit as a radius that extends over the receiving water in all directions. The typical mixing zone radius is no greater than 200 feet but does not exceed one-half the width of the receiving water at the discharge point.

ZIDs may not exceed a 50-foot radius in all directions (or equivalent volume or area for discharges through diffuser systems) from the point of discharge and are normally assigned a value that is one-fourth the radius of the mixing zone.

Narrow Tidal Rivers

Mixing zones and ZIDs for discharges into narrow tidal rivers depend on the availability and use of upstream flow data to calculate effluent percentages. If such flow information is available and used, the mixing zone and ZID are defined as for perennial streams, ditches, and rivers. If flow information is not available or not used, the mixing zone and ZID are defined as for bays, estuaries, and wide tidal rivers.

Wetlands and Sand or Mud Flats

Generally, no mixing zone is assigned to discharges to wetlands or to sand or mud flats. Discharges to permanently inundated wetlands may be assigned a mixing zone. The size of the mixing zone is evaluated on a case-by-case basis.

Critical Conditions for Aquatic Life Protection

Effluent concentration limits for specific toxic materials are calculated, using critical mixing conditions, to meet numerical standards for chronic toxicity at the edge of the mixing zone and numerical standards for acute toxicity at the edge of the ZID (see the section of this document entitled "Deriving Permit Limits for Aquatic Life Protection" on page 131). The effluent fraction at the edge of the mixing zone, when expressed as a percentage, is also referred to as the critical dilution, and is used as the primary concentration for whole effluent toxicity testing (see the subsection of this document entitled "Dilution Series, Dilution Water, and Type of WET Test" on page 110).

Intermittent Streams and Ditches

For discharges into intermittent streams or ditches with minimal aquatic life uses, acute toxic criteria apply at the point of discharge, and no dilution is assumed (that is, the critical dilution is 100%). If the discharge reaches a perennial water body within three miles, chronic toxic criteria apply at that perennial water body (see subsequent discussions. For discharges into intermittent streams or ditches with limited, intermediate, high, or exceptional aquatic life uses created by perennial pools, acute and chronic toxic criteria apply at the point of discharge, and no dilution is assumed (that is, the critical dilution is 100%).

Perennial Streams, Ditches, and Rivers

For discharges into perennial streams, ditches, and rivers, chronic toxic criteria apply at the edge of the mixing zone in the perennial water body using the effluent percentage that occurs at the 7Q2. For streams and rivers that are dominated by springflow, an alternative critical low-flow value may be calculated (see page 77).

$$\%\ effluent\ at\ edge\ of\ \ MZ = \frac{Q_E}{Q_E + 7Q2} \times 100\%$$

In addition, acute toxic criteria apply at the edge of the ZID in the perennial water body using the effluent percentage that occurs at the one-day, two-year low flow (1Q2), which is estimated as 25% of the 7Q2 (or 25% of the alternative critical low-flow value for streams and rivers that are dominated by springflow). The following equations are used to calculate the effluent percentages:

$$\%\ effluent\ at\ edge\ of\ \ ZID = \frac{Q_E}{Q_E + 0.25(7Q2)} \times 100\%$$

where: Q_E = effluent flow

For more information about what effluent flow is used in these equations, see the section of this document entitled “Deriving Permit Limits for Aquatic Life Protection” on page 131. For more information on how the 7Q2 is determined, see the section of this document entitled “Determining the 7Q2” on page 75.

Lakes, Reservoirs, Bays, Estuaries, and Wide Tidal Rivers

Critical conditions at mixing zone boundaries for discharges into lakes, reservoirs, bays, estuaries, and wide tidal rivers are estimated from appropriate models of discharge plume dispersion. To estimate the percent effluent, TCEQ uses the horizontal Jet Plume equation[5]:

$$\%\ effluent = \frac{2.8 \times D \times (3.14)^{1/2}}{R} \times 100\,\%$$

where: D = pipe diameter (ft) that corresponds to effluent flow (based on Manning's equation, but not less than 3 ft)

R = radius (ft) of mixing zone or ZID

Model results and empirical data indicate that the following initial assumptions are appropriate for discharges of less than or equal to 10 MGD:

- The percentage of effluent at the edge of the mixing zone is 15% for lakes and 8% for bays, estuaries, and wide tidal rivers.

- The percentage of effluent at the edge of the ZID is 60% for lakes and 30% for bays, estuaries, and wide tidal rivers.

These assumed critical dilutions are based on a pipe diameter of 3 feet and the standard mixing zone sizes of 100 feet (lakes and reservoirs) and 200 feet (bays, estuaries, and wide tidal rivers). If it is necessary to assign a smaller mixing zone or larger pipe size, these effluent percentages will increase. TCEQ staff assigns a critical dilution of 100% effluent for discharges equal to or greater than 100 MGD.

Data from appropriately performed effluent dispersion dye studies or effluent mixing models may be used to vary from the conservative initial dilution assumptions.

Narrow Tidal Rivers

Critical conditions at mixing zone boundaries for discharges into narrow tidal rivers (< 400 feet across) are calculated as for perennial streams and rivers if upstream flow data from USGS gages or other sources are available. The typical mixing zone extends 300 feet downstream and 100 feet upstream from the discharge point.

[5] The horizontal Jet Plume equation is based on Fischer, H.B., E.J. List, R.C.Y. Koh, J. Imberger, N.H. Brooks, 1979. *Mixing in Inland and Coastal Waters*. Chapter 9: Turbulent Jets and Plumes, p. 328.

In the absence of site-specific data such as dispersion dye studies or nearby flow measurements, minimum effluent percentages of 8% at the edge of the mixing zone and 30% at the edge of the ZID are assumed. Because mixing conditions in tidal rivers with upstream flow are not well understood, these minimum effluent percentages should provide narrow tidal rivers with the same level of protection given to bays, estuaries, and wide tidal rivers.

If upstream flow data from USGS gages or other sources is unavailable, the horizontal Jet Plume equation is used to calculate critical conditions. In these cases, the mixing zone radius is one-half the width of the narrow tidal river at the discharge point, and the critical dilutions are greater than 8% at the edge of the mixing zone and greater than 30% at the edge of the ZID. TCEQ staff may also consider tracer analyses, empirical data, or other models to determine site-specific instream dilution in narrow tidal rivers.

Wetlands and Sand or Mud Flats

For discharges into wetlands or sand or mud flats, very little mixing is likely to occur. Therefore, in the absence of site-specific data (such as dispersion dye studies), acute and chronic toxic criteria apply at the point of discharge, and no dilution is assumed (that is, the critical dilution is 100%).

Determining the 7Q2

The 7Q2 is defined in the Standards as “the lowest average stream flow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data.” Effluent limits in TPDES wastewater discharge permits are designed to maintain the applicable numerical water quality standards for the protection of aquatic life when instream flows are at or above the 7Q2.

Many of the numerical water quality standards, as established in the Standards, do not apply when stream flow conditions are less than “critical low-flow conditions.” Generally, critical low-flow conditions are determined as the 7Q2. The following criteria apply at and above the 7Q2:

- numerical criteria for dissolved oxygen
- numerical criteria for temperature and pH
- numerical criteria for *E. coli*, Enterococci, and fecal coliform
- numerical criteria to protect aquatic life from acute toxicity (apply at and above ¼ of the 7Q2)

- numerical criteria to protect aquatic life from chronic toxicity

- requirements to preclude chronic toxicity in whole effluent toxicity testing

For purposes of water quality regulation, the 7Q2 is calculated from approximately 30 years of flow data at USGS or International and Boundary Water Commission (IBWC) gages. A shorter period of record is used if the longer period of record is unavailable or inappropriate. If a major, permanent hydrologic alteration has occurred, such as upstream reservoir construction, then only the flows recorded after the alteration are used in the 7Q2 calculation. Gage data is also examined for trends and the period of record may be adjusted if a trend is identified.

Appendix C of this document lists 7Q2s for classified segments (see page 217), but the 7Q2 is usually recalculated annually to incorporate new flow data. Values in Appendix C should be verified with the Water Quality Assessment Section to ensure they have not changed since the last date of publication of this document.

If less than five years of continuous daily average flow data is available, the tenth percentile flow is normally used as an estimate of the 7Q2. Otherwise, the following procedure is used in a FORTRAN program to calculate the 7Q2 using daily average flow data from a gage:

1. Determine the minimum seven-day average flow for each year of data.

2. Rank the minimum seven-day average flows from lowest to highest.

3. Calculate the recurrence interval for each minimum seven-day average flow. If N is the total number of years of flow data, then the recurrence interval is (N+1)/rank.

4. The 7Q2 is the minimum seven-day average flow with a recurrence interval of 2. If an even number of years is used, interpolate the 7Q2.

In the absence of USGS or IBWC flow data, other sources of flow information may be used to estimate the 7Q2. These sources include self-reporting data from upstream dischargers, Surface Water Quality Monitoring (SWQM) stations (including Clean Rivers Program targeted monitoring), or other data sources as available. Estimates of the 7Q2 using this kind of data are generally based on the 10th percentile of the available flow data or on comparisons with a nearby USGS or IBWC gage.

In the absence of flow data, a drainage area ratio is used to estimate the 7Q2. The drainage area above the point of discharge or point of interest is determined, a nearby gage is selected for the comparison, and based on work done by the USGS[6], the following equation is used to estimate the 7Q2:

$$7Q2_d = 7Q2_g \times \left[\frac{DA_d}{DA_g} \right]^{0.89}$$

where: $7Q2_d$ = 7Q2 just above the discharge point or point of interest
DA_d = drainage area above the discharge point or point of interest
$7Q2_g$ = 7Q2 of the gage
DA_g = drainage area above the gage

Determining Critical Low-Flows for Streams and Rivers that are Dominated by Springflow

Streams and rivers that are dominated by springflow typically have 7Q2s that correspond to a much higher percentile of the flow data than streams and rivers that are not dominated by springflow. For example, the 7Q2 of a stream or river that is not dominated by springflow tends to be about a 10th percentile; the 7Q2 of a stream or river that is dominated by spring flow tends to be a 20th percentile or greater. In addition, it is not unusual for spring-fed streams to contain federally listed endangered or threatened species.

In order to avoid providing less protection to spring-fed systems than is afforded to other streams and rivers, the TCEQ employs the following statistical approaches, using all available flow data, to derive the critical low-flow for spring-fed streams and rivers:

- for spring-fed streams that contain federally-listed endangered or threatened species (as listed in Appendix B of this document), the critical low-flow will be the 0.1 percentile of the lognormal fit to the flow data. Where determined to be appropriate, for spring-fed streams that contain state-listed endangered or threatened species, the critical low-flow will be the 0.1 percentile of the lognormal fit to the flow data.

[6] Asquith, William H.; Roussel, Meghan C.; Vrabel, Joseph. 2006. Statewide Analysis of the Drainage-Area Ratio Method for 34 Streamflow Percentile Ranges in Texas. United States Geological Survey Scientific Investigations Report 2006-5286.

- for spring-fed streams that do not contain federally-listed endangered or threatened species (as listed in Appendix B of this document), or state-listed endangered or threatened species, the critical low-flow will be the 5th percentile of the flow data.

Mixing Zones and Critical Conditions for Human Health Protection

Intermittent Streams and Ditches

No human health mixing zone is applied to discharges to intermittent streams with no significant aquatic life uses, since human health toxic criteria do not apply. If the effluent reaches perennial waters or an intermittent stream with perennial pools within three miles of the discharge point, human health criteria apply at those waters.

Intermittent Streams with Perennial Pools

Human health mixing zones for discharges into intermittent streams with perennial pools typically extend 300 feet downstream and 100 feet upstream from the discharge point. Human health criteria apply at the edge of the human health mixing zone using the effluent percentage that occurs at the harmonic mean flow. The equation under "Perennial Streams, Ditches, and Rivers" is used to calculate the human health effluent percentage.

Perennial Streams, Ditches, and Rivers

Human health mixing zones for discharges into perennial streams, ditches, or rivers typically extend 300 feet downstream and 100 feet upstream from the discharge point. Human health criteria apply at the edge of the human health mixing zone using the effluent percentage that occurs at the harmonic mean flow. The following equation is used to calculate the human health effluent percentage:

$$\%\ effluent\ at\ edge\ of\ \ HH\ \ MZ = \frac{Q_E}{Q_E + HM} \times 100\%$$

where: Q_E = effluent flow
HM = harmonic mean flow

For more information on what effluent flow is used in this equation, see the section of this document entitled "Deriving Permit Limits for Human Health Protection" on page 140. For more information on how the harmonic mean flow is determined, see the section of this document entitled "Determining the Harmonic Mean Flow" on page 80.

Lakes, Reservoirs, Bays, Estuaries, and Wide Tidal Rivers

The typical human health mixing zone radius for lakes and reservoirs extends no greater than 200 feet in all directions over the receiving water from the point of discharge. The typical human health mixing zone radius for bays, estuaries, and wide tidal rivers extends no greater than 400 feet in all directions over the receiving water from the point of discharge.

Critical conditions at human health mixing zone boundaries for discharges into lakes, reservoirs, bays, estuaries, and wide tidal rivers are estimated from appropriate models of discharge plume dispersion. To estimate the effluent percentage, TCEQ uses the horizontal Jet Plume equation[7]:

$$\%\ effluent = \frac{2.8 \times D \times (3.14)^{1/2}}{R} \times 100\,\%$$

where: D = pipe diameter (ft) that corresponds to effluent flow (based on Manning's equation, but not less than 3 ft)

R = radius (ft) of human health mixing zone

Model results and empirical data indicate that the following initial assumptions are appropriate for discharges of less than or equal to 10 MGD:

- The percentage of effluent at the edge of the human health mixing zone is 8% for lakes and reservoirs.
- The percentage of effluent at the edge of the human health mixing zone is 4% for bays, estuaries, and wide tidal rivers.

These assumed effluent percentages are based on a pipe diameter of 3 feet and the standard human health mixing zone sizes of 200 feet (lakes and reservoirs) and 400 feet (bays, estuaries, and wide tidal rivers). If it is necessary to assign a smaller mixing zone or a larger pipe size, these effluent percentages will increase. TCEQ staff assigns an effluent percentage of 100% for discharges equal to or greater than 100 MGD.

Data from appropriately performed effluent dispersion dye studies or effluent mixing models may be used to vary from the conservative initial dilution assumptions.

[7] The horizontal Jet Plume equation is based on Fischer, H.B., E.J. List, R.C.Y. Koh, J. Imberger, N.H. Brooks, 1979. *Mixing in Inland and Coastal Waters*. Chapter 9: Turbulent Jets and Plumes, p. 328.

Narrow Tidal Rivers

In narrow tidal rivers, the critical conditions for human health protection are calculated as for perennial streams and rivers if upstream flow data from USGS or IBWC gages or other sources are available. In this case, the human health mixing zone typically extends 300 feet downstream and 100 feet upstream from the discharge point.

In the absence of site-specific data such as dispersion dye studies or nearby flow measurements, a minimum effluent percentage of 4% at the edge of the human health mixing zone is assumed. Because mixing conditions in tidal rivers with upstream flow are not well understood, this minimum effluent percentage should provide narrow tidal rivers with the same level of protection given to bays, estuaries, and wide tidal rivers.

If upstream flow data from USGS or IBWC gages or other sources is unavailable, the horizontal Jet Plume equation is used to calculate the effluent percentage. In these cases, the mixing zone radius is equal to the width of the river at the discharge point, and the effluent percentage is greater than 4% at the edge of the human health mixing zone.

More protective human health critical conditions may be used where bioaccumulative or persistent pollutants are a concern. TCEQ staff may also consider tracer analyses, empirical data, or other models to determine site-specific instream dilution in narrow tidal rivers.

Wetlands and Sand or Mud Flats

Generally, no human health mixing zone is assigned to discharges to wetlands or sand or mud flats. Discharges to permanently inundated wetlands may be assigned a human health mixing zone whose size is evaluated on a case-by-case basis. Very little mixing is likely to occur in a wetland or on a sand or mud flat, so in the absence of site-specific data (such as dispersion dye studies), human health criteria apply at the point of discharge, and no dilution is assumed (that is, the effluent percentage is 100%).

Determining the Harmonic Mean Flow

The harmonic mean flow is defined in the Standards as “a measure of mean flow in a water course which is calculated by summing the reciprocals of the individual flow measurements, dividing this sum by the number of measurements, and then calculating the reciprocal of the resulting number.” Harmonic mean flows are usually, but not always, greater than 7Q2s. Effluent limits in TPDES wastewater discharge permits are designed to maintain the applicable numerical water quality standards as long-term averages for the protection of human health.

For purposes of water quality regulation, the harmonic mean flow is calculated from approximately 30 years of flow data at USGS or IBWC gages. A shorter period of record is used if the longer period of record is unavailable or inappropriate. If a major, permanent hydrologic alteration has occurred, such as upstream reservoir construction, then only the flows recorded after the alteration are used in the harmonic mean calculation. Gage data is also examined for trends, and the period of record may be adjusted if a trend is identified.

Harmonic mean flows for designated stream segments are listed in Appendix C of this document, but the harmonic mean flow is usually recalculated annually to incorporate new flow data. Values in Appendix C should be verified with the Water Quality Assessment Section to ensure they have not changed since the last date of publication of this document.

The following equation is used to calculate the harmonic mean flow for any set of flow data:

$$HM = \left[\frac{\sum_{i=1}^{N_T - N_0} \frac{1}{Q_i}}{N_T - N_0} \right]^{-1} \times \left[\frac{N_T - N_0}{N_T} \right]$$

where:

HM = harmonic mean flow
Q_i = nonzero flow
N_T = total number of flow values
N_0 = number of zero flow values

In order to calculate effluent limits based on water quality criteria for human health protection, a harmonic mean flow is determined for all perennial streams and for streams that are intermittent with perennial pools.

Sometimes these streams have days on which measured flow is zero. Because a zero flow cannot be used in the calculation of harmonic mean flow, the second term in the harmonic mean equation is an adjustment factor used to lower the harmonic mean to compensate for days when the flow was zero. This is the same correction used by the EPA computer program DFLOW. (Note that if there are no days on which the flow was zero, the adjustment term is equal to unity.)

In the absence of USGS or IBWC flow data, other sources of flow information may be used to estimate the harmonic mean. These sources include self-reporting data from upstream dischargers, Surface Water Quality Monitoring stations (including Clean Rivers Program targeted monitoring), or other data sources as available. Estimates of the harmonic

mean using this kind of data are generally based on the harmonic mean of the available flow data or on comparisons with a nearby USGS or IBWC gage.

In the absence of flow data, a drainage area ratio is used to estimate the harmonic mean flow. The drainage area above the point of discharge or point of interest is determined, a nearby gage is selected for the comparison, and based on work done by the USGS[8], the following equation is used to estimate the harmonic mean flow:

$$HM_d = HM_g \times \left[\frac{DA_d}{DA_g} \right]^{0.89}$$

where: HM_d = harmonic mean flow just above the discharge point or point of interest

DA_d = drainage area above the discharge point or point of interest

HM_g = harmonic mean flow of the gage

DA_g = drainage area above the gage

Diffusers

Diffusers installed at the end of discharge pipes may increase mixing and lower critical dilutions. The model most commonly used to design diffusers and evaluate the resulting mixing conditions is CORMIX. Mixing is evaluated under both summer and winter temperature conditions and at different combinations of effluent and receiving water densities. The highest effluent percentages at the edge of the mixing zone and ZID are used to determine water quality-based effluent limits for the protection of aquatic life. The highest effluent percentage at the edge of the human health mixing zone is used to determine water quality-based effluent limits for the protection of human health.

[8] Asquith, William H.; Roussel, Meghan C.; Vrabel, Joseph. 2006. Statewide Analysis of the Drainage-Area Ratio Method for 34 Streamflow Percentile Ranges in Texas. United States Geological Survey Scientific Investigations Report 2006-5286.

Modeling Dissolved Oxygen

General Information

Numerical criteria for dissolved oxygen correspond to specific aquatic life use categories as specified in Table 1 on page 16 of this document. All classified water bodies have numerical dissolved oxygen criteria specified in the Standards. All unclassified water bodies have either assigned or presumed uses, depending on data availability. In cases where data indicate the appropriate use is lower than the presumption, the appropriate use has to be adopted as part of the Standards before it can be used to set permit limits.

All TPDES applications for facilities that may decrease a water body's dissolved oxygen are evaluated to determine what effluent limits are needed to maintain appropriate dissolved oxygen levels. Numerical models or other techniques are used to develop permit limits for oxygen-demanding constituents, in order to ensure the attainment of numerical criteria for dissolved oxygen.

Model Selection and Inputs

Model selection depends on factors such as:

- the type of water body to be analyzed
- the type and quantity of available site-specific information
- the location of the discharge point
- the availability of previously developed models.

If available, waste load evaluations (WLEs), total maximum daily loads (TMDLs), or models calibrated to site-specific information are used to generate permit limits. In the absence of these, simplified screening level methods are used. These methods can be used with little site-specific information, but substituting site-specific values for default parameters is encouraged when available. The 24-hour mean dissolved oxygen is the principal criterion of concern in these analyses. Effects on dissolved oxygen due to the presence of aquatic plants are usually not considered.

Additional scrutiny is given to applications for discharges that enter water bodies with impaired dissolved oxygen levels. Impaired water bodies are listed on the state's Clean Water Act Section § 303(d) List. The § 303(d) List is developed by the Surface Water Quality Monitoring Program in cooperation with the TMDL Program.

Screening Level Methods

Nontidal Streams and Rivers

To evaluate discharges into nontidal streams and rivers without specific WLEs, TMDLs, or other calibrated models, the TCEQ uses uncalibrated steady-state models. The preferred model for these analyses is QUAL-TX. Other public domain models may also be used. Using this approach, effluent limits may be derived for the following parameters: biochemical oxygen demand (BOD) or carbonaceous biochemical oxygen demand (CBOD), ammonia-nitrogen (NH_3-N), and dissolved oxygen (DO).

Apart from discharge flow and quality, the most important model inputs for this approach can be categorized as follows:

- stream hydraulic characterization
- chemical kinetic rates
- reaeration rates
- critical conditions
- background water quality

Many of these parameters are stipulated in a modeling memorandum of agreement (MOA) between the TCEQ and the EPA (see page 99). The following paragraphs describe these model inputs in more detail.

Stream Hydraulic Characterization

Site-specific hydraulic information is used if it is available and of acceptable quality. In the absence of site-specific hydraulic information, generalized hydraulic equations are adopted for the model analysis. The TCEQ has developed these equations using data collected during studies performed throughout the state, and the coefficients represent the median values from those data.

Chemical Kinetic Rates

The most important kinetic rates for dissolved oxygen analysis are: aerobic CBOD decay rate (K_d), ammonia-nitrogen oxidation rate (K_n), and sediment oxygen demand (SOD). A statistical analysis of rates used in previous calibrated and approved WLE models was performed to arrive at representative default rates. Normality tests performed on these data sets indicate that they are approximately lognormally distributed. The data used in the statistical analysis were taken from approximately 1,300 calibrated model reaches from water bodies throughout the state. For uncalibrated QUAL-TX modeling, the median value for K_d and K_n is normally used. For SOD, a value equivalent to approximately the 75th percentile is used. These values are:

- K_d of 0.10/day
- K_n of 0.30/day
- SOD of 0.35 g/m^2-day.

These rates are expressed at a standard temperature of 20ºC and are corrected to the temperature or temperatures used in the modeling analysis.

Reaeration Rates

Reaeration rates account for the oxygen exchange between the atmosphere and the water body. Typically, an equation relating stream hydraulic properties to reaeration rate is used to estimate this parameter. The preferred equation for use in dissolved oxygen models of streams and rivers is the Texas Equation:

$$K_2\,(\text{at } 20°\text{C}) = \frac{1.923V^{0.273}}{D^{0.894}}$$

where: K_2 = reaeration rate (day^{-1})
V = average stream velocity (m/s)
D = average stream depth (m)

This equation was derived from regression of measured reaeration and hydraulic data collected throughout the state and is considered to be adequate for most Texas streams. The Texas Equation can be reliably applied to streams with depths between 0.2 and 1.0 meters coupled with velocities between 0.01 and 0.30 m/s. In specific cases where stream depth or velocity falls outside these ranges, other reaeration equations may be used. K_2 is limited to a maximum value of 10/day at 20ºC, and the minimum value for this parameter is not allowed to go below the value calculated from the following equation:

$$K_{2\,\min}\,(\text{at } 20°\text{C}) = \frac{0.6}{D}$$

where: $K_{2\min}$ = minimum allowable reaeration rate (day^{-1})
D = average stream depth (m)

Critical Conditions

Critical conditions are those combinations of environmental conditions and wastewater inputs that typically result in the lowest dissolved oxygen levels in a water body. Critical conditions are defined by three primary parameters: ambient flow, wastewater flow, and ambient water temperature.

- Simplified modeling of streams and rivers is performed using low **ambient flow** values—either the seven-day, two-year low-flow (7Q2) or flows specified in Table 4 (see page 90) or Tables 4a-4e (see pages 96-99), as appropriate. If base flow information is not available to estimate the 7Q2, then a value of 0.1 ft^3/s is usually assumed for perennial streams, and a value of 0.0 ft^3/s is used for intermittent streams. For perennial streams, 7Q2 flows may also be estimated using a proportional watershed approach or similar technique. Tenth percentile stream flows may be used to develop seasonal permit limits if measured flow data is readily available. For more information on the flows in Table 4, see the section of this chapter entitled "Critical Low-Flow Values for East and South Texas Streams" on page 88. For more information on the flows in Tables 4a-4e, see the section of this chapter entitled "Regression Equation for Establishing Critical Low-Flows in Specific Water Bodies in the Cypress Creek Basin" on page 92.

- For renewal applications, the **wastewater flow** used in the model is the existing permitted average flow or flows of the facility as reflected in the current permit. For new or amendment applications, the wastewater flow used in the model is the proposed average flow or flows.

- Model analyses for effluent limits are usually performed with summer **temperatures**. The temperature is normally assumed to be 30.5ºC unless critical low-flows reliably occur only at other temperatures. Alternative critical temperatures can be used if justifiable based on analysis of measured temperatures.

  For the development of seasonal permit limits, the following temperatures/derivation methodologies are used:

  - *Non-Summer Months*: The ninetieth percentile temperature for each month is used to assess compliance with general dissolved oxygen criteria.

- *Summer Season (three hottest months)*: The mean of the average monthly temperatures for each of the three hottest months of the year plus the average of the standard deviations for these months is used to assess compliance with general dissolved oxygen criteria.

- *Spawning Season*: A temperature of 22.8°C is used to assess compliance with spawning season DO criteria contained in Table 1 of this document. Monthly average temperatures are used to determine months when spawning criteria apply. Compliance with the general dissolved oxygen criteria during the spawning month(s) is evaluated using appropriate ninetieth percentile temperature(s).

Ninetieth percentile temperatures are developed from data measured on the stream under evaluation if possible. In the absence of these data or if the amount of data is insufficient, the estimated ninetieth percentile values from data measured at USGS or IBWC gaging station(s) from similar water bodies are used.

Background Water Quality

Simplified modeling normally employs assumptions for background water quality. These assumptions include an ultimate BOD concentration of 3 mg/L, an ammonia-nitrogen concentration of 0.05 mg/L, and a dissolved oxygen value equivalent to approximately 80% saturation at the model temperature. Alternatively, other values may be used based on analysis of measured data.

Tidal Water Bodies, Ponds, and Lakes

Tidal Water Bodies

Tidal streams or rivers may be evaluated using an uncalibrated QUAL-TX model or other suitable technique. Bays can be evaluated using previously developed calibrated models, judicious use of a CSTR (continuously stirred tank reactor) model, or best professional judgment. Near-field dilution models may be used to provide supplementary information.

Ponds

Small impoundments such as ponds may be evaluated using a CSTR model or other suitable technique.

Lakes and Reservoirs

Due to the highly variable nature of potential discharge locations in large lakes and reservoirs, no single screening level modeling technique is

satisfactory for evaluating these discharges. Therefore, the evaluation method employed by TCEQ staff comprises a variety of techniques. While it is desirable to use mathematical models to determine treatment requirements, in some cases an appropriate model cannot be feasibly developed due to the lack of crucial site-specific information or to the large amount of time needed to develop a model. The following factors are considered in the review of these discharges:

- the size and quality of the proposed discharge;
- its proximity to other dischargers;
- the location of the outfall relative to areas that are likely to be highly limiting (such as small coves, flooded creek channels, or other areas with restricted interaction and water exchange with the main body of the reservoir); and
- suitability of analyzing the discharge using a predictive analytical tool.

Direct discharges to relatively open waters can be evaluated using previously developed calibrated models, judicious use of a CSTR model, or best professional judgment. Near-field dilution models may be used to provide supplementary information. Analyses of discharges to lakes and reservoirs are performed using dimensions that would be present at normal pool elevation.

Tributaries of Lakes and Reservoirs

Discharges to tributaries of lakes and reservoirs are generally evaluated with a model or series of models. An uncalibrated QUAL-TX model is normally used to evaluate streams and rivers upstream of the normal pool elevation of the reservoir. However, other suitable models may also be used. If the model predicts that there would be significant levels of oxygen-demanding pollutants remaining in the stream as it enters the impoundment, then some portion of the impoundment is evaluated. Discharges into small coves may be modeled using a CSTR model or other suitable technique.

Critical Low-Flow Values for East and South Texas Streams

As specified in § 307.7(b)(3)(A)(ii) of the Standards, streams with limited, intermediate, high, or exceptional aquatic life uses and those listed in Appendix A or D of the Standards in the eastern and southern portions of the state may be evaluated for 24-hour dissolved oxygen attainment at stream flows greater than 7Q2 flows as presented in Table 4 on page 90. Flows in Table 4 apply in the months April through October.

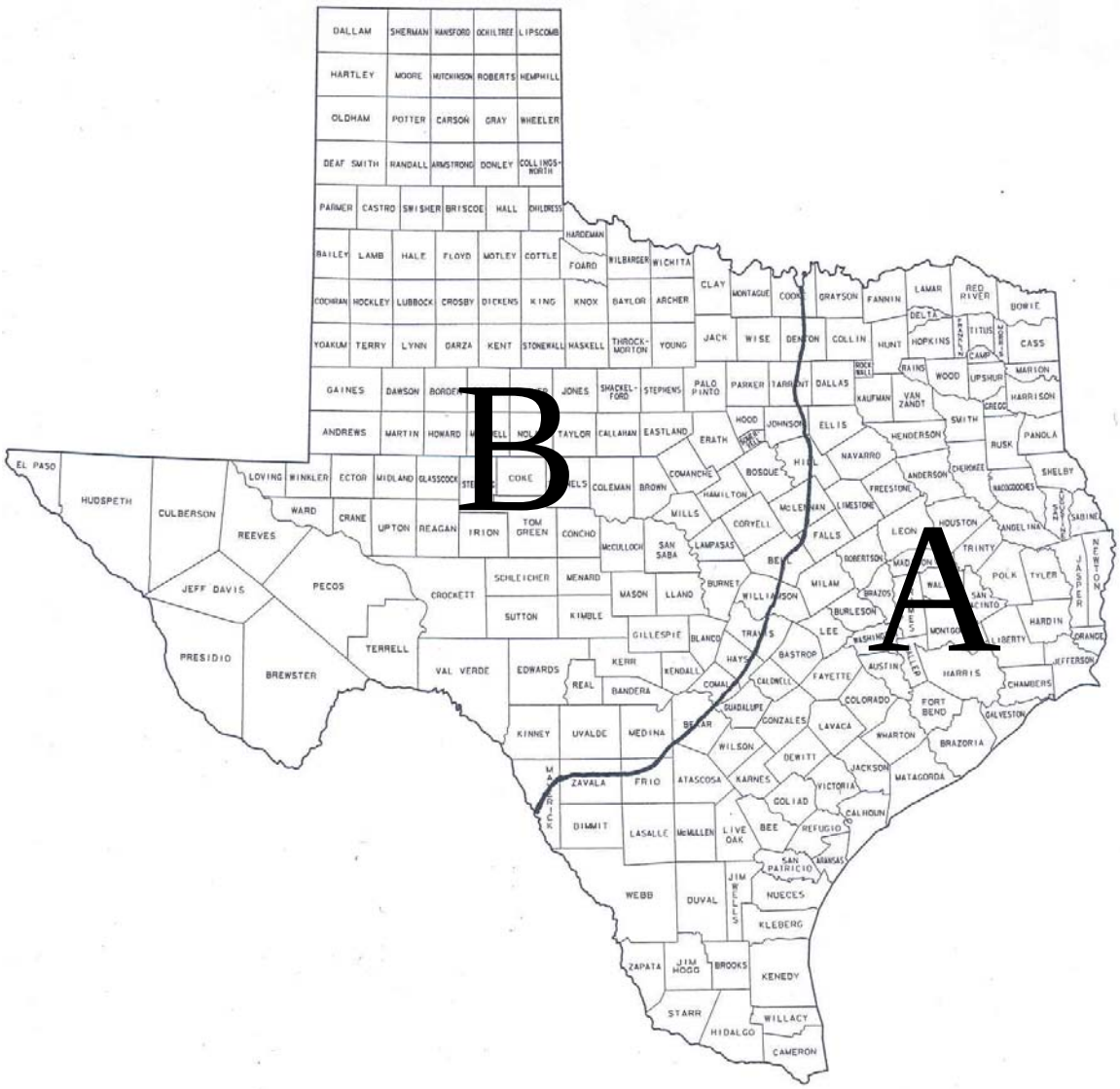

Figure 3. Headwater flows for streams in area "A" may be adjusted based on Table 4

Table 4. Critical Low-Flow Values for Dissolved Oxygen for East and South Texas

Bedslope (m/km)	Critical Low-Flow (ft^3/s)			
	DO[a] = 6.0 mg/L	5.0 mg/L	4.0 mg/L	3.0 mg/L
0.1	— [b]	18.3	3.0	0.5
0.2	— [b]	7.7	1.3	0.2
0.3	28.6	4.7	0.8	0.1
0.4	20.0	3.3	0.5	0.1
0.5	15.2	2.5	0.4	0.1
0.6	12.1	2.0	0.3	0.1
0.7	10.0	1.6	0.3	0.0
0.8	8.4	1.4	0.2	0.0
0.9	7.3	1.2	0.2	0.0
1.0	6.4	1.0	0.2	0.0
1.1	5.7	0.9	0.2	0.0
1.2	5.1	0.8	0.1	0.0
1.3	4.6	0.8	0.1	0.0
1.4	4.2	0.7	0.1	0.0
1.5	3.9	0.6	0.1	0.0
1.6	3.6	0.6	0.1	0.0
1.7	3.3	0.5	0.1	0.0
1.8	3.1	0.5	0.1	0.0
2.1	2.5	0.4	0.1	0.0
2.4	2.2	0.4	0.1	0.0

Note: Flows in this table apply only to the months April through October.

[a] Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

[b] Flows are beyond the observed data used in the regression equation.

Example: If the bedslope of the stream is 1.1 m/km, and the DO criterion is 5.0 mg/L, then the critical low-flow value is 0.9 ft^3/s.

The critical low-flows in Table 4 apply to streams that occur in the portion of the state east of a line defined by Interstate Highway 35 and 35W from the Red River to the community of Moore in Frio County, and by U.S. Highway 57 from the community of Moore to the Rio Grande (area "A" in Figure 3 on page 89). The flows shown in Table 4 may be used to evaluate summertime 24-hour dissolved oxygen criteria (see Table 1 on page 16) for a presumed, designated, or assigned aquatic life use. Certain water bodies in the Cypress Creek Basin should be evaluated using the procedures in the section of this document entitled "Regression Equation for Establishing Critical Low-Flows for Specific Water Bodies in the Cypress Creek Basin" on page 92.

Regression Equation Relating Dissolved Oxygen, Flow, and Bedslope

The flow values in Table 4 were derived from a multiple regression equation using data collected from the TCEQ's study of least impacted streams (Texas Aquatic Ecoregion Project). Results of this study indicate a strong dependent relationship for average summertime dissolved oxygen concentrations and several hydrologic and physical stream characteristics—particularly stream flow and bedslope (stream gradient).

Stream flows and average dissolved oxygen concentrations were measured during steady-state conditions, and bedslopes were estimated from 1:24,000 scale USGS topographic maps. Approximately 72% of the variation in observed average dissolved oxygen concentrations in these minimally impacted streams is explained by the following regression equation:

$$DO = 7.088 + 0.551\ln(Q + 0.01) + 0.686\ln(Bd) - k$$

where:

DO = dissolved oxygen (mg/L)

Q = flow (ft^3/s)

Bd = bedslope (m/km)

k = 1.61 (constant for 50th percentile of tree canopy cover)

The coefficient of determination (r^2) for this equation, adjusted for degrees of freedom, is 0.72 ($p < 0.0001$). This equation may be used to calculate headwater flows for bedslopes within the range of 0.1 m/km to 2.4 m/km. For streams that have bedslopes greater than 2.4 m/km, a bedslope of 2.4 m/km will be used. For streams that have bedslopes less than 0.1 m/km, a bedslope of 0.1 m/km will be used. The headwater flows are calculated for dissolved oxygen concentrations of 0.5 mg/L greater than the criteria obtained from Table 1.

Calculating Bedslope

Bedslopes are calculated from USGS 1:24,000 scale topographic maps for the portion of stream from the first contour line crossing the stream greater than one-half mile upstream of the point of discharge to the first contour line crossing the stream downstream beyond the estimated distance of discharge impact. The actual stream bedslope is calculated using the following equation:

$$Bd = \frac{(E_u - E_d)}{D}$$

where:

Bd =	bedslope (m/km)
E_u =	upstream elevation (m)
E_d =	downstream elevation (m)
D =	linear distance along the streambed between the two elevation contours (km)

(Note: the elevations and linear distance in the formula can be calculated in feet and then multiplied by 1,000 to convert to meters per kilometer.)

Guidelines for Adjusting the Regression Equation

The critical low-flows in Table 4 may be adjusted based on site-specific data. The following guidelines should be followed in order to apply site-specific changes to the regression equation used to calculate the Table 4 flows:

- Collect data on streams in areas that are unaffected by other point source discharges. Data can be collected upstream of a discharger's outfall as long as it is outside the mixing zone **or** on an adjacent stream with similar hydrology, drainage basin size, land use, habitat availability, and canopy cover.

- Collect data during all seasons for at least one year.

- Site-specific flow, temperature, or hydraulic conditions that affect dissolved oxygen can also be used to adjust critical low-flows.

- Site-specific changes in critical low-flows will have to be reviewed and approved by the TCEQ.

- EPA will review any site-specific, critical low-flows that could affect permits or other regulatory actions that are subject to EPA approval.

Regression Equation for Establishing Critical Low-Flows in Specific Water Bodies in the Cypress Creek Basin

DO criteria for the following water bodies are based on a regression equation that relates dissolved oxygen, temperature, flow, and watershed size:

- Segments 0406, 0407, 0409, and 0410 as specified in § 307.10, Appendix A, of the Standards.

- Harrison Bayou (in Segment 0401) and Black Cypress Bayou (Creek) upstream of Segment 0410 as specified in § 307.10, Appendix D, of the Standards.

Data to define the DO relationship with these physical and chemical characteristics were collected in the watershed of Black Cypress Bayou (Creek) from 1998 to 2005. About 95% of the variation in observed 24-hour average DO concentrations can be explained by the regression equation.[9] The procedures in this section should be used for these water bodies in lieu of the more general East Texas procedures discussed in the preceding sections.

The critical low-flows for the applicable instream DO concentrations (1.5 mg/L – 5 mg/L) in Tables 4a-4e (see pages 96-99) were derived in order to develop effluent limits that will meet the 24-hour DO criteria. Each table applies at the appropriate critical temperature for each water body. The flows in Tables 4a-4e are based on the following equation:

$$DO = 12.61 - 0.309T + 1.05\log(Q) - 1.02\log(WS)$$

where:

DO = dissolved oxygen criterion + 0.5 (mg/L)

T = temperature (˚C)

Q = flow (ft^3/s)

WS = watershed size (km^2)

This equation may be used directly to calculate headwater flows for watershed sizes that fall between those included in the table. The equation and tables are applicable for watershed sizes within the range of 50 km^2 to 1000 km^2. For sites that have watershed sizes greater than 1000 km^2, a watershed size of 1000 km^2 will be used. For sites that have watershed sizes less than 50 km^2, a watershed size of 50 km^2 will be used. The headwater flows are calculated for DO concentrations of 0.5 mg/L greater

[9] Crowe, Arthur L. and Charles W. Bayer. "A Biological, Physical, and Chemical Survey of a Least-Impacted Watershed : Black Cypress Bayou (Creek), Texas, 1998-2005, AS-197. Texas Commission on Environmental Quality, November 2005 (revised March 2008).

than the calculated criteria. The maximum flow measured during the study was 1,140 ft^3/s; this is also the maximum flow to be used in DO modeling.

Water Bodies with a Dissolved Oxygen Impairment

More comprehensive approaches to setting effluent limits based on water quality criteria are necessary when water bodies receiving the discharge are included on the § 303(d) List as having dissolved oxygen concentrations lower than the criterion. When evaluating discharges to water bodies with existing WLEs or TMDLs, effluent limits are based on the WLE or TMDL model, or report as applicable. WLEs assess the effects of point source waste loading on dissolved oxygen concentrations. TMDLs typically are comprehensive analyses that include both point and nonpoint sources of oxygen-demanding pollutants.

All water bodies contained on the § 303(d) List will be considered for TMDL development. Reviews of TPDES applications received before TMDL development may be conducted with the screening level methodologies discussed previously (see page 84).

For applications that are proposing a new or increased load of oxygen-demanding constituents into the watershed of water bodies on the § 303(d) list for depressed DO, the potential of the additional loading to negatively affect the listed portion of the water body is assessed. If the new or increased flow and resulting loadings of oxygen-demanding substances will cause or further contribute to the depressed DO conditions in the impaired water body, the discharge will not be allowed.

Table 4a. Critical Low-Flow Values for Dissolved Oxygen for Harrison Bayou, in Segment 0401.

Drainage Area (km^2)	Critical Low-Flow (ft^3/s)				
	DO[a] = 5.0 mg/L	4.0 mg/L	3.0 mg/L	2.0 mg/L	1.5 mg/L
50	273	31	3.4	0.38	0.13
100	536	60	6.7	0.74	0.25
150	795	89	9.9	1.1	0.37
200	1051	117	13	1.5	0.49
250	1140[b]	146	16	1.8	0.61
300	1140[b]	174	19	2.2	0.72
350	1140[b]	202	23	2.5	0.84
400	1140[b]	230	26	2.9	0.96
450	1140[b]	258	29	3.2	1.1
500	1140[b]	286	32	3.6	1.2
550	1140[b]	313	35	3.9	1.3
600	1140[b]	341	38	4.2	1.4
650	1140[b]	369	41	4.6	1.5
700	1140[b]	396	44	4.9	1.6
750	1140[b]	424	47	5.3	1.8
800	1140[b]	451	50	5.6	1.9
850	1140[b]	478	53	6.0	2.0
900	1140[b]	506	56	6.3	2.1
950	1140[b]	533	59	6.6	2.2
1000	1140[b]	560	63	7.0	2.3

Note: Flows in this table apply at the critical summer temperature of 27.3˚C for Harrison Bayou.

[a] Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

[b] Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft^3/s).

Example: If the drainage area of the stream is 550 km^2, then the following headwater flows are included in the model to meet the corresponding DO criteria:

1140 ft^3/s to meet 5 mg/L DO,
313 ft^3/s to meet 4 mg/l DO,
35 ft^3/s to meet 3 mg/L DO,
3.9 ft^3/s to meet 2 mg/L DO, and
1.3 ft^3/s to meet 1.5 mg/L DO.

Table 4b. Critical Low-Flow Values for Dissolved Oxygen for Black Bayou, Segment 0406.

Drainage Area (km^2)	Critical Low-Flow (ft^3/s)				
	DO[a] = 5.0 mg/L	4.0 mg/L	3.0 mg/L	2.0 mg/L	1.5 mg/L
50	223	25	2.8	0.31	0.10
100	437	49	5.4	0.61	0.20
150	649	72	8.1	0.90	0.30
200	858	96	11	1.2	0.40
250	1065	119	13	1.5	0.49
300	1140[b]	142	16	1.8	0.59
350	1140[b]	165	18	2.1	0.69
400	1140[b]	188	21	2.3	0.78
450	1140[b]	210	23	2.6	0.88
500	1140[b]	233	26	2.9	0.97
550	1140[b]	256	29	3.2	1.1
600	1140[b]	278	31	3.5	1.2
650	1140[b]	301	34	3.7	1.3
700	1140[b]	323	36	4.0	1.3
750	1140[b]	346	39	4.3	1.4
800	1140[b]	368	41	4.6	1.5
850	1140[b]	390	44	4.9	1.6
900	1140[b]	413	46	5.1	1.7
950	1140[b]	435	49	5.4	1.8
1000	1140[b]	457	51	5.7	1.9

Note: Flows in this table apply at the critical summer temperature of 27.0˚C for Segment 0406.

[a] Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

[b] Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft^3/s).

Example: If the drainage area of the stream is 550 km^2, then the following headwater flows are included in the model to meet the corresponding DO criteria:

1140 ft^3/s to meet 5 mg/L DO,
256 ft^3/s to meet 4 mg/l DO,
29 ft^3/s to meet 3 mg/L DO,
3.2 ft^3/s to meet 2 mg/L DO, and
1.1 ft^3/s to meet 1.5 mg/L DO.

Table 4c. Critical Low-Flow Values for Dissolved Oxygen for James Bayou, Segment 0407.

Drainage Area (km^2)	Critical Low-Flow (ft^3/s)				
	DO[a] = 5.0 mg/L	4.0 mg/L	3.0 mg/L	2.0 mg/L	1.5 mg/L
50	470	52	5.9	0.65	0.22
100	922	103	11	1.3	0.43
150	1140[b]	153	17	1.9	0.63
200	1140[b]	202	23	2.5	0.84
250	1140[b]	251	28	3.1	1.0
300	1140[b]	299	33	3.7	1.2
350	1140[b]	347	39	4.3	1.4
400	1140[b]	395	44	4.9	1.6
450	1140[b]	443	49	5.5	1.8
500	1140[b]	491	55	6.1	2.0
550	1140[b]	539	60	6.7	2.2
600	1140[b]	586	65	7.3	2.4
650	1140[b]	634	71	7.9	2.6
700	1140[b]	681	76	8.5	2.8
750	1140[b]	728	81	9.1	3.0
800	1140[b]	775	87	9.7	3.2
850	1140[b]	823	92	10	3.4
900	1140[b]	869	97	11	3.6
950	1140[b]	916	102	11	3.8
1000	1140[b]	963	107	12	4.0

Note: Flows in this table apply at the critical summer temperature of 28.1˚C for Segment 0407.

[a] Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

[b] Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft^3/s).

Example: If the drainage area of the stream is 550 km^2, then the following headwater flows are included in the model to meet the corresponding DO criteria:

1140 ft^3/s to meet 5 mg/L DO,
539 ft^3/s to meet 4 mg/l DO,
60 ft^3/s to meet 3 mg/L DO,
6.7 ft^3/s to meet 2 mg/L DO, and
2.2 ft^3/s to meet 1.5 mg/L DO.

Table 4d. Critical Low-Flow Values for Dissolved Oxygen for Little Cypress Creek (Bayou), Segment 0409.

Drainage Area (km^2)	Critical Low-Flow (ft^3/s)				
	DO[a] = 5.0 mg/L	4.0 mg/L	3.0 mg/L	2.0 mg/L	1.5 mg/L
50	617	69	7.7	0.86	0.29
100	1140[b]	135	15	1.7	0.56
150	1140[b]	200	22	2.5	0.83
200	1140[b]	265	30	3.3	1.1
250	1140[b]	329	37	4.1	1.4
300	1140[b]	392	44	4.9	1.6
350	1140[b]	456	51	5.7	1.9
400	1140[b]	519	58	6.5	2.2
450	1140[b]	581	65	7.2	2.4
500	1140[b]	644	72	8.0	2.7
550	1140[b]	707	79	8.8	2.9
600	1140[b]	769	86	9.6	3.2
650	1140[b]	831	93	10	3.5
700	1140[b]	893	100	11	3.7
750	1140[b]	955	107	12	4.0
800	1140[b]	1017	113	13	4.2
850	1140[b]	1079	120	13	4.5
900	1140[b]	1140	127	14	4.7
950	1140[b]	1140[b]	134	15	5.0
1000	1140[b]	1140[b]	141	16	5.3

Note: Flows in this table apply at the critical summer temperature of 28.5˚C for Segment 0409.

[a] Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

[b] Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft^3/s).

Example: If the drainage area of the stream is 550 km^2, then the following headwater flows are included in the model to meet the corresponding DO criteria:

1140 ft^3/s to meet 5 mg/L DO,
707 ft^3/s to meet 4 mg/l DO,
79 ft^3/s to meet 3 mg/L DO,
8.8 ft^3/s to meet 2 mg/L DO, and
2.9 ft^3/s to meet 1.5 mg/L DO.

Table 4e. Critical Low-Flow Values for Dissolved Oxygen for Black Cypress Bayou (Creek), Segment 0410 and Black Cypress Bayou (Creek) upstream of Segment 0410.

Drainage Area (km^2)	Critical Low-Flow (ft^3/s)				
	DO[a] = 5.0 mg/L	4.0 mg/L	3.0 mg/L	2.0 mg/L	1.5 mg/L
50	503	56	6.3	0.70	0.23
100	986	110	12	1.4	0.46
150	1140[b]	163	18	2.0	0.68
200	1140[b]	216	24	2.7	0.90
250	1140[b]	268	30	3.3	1.1
300	1140[b]	320	36	4.0	1.3
350	1140[b]	372	41	4.6	1.5
400	1140[b]	423	47	5.3	1.8
450	1140[b]	475	53	5.9	2.0
500	1140[b]	526	59	6.5	2.2
550	1140[b]	577	64	7.2	2.4
600	1140[b]	628	70	7.8	2.6
650	1140[b]	678	76	8.4	2.8
700	1140[b]	729	81	9.1	3.0
750	1140[b]	779	87	9.7	3.2
800	1140[b]	830	93	10	3.5
850	1140[b]	880	98	11	3.7
900	1140[b]	930	104	12	3.9
950	1140[b]	981	109	12	4.1
1000	1140[b]	1031	115	13	4.3

Note: Flows in this table apply at the critical summer temperature of 28.2˚C for Segment 0410.

[a] Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

[b] Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft^3/s).

Example: If the drainage area of the stream is 550 km^2, then the following headwater flows are included in the model to meet the corresponding DO criteria:

1140 ft^3/s to meet 5 mg/L DO,
577 ft^3/s to meet 4 mg/l DO,
64 ft^3/s to meet 3 mg/L DO,
7.2 ft^3/s to meet 2 mg/L DO, and
2.4 ft^3/s to meet 1.5 mg/L DO.

Memorandum of Agreement
between the
Texas Natural Resource Conservation Commission
and the
Environmental Protection Agency - Region 6

for

Application of Uncalibrated Water Quality Modeling
for
Texas Freshwater Streams

The purpose of this Memorandum of Agreement (MOA) is to streamline the processes associated with the review and approval of individual permit waste load allocations (WLAs), water quality management plans (WQMPs), and Texas Pollutant Discharge Elimination System (TPDES) permits while assuring technical acceptability and consistency with the Clean Water Act (CWA).

The Environmental Protection Agency (EPA), Region 6, Water Quality Protection Division and the Texas Natural Resource Conservation Commission (TNRCC), Office of Permitting, Remediation & Registration agree to the following provisions:

1. WLAs for facilities included in a WQMP update with discharge flows less than or equal to 0.2 million gallons per day (MGD), which are developed using uncalibrated QUAL-TX modeling, where appropriate, with the reaction rates outlined below in Number 2, will be considered technically acceptable without EPA Region 6 review. The EPA Region 6 may review these WLAs during the semi-annual evaluations for the Section 106 State Water Pollution Control Program Grant.

2. The TNRCC will use the following reaction rates (expressed at 20ºC) when performing uncalibrated QUAL-TX modeling in freshwater streams:

   a. CBOD decay rate: $K_d = 0.10$/day; and
      CBOD settling rate: $K_s = 0.0$ m/day

   b. Ammonia-Nitrogen oxidation rate: $K_n = 0.30$/day

   c. Sediment Oxygen Demand: SOD = 0.35 g/m^2/day

   d. Reaeration Rate: K_2 will be calculated from equations contained in "<u>Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition)</u> June 1985, EPA/600/3-85/040." The equation(s) will be chosen consistent with the hydraulic character of the stream and the following minimum and maximum constraints will apply; $0.6/\text{depth(m)} \leq K_2 \leq 10$/day.

3. The level of algae specified in the model will be set to zero except in cases where site-specific measurements demonstrate appropriate minimum levels.

4. This agreement does not apply to WLAs for dischargers in the following segments: 1001, 1005, 1006, 1007, 2426, 2427, 2428, 2429, 2430 and 2436.

5. Treatment limits developed from calibrated models and those contained in approved Waste Load Evaluations and Total Daily Maximum Load (TMDL) reports or implementation plans will supersede those derived from this methodology.

6. All remaining WLAs (>0.2 MGD) will be submitted for EPA technical review and approval. The EPA will provide a response to these submittals to the TNRCC within 30 days of receipt of modeling documentation. If a response is not received within 30 days, the WLA will be considered approved as submitted and TPDES permits can be issued without a formal approval on these WLAs from the EPA.

7. The EPA Region 6 will approve WQMP updates for WLAs prepared in accordance with this MOA after the WQMP updates have undergone public participation in accordance with 40 Code of Federal Regulations 25 and are certified by the TNRCC.

8. This MOA may be revised upon mutual consent of the TNRCC and the EPA.

9. The provisions of this MOA will apply to all domestic TPDES applications that are administratively complete on or after the effective date of the "*Procedures to Implement the Texas Surface Water Quality Standards*" which incorporates these modeling parameters. Prior to this date, the EPA will conditionally or fully approve WLAs submitted that were developed with the existing TNRCC Streeter-Phelps modeling protocols unless pollutants in the effluent from those facilities could cause or contribute to pollutants of concern on 303(d) listed streams.

We agree with the provisions outlined in this MOA and commit our agency to implement them in a spirit of cooperation and mutual support.

Sam Becker, Acting Director
Water Quality Protection Division
Environmental Protection Agency, Region 6

4/04/01
Date

Leigh Ing, Deputy Director
Office of Permitting, Remediation & Registration
Texas Natural Resource Conservation Commission

3/22/01
Date

Whole Effluent Toxicity Testing (Biomonitoring)

Applicability

Whole effluent toxicity (WET) testing, also known as biomonitoring, is required in permits for dischargers whose effluent has a significant potential to exert toxicity in the receiving water (*See* § 307.6(e)(2)(A) of the Standards). WET testing directly measures a discharge's aggregate toxic effect by exposing surrogate sensitive test species to effluent at the critical dilution of the receiving water. Thus, it is an integral tool in the assessment of water quality for the protection of aquatic life and part of EPA's integrated strategy that includes the use of three control approaches (the other two being chemical-specific limits and biological criteria).

Domestic Dischargers

The TCEQ requires WET testing of domestic wastewater dischargers that have **either or both** of the following conditions:

- classification as an EPA major domestic discharger (a design flow of 1 MGD or greater or an interim or final phase design flow of 1 MGD or greater); or
- any individual WWTP with an approved pretreatment program with significant industrial users discharging into its collection system.

Permittees with more than one flow phase in their permit begin WET testing upon expansion to 1 MGD or greater.

Industrial Dischargers

The TCEQ requires WET testing of industrial dischargers that have **any** of the following conditions:

- classification as an EPA major industrial discharger;
- a continuous discharge of process treated wastewater; or
- a discharge with the potential to exert toxicity in the receiving water.

Although the TCEQ generally does not require WET testing of EPA-classified minor industrial dischargers, the TCEQ may require WET testing of such discharges in any of the following situations:

- the permittee applies water treatment chemicals or biocides;

- the TCEQ determines that the effluent has the potential to exert toxicity in the receiving water; or

- the permit requires effluent limits based on aquatic life water quality criteria because the effluent analysis exceeds the screening criteria.

Chapter Outline

The rest of this chapter covers the following topics:

- **types of WET tests** (chronic and 48-hour acute—page 104; 24-hour acute—page 118)

- **test acceptability criteria** (chronic and 48-hour acute—page 105; 24-hour acute—page 119)

- **statistical interpretation of test results** (chronic and 48-hour acute only—page 107)

- **test frequencies** (chronic and 48-hour acute—page 108; 24-hour acute—page 119)

- **dilution series, dilution water, and type of WET tests**—page 110

- **reasonable potential determination** (chronic and 48-hour acute only—page 113)

- **toxicity reduction evaluations** (chronic and 48-hour acute—page 115; 24-hour acute—page 121)

- **toxicity control measures** (chronic and 48-hour acute—page 116; 24-hour acute—page 122)

- **toxicity caused by some specific pollutants**—dissolved salts (page 122), ammonia (page 128), and Diazinon (page 129).

Chronic and 48-Hour Acute Tests

The TCEQ may require permittees to conduct 7-day chronic or 48-hour acute WET tests to measure compliance with the requirements of § 307.6(e) of the Standards. Toxicity in these tests is defined as a statistically significant difference (usually at the 95% confidence level) between the survival, reproduction, or growth of the test organisms at a specified effluent dilution (the critical dilution) compared to the survival, reproduction, or growth of the test organisms in the control (0% effluent).

Test Types

The permit will specify that tests be conducted using the latest version of the appropriate EPA method. These methods can be found in the following publications (or their most recent versions):

- *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition*, EPA-821-R-02-013, October 2002.

- *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition*, EPA-821-R-02-014, October 2002.

- *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition*, EPA-821-R-02-012, October 2002.

In addition, information on interpreting non-monotonic test results and percent minimum significant difference (PMSD) values can be found in the following publications:

- *Understanding and Accounting for Method Variability in Whole Effluent Toxicity Applications Under the National Pollutant Discharge Elimination System Program*, EPA 833-R-00-003, June 2000.

- *Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing (40 CFR Part 136)*, EPA 821-R-B-00-004, July 2000.

The permittee must use a revised promulgated method if one becomes available during the term of the permit. Alternate test methods are subject to EPA review and approval. Depending on the type of receiving water, the permit will specify chronic or 48-hour acute tests to assess toxicity to freshwater or saltwater organisms. The test organisms used for each type of test are listed below.

FRESHWATER STREAMS AND LAKES (SALINITY < 2 PPT)

CHRONIC 3-brood *Ceriodaphnia dubia* (water flea) survival and reproduction test

7-day *Pimephales promelas* (fathead minnow) larval survival and growth test

ACUTE 48-hour *Daphnia pulex* or *Ceriodaphnia dubia* (water fleas) survival test

48-hour *Pimephales promelas* (fathead minnow) survival test

MARINE RECEIVING WATER (SALINITY ≥ 2 PPT)

CHRONIC 7-day *Americamysis bahia* (mysid shrimp, formerly *Mysidopsis bahia*) survival and growth test

7-day *Menidia beryllina* (inland silverside) larval survival and growth test

ACUTE 48-hour *Americamysis bahia* (mysid shrimp) survival test

48-hour *Menidia beryllina* (inland silverside) survival test

Permittees may substitute other EPA approved tests and species if they obtain approval from the TCEQ during the permit application process (see the sections of this document entitled "Toxicity Attributable to Dissolved Salts" on page 122 and "Site-Specific Standards for Total Toxicity" on page 207).

Typically, if the segment criterion for total dissolved solids (TDS) or the site-specific TDS concentration in the receiving water is too high to support *Ceriodaphnia dubia* or *Daphnia pulex*, *Daphnia magna* (another water flea) will be substituted as the invertebrate freshwater test organism after the need to make the substitution is demonstrated. The permittee may submit evidence substantiating the need for an alternative species before or during the application process. However, draft permits with alternate tests, alternate species, or testing requirements that exclude a species are subject to EPA review and approval.

Test Acceptability Criteria

A toxicity test that fails to meet **any** of the following acceptability criteria is considered invalid, and the permittee will have to repeat the test. Other factors may also invalidate a test. All test results, valid or invalid, are to be submitted to the TCEQ.

Chronic Freshwater

- a mean survival of 80% or greater in the control.

- a mean number of 15 or greater water flea neonates per surviving adult in the control.

- a mean dry weight of 0.25 mg or greater for surviving fathead minnow larvae in the control.

- a coefficient of variation percent (CV%) of 40 or less between replicates in the control and in the critical dilution for:

  - the young of surviving females in the water flea reproduction and survival test; and
  - the growth and survival endpoints in the fathead minnow growth and survival test.

  However, if statistically significant lethal or sublethal effects are exhibited , a CV% greater than 40 does not invalidate the test.

- a PMSD of 47 or less for the water flea and a PMSD of 30 or less for the fathead minnow. However, if statistically significant sublethal effects are exhibited, a PMSD in excess of that specified above does not invalidate the test.

- a test population of < 20% males in a single concentration or < 20% males in a whole test for the water flea reproduction test.

Chronic Saltwater

- a mean survival of 80% or greater in the control.

- a mean dry weight of 0.20 mg or greater for surviving mysid shrimp in the control.

- a mean dry weight in the control of 0.50 mg or greater for surviving unpreserved inland silverside and 0.43 mg or greater for surviving preserved inland silverside.

- a CV% of 40 or less in the control and in the critical dilution in the growth and survival tests. However, if statistically significant lethal or sublethal effects are exhibited, a CV% greater than 40 does not invalidate the test.

- a PMSD of 37 or less for the mysid shrimp and a PMSD of 28 or less for the inland silverside. However, if statistically significant sublethal effects are exhibited, a PMSD in excess of that specified above does not invalidate the test.

48-hour Acute Freshwater and Saltwater

- a mean survival of 90% or greater in the control.

- a CV% of 40 or less in the control and in the critical dilution.

However, if significant lethality is demonstrated, a CV% greater than 40 does not invalidate the test.

Once-Through Cooling Water Facilities

Once-through cooling water facilities that use intake water as the control do not have to retest and report a valid test for each test species during the reporting period **if** the test is invalid because the control fails to meet acceptability criteria. This exception recognizes that running additional tests is not useful when the source waterbody itself is already toxic to one or both test organisms due to total dissolved solids (TDS), pathogenic bacteria, or toxic algae blooms.

Statistical Interpretation of Test Results

If significant lethality is demonstrated (that is, if there is a statistically significant difference in survival at the critical dilution when compared to the control), but the conditions of test acceptability are met and the survival endpoint equals or exceeds the acceptability criteria at the critical dilution and all dilutions below that, then the permittee may report a survival NOEC of not less than the critical dilution.

While the nominal error rate (alpha) used for hypothesis testing in WET data is 0.05 (95% confidence interval), the alpha level for sublethal statistical analysis may be modified in accordance with EPA guidelines under appropriate conditions.[10]

While the method manuals list a range for PMSDs, a value below that range does not invalidate the test. If no significant sublethal effects are indicated, the NOEC should be reported as is. However, if the test indicates statistically significant sublethal effects, additional calculations should be performed in order to determine the NOEC.[11]

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[10] *Method Guidance and Recommendations for Whole effluent Toxicity (WET) Testing (40 CFR Part 136)*, EPA 821-B-00-004, July 2000.

[11] *Understanding and Accounting for Method Variability in Whole Effluent Toxicity Applications Under the National Pollutant Discharge Elimination System Program*, EPA 833-R-00-003, June 2000.

Test Frequencies

General

Figure 4 on page 109 illustrates the chronic and 48-hour acute testing frequencies for facilities with WET requirements. Testing is typically performed quarterly for both the vertebrate and the invertebrate test species for the first year of the permit term. EPA requires quarterly testing for at least one year to assess the variability and toxic potential of effluents.

If no significant effects are demonstrated in the first year of quarterly testing, the permittee may request a testing frequency reduction to once per six months for the invertebrate and once per year for the vertebrate for the remainder of the permit term.

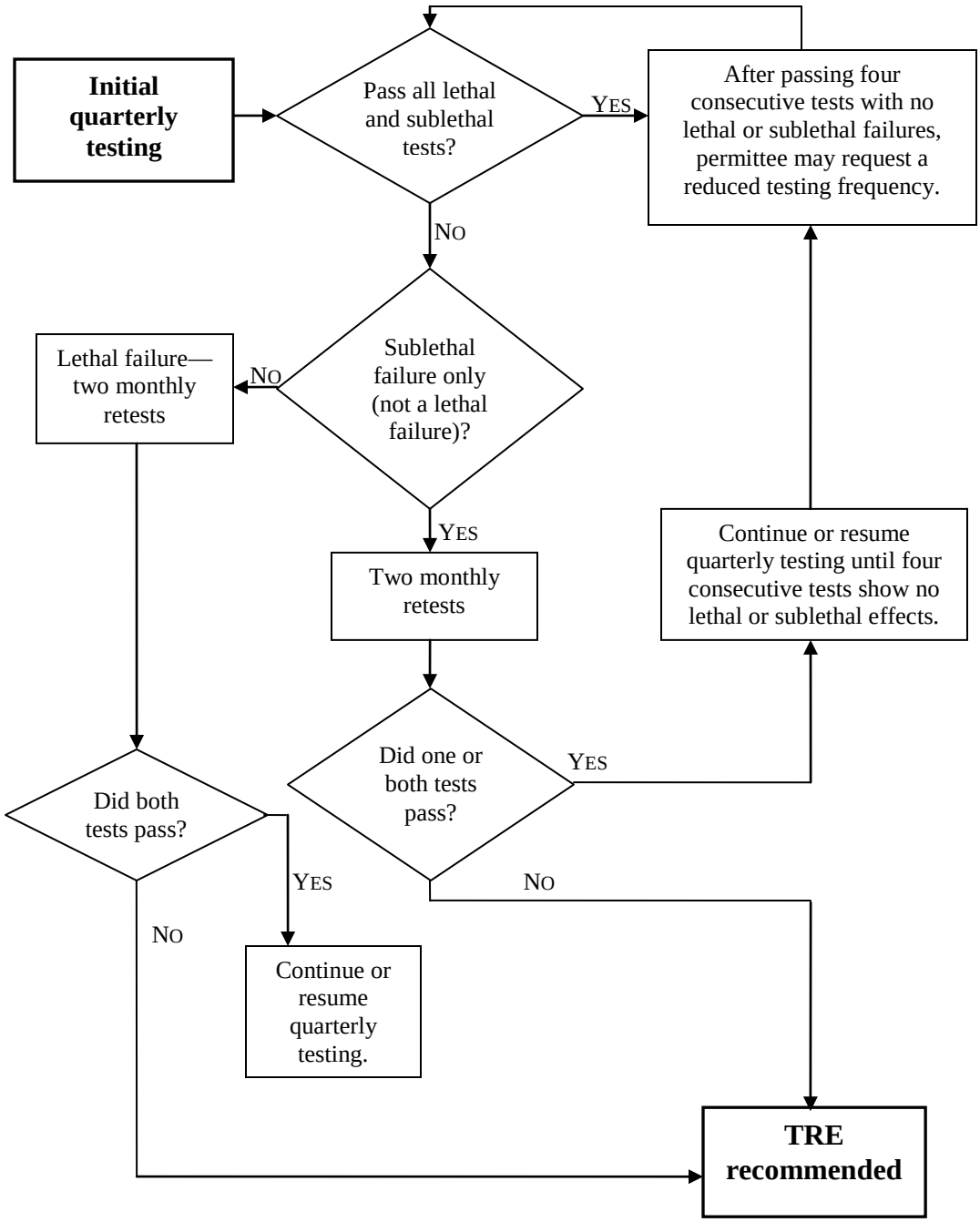

Figure 4. Chronic and 48-Hour WET Testing Frequencies

If significant lethality is demonstrated in the first year of quarterly testing, that species is not eligible for the testing frequency reduction and the permittee must then test quarterly for the permit term. If significant sublethality is demonstrated in the first year of quarterly testing, the permittee will not be eligible for the testing frequency reduction for that species until no significant effects are demonstrated for four consecutive quarterly tests.

If a testing frequency reduction has been granted for a species, but that species subsequently demonstrates significant lethality, the quarterly testing frequency for that species will be resumed for the permit term. If a testing frequency reduction has been granted for a species, but that species subsequently demonstrates significant sublethality, the quarterly testing frequency for that species will be resumed until four consecutive quarterly tests demonstrate no significant effects.

With a WET Limit

Permittees will be required to perform quarterly testing for at least three years when a WET limit is added to the permit. This frequency only applies to the species with the WET limit. Best professional judgment (BPJ) will be used to establish testing frequencies when a chemical-specific limit or best management practice (BMP) is placed in the permit to control effluent toxicity.

Dilution Series, Dilution Water, and Type of WET Test

Dilution Series

Chronic and some 48-hour acute tests are based on the critical dilution in the receiving water. The critical dilution represents the percentage of effluent at the edge of the mixing zone during critical low-flow (that is, the 7Q2 or appropriate critical low-flow for spring-fed streams) or critical mixing conditions. Some 48-hour acute tests are based on the percentage of effluent at the edge of the zone of initial dilution (ZID). The test results at the critical dilution are statistically compared with the test results at the control dilution (0% effluent) to measure compliance. The permit specifies the critical dilution and the dilution series as well as the type of WET tests required.

The dilution series consists of four effluent concentrations in addition to the critical dilution. For domestic dischargers, the design flow is normally used to calculate the critical dilution. For industrial dischargers who are renewing permits, the highest monthly average flow from the preceding two years is normally used to calculate the critical dilution. For new or expanding industrial facilities, the design flow is used to calculate the critical dilution.

Dilution Water

As specified in the permit, receiving water unaffected by the discharge should be used as the control and as dilution water for at least the first series of WET tests performed after a new permit is issued.

If the receiving water demonstrates pre-existing instream toxicity (by failing to meet the appropriate test acceptability criteria in the control), the test is considered invalid, and a repeat test has to be performed unless a "performance control" using synthetic dilution water was run at the same time and no toxic effects were demonstrated.

Upon demonstrating that the receiving water is toxic, the permittee may substitute synthetic dilution water for receiving water as the control and as dilution water in all subsequent tests for that permit term. The physical and chemical properties (for example, pH, hardness, TSS, alkalinity) of the synthetic dilution water should be similar to those of the receiving water.

Type of Test

The TCEQ determines what type of WET test (freshwater or marine, acute or chronic) to place in the permit based on the salinity and critical conditions of the receiving waters. In general, TCEQ staff considers salinities at or above 2,000 mg/L (2.0 ppt) to represent saltwater conditions.

If the TCEQ determines that WET testing is required for a storm water discharge, TCEQ staff may use an analysis of the watershed to determine runoff volumes for dilution estimates. In addition, the TCEQ may require WET testing or other methods to protect water bodies with endangered species.

INTERMITTENT STREAMS WITH MINIMAL AQUATIC LIFE USE

Permittees that discharge into intermittent streams with a minimal aquatic life use will conduct 48-hour acute testing with a critical dilution of 100% effluent.

INTERMITTENT STREAMS WITH PERENNIAL POOLS

Permittees that discharge into intermittent streams with perennial pools will conduct chronic testing with a critical dilution of 100% effluent.

INTERMITTENT STREAMS WITH SEASONAL AQUATIC LIFE USES

TCEQ may require dischargers to conduct chronic testing to protect intermittent streams that may have seasonal aquatic life uses. TCEQ determines the critical dilution from the typical flows in the season in which the use occurs.

INTERMITTENT STREAMS WITHIN THREE MILES OF A PERENNIAL FRESHWATER STREAM

Permittees that discharge into intermittent streams that flow into a perennial stream within a moderate distance downstream (normally 3 miles) will conduct either a 48-hour acute or a chronic test. The type of test depends on the size of the discharge relative to the flow of the perennial water downstream.

If the effluent flow equals or exceeds 10% of the low-flow of the perennial water, the permittee will conduct chronic testing with a critical dilution representative of the percentage of effluent in the perennial stream during low-flow. If the effluent flow is less than 10% of the low-flow in the perennial stream, the permittee will conduct 48-hour acute toxicity tests with a critical dilution of 100% effluent. The TCEQ generally requires permittees that discharge into intermittent streams within 3 miles of a bay, estuary, or tidal river to conduct chronic marine testing.

PERENNIAL FRESHWATER STREAMS

Permittees that discharge directly into perennial freshwater streams or rivers with a designated or limited, intermediate, high, or exceptional aquatic life use will conduct chronic testing; the critical dilution will be based on the effluent flow and critical low-flow of the stream or river. If the critical dilution is less than 5%, the TCEQ requires 48-hour acute testing and uses an acute-to-chronic ratio (ACR) of 10:1 to determine the appropriate critical dilution. The ACR is the ratio of the acute toxicity of an effluent or toxicant to its chronic toxicity. It is used to estimate the chronic toxicity based on acute toxicity results. An ACR of 10 represents the upper 90th percentile of the ACR data available to EPA in 1991.

LAKES

Permittees that discharge to a lake will normally conduct chronic WET tests with a critical dilution of 15% if the effluent flow is less than or equal to 10 MGD and the mixing zone is 100 feet wide. If the effluent flow is greater than 10 MGD or if the mixing zone is less than 100 feet wide, the TCEQ typically uses the horizontal Jet Plume equation (see page 74) to determine the percentage of effluent at the edge of the mixing zone. In these cases the critical dilution is generally greater than 15%. The TCEQ assigns a critical dilution of 100% effluent for discharges greater than 100 MGD.

BAYS, ESTUARIES, AND WIDE TIDAL RIVERS

Permittees that discharge into bays, estuaries, and wide tidal rivers (≥ 400 feet across) will normally conduct chronic WET tests with a critical dilution of 8% if the effluent flow is less than or equal to 10 MGD. If the effluent flow is greater than 10 MGD, the TCEQ uses the horizontal Jet Plume equation (see page 74) to determine the percentage of effluent at the edge of the mixing zone. The TCEQ assigns a critical dilution of 100% effluent for discharges greater than 100 MGD.

NARROW TIDAL RIVERS

Permittees that discharge into narrow tidal rivers (< 400 feet across) will normally conduct chronic WET tests with the critical dilution based on upstream flow whenever flow information is available. In the absence of site-specific data such as dispersion dye studies or nearby flow measurements, the critical dilution typically is not less than 8% to ensure the same level of protection given to other marine waters. If upstream flows are not available, the horizontal Jet Plume equation (see page 74) is used to determine the critical dilution at the edge of the mixing zone. Critical dilutions calculated in this way are greater than 8% because the mixing zone size is less than 200 feet.

Diffusers

An effluent diffuser installed at the end of a discharge pipe may increase mixing and lower critical dilutions. See the section of this document entitled "Diffusers" on page 82 for more information. The effluent percentage at the edge of the mixing zone for a diffuser discharge is usually determined through modeling. This effluent percentage, if determined to be appropriate, is normally used as the critical dilution for chronic WET testing. If the critical dilution is less than 5%, the TCEQ may instead require 48-hour acute testing using an ACR of 10:1 to determine the appropriate critical dilution.

Reasonable Potential Determination

Permit applications that meet the applicability criteria for WET testing will be screened to determine if the discharge has a reasonable potential (RP) to cause significant toxicity. A reasonable potential analysis is performed in order to determine whether an effluent can reasonably be expected to cause or contribute to an exceedance of a state water quality standard or criterion within that standard.

For renewed or amended permit applications, screening for RP will be based on representative data from the previous five years of WET testing. New permit applications will not be screened for RP, since there will be no data from previous WET testing. Toxicity for new permits will be assessed by routine, periodic WET testing after the permits are issued.

Toxicity is presumed if a test fails for the lethal or sublethal endpoint. A test is considered to have failed if a statistically significant difference occurs between the control and the critical dilution.

In accordance with federal regulations, the TCEQ will make an RP determination for toxicity. The determination will be based on best professional judgment as well as additional factors, such as duration and magnitude, as agreed upon by the TCEQ and the EPA. Each test species will be evaluated separately.

When a final determination of RP is made, the permit will be issued for a five-year term, including an initial one-year investigative period for the permittee to conduct an initial toxicity investigation. The investigative period will be followed by up to a three-year compliance period to allow for assessment of the cause and/or elimination of toxicity prior to the effective date of the WET limit.

If appropriate, the permittee may apply for a permit amendment to remove the WET limit by replacing it with a chemical-specific limit or a best management practice (BMP) prior to the end of the compliance period (see below). If there are no further demonstrations of toxicity during the compliance period, the WET limit will not become effective. If the WET limit does become effective, the permittee may, after three years of compliance, submit a major amendment application to request removal of the WET limit and resumption of routine WET testing.

Addressing WET Limit Violations

If the permittee fails a WET test (that is, demonstrates significant toxicity at the critical dilution) while the limit is in effect, the testing frequency for the species increases to monthly until the permittee passes (does not demonstrate significant toxicity at the critical dilution) three consecutive tests, after which the permittee may resume quarterly testing.

However, if the permittee fails two tests during the increased monthly testing period, the permittee will be considered noncompliant with the WET limit, will receive a Notice of Enforcement (NOE), and will be referred to TCEQ's Enforcement Division for formal enforcement action. This process is illustrated in Figure 5 on page 117.

Chemical-Specific Limit

In order to be eligible for a chemical-specific limit in lieu of a WET limit, the permittee has to demonstrate that one or more known pollutants caused the toxicity and should attempt to determine a specific concentration of the pollutant that will not cause toxicity. A chemical-specific limit may be inadequate to address toxicity in the following situations:

- failure to identify the toxicant or toxicants.
- presence of multiple toxicants.
- lack of a routine test method capable of detecting a pollutant at levels causing persistent significant toxicity.

BMP

In terms of WET testing, BMPs are defined as a practice or combination of practices that remove toxicity from the effluent by eliminating the source of toxicity. In order to be eligible for a BMP in lieu of a WET limit, the permittee has to demonstrate that such a provision can adequately address toxicity. If successful, the BMP becomes an enforceable part of the permit. A BMP does not include making changes to operations or housekeeping practices to reduce toxicity. In these cases, the source of toxicity still remains.

Toxicity Reduction Evaluations (TREs)

When is a TRE Performed?

The TCEQ suggests that a permittee initiate a TRE when persistent significant toxicity occurs during routine WET testing. A TRE may allow the permittee to avoid a WET limit as the toxicity control measure.

If a permittee fails a WET test, that is, statistically significant toxicity occurs at the critical dilution, the permittee will conduct two retests with that test species. The retests are to be conducted monthly during the next two consecutive months. If persistent significant toxicity is demonstrated by failure of one or both retests, the permittee may wish to perform a TRE. A second retest is not required if the first retest confirms persistent toxicity.

TRE Purpose and Content

The purpose of the TRE is to determine the cause and source of toxicity, and to determine methods to reduce or eliminate the toxicity. Components of a TRE may include, but are not limited to:

- chemical analyses
- effluent characterization tests (physical/chemical properties)
- WET tests on effluent before and after characterization test manipulations
- WET tests on effluent after chemical/physical separations
- source identification evaluation or toxicity source evaluation
- instream WET tests
- chemical identification after chemical/physical separations of toxic phase
- assessment of treatment technology available to remove the toxic substance from the effluent.

For more information on methods used in TREs, see the following documents (or their most recent versions):

- *Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I*, EPA/600/6-91/005F, May 1992.

- *Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures, Second Edition*, EPA/600/6-91/003, February 1991.

- *Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity*, EPA/600/R-92/080, September 1993.

- *Methods for Aquatic Toxicity Identification Evaluations: Phase III Toxicity Confirmation Procedures for Samples Exhibiting Acute and Chronic Toxicity*, EPA/600/R-92/081, September 1993.

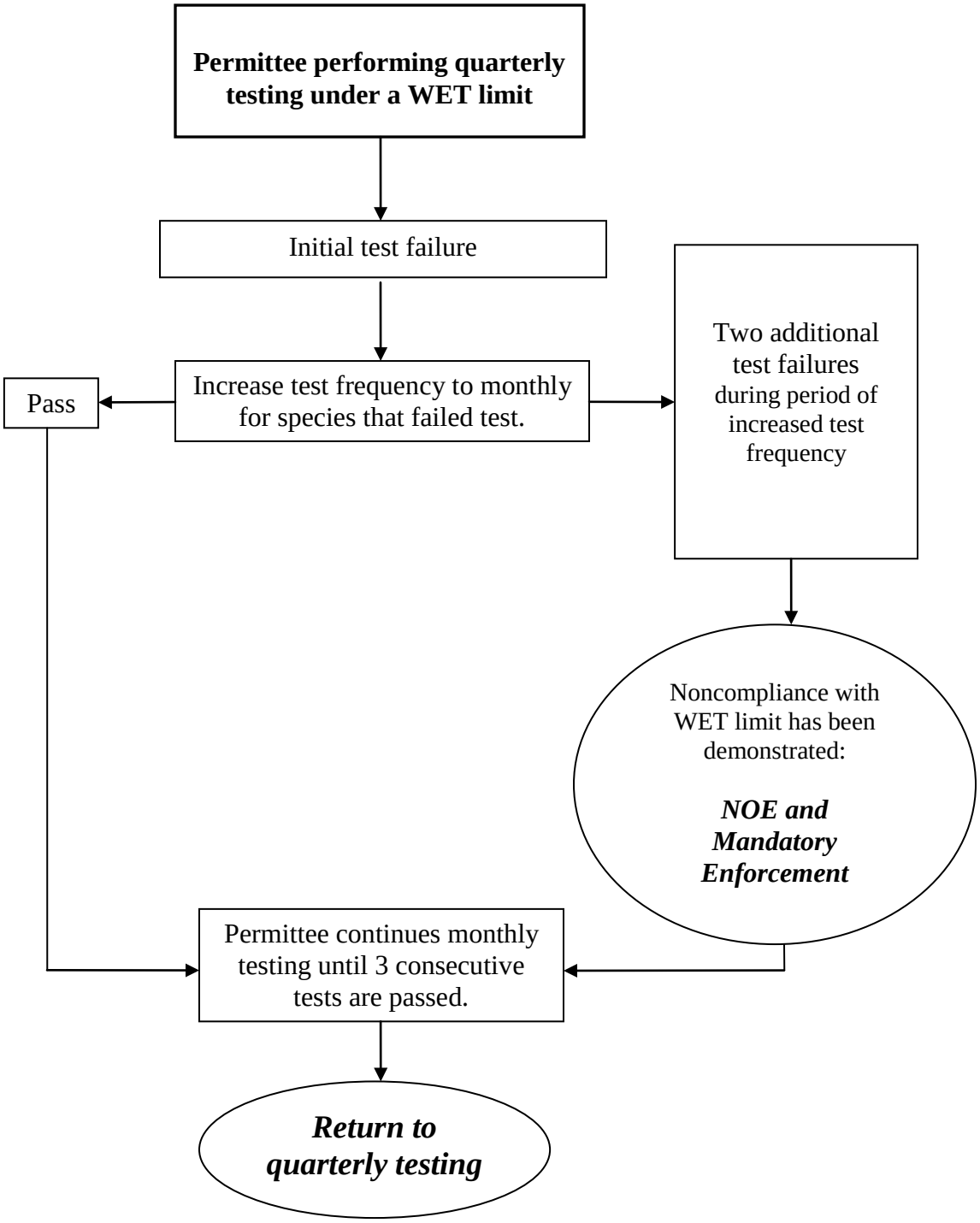

Figure 5. Procedure for Addressing WET Limit Violations

24-Hour Acute (100% End-of-Pipe) Tests

In addition to conducting chronic or 48-hour acute tests, dischargers are required to conduct 24-hour acute tests using 100% effluent. This end-of-pipe test measures compliance with § 307.6(e)(2)(B) of the Standards, which requires that greater than 50% of the test organisms survive exposure to 100% effluent for 24 hours. This provision is designed to ensure that water in the state will not be acutely toxic to aquatic life passing through the ZID.

In addition to facilities mentioned previously in the section "Applicability" (see page 102), the TCEQ may require 24-hour acute testing for intermittent process water outfalls and/or storm water outfalls with the potential for causing toxicity. Dischargers with multiple outfalls will test each outfall that has the potential to cause toxicity. Multiple outfall samples may not be composited for this test.

Test Types

The permit will specify that the tests be conducted using the latest version of the appropriate EPA method. The 24-hour acute test species and methods are the same as those for 48-hour acute testing and can be found in the manual listed on page 104. Depending on the type of receiving water, the permit will specify 24-hour acute tests to assess toxicity to freshwater or saltwater organisms. The test organisms for each type of test are as follows:

Freshwater streams and lakes (salinity < 2 ppt):

- 24-hour *Daphnia pulex* or *Ceriodaphnia dubia* (water fleas) survival test
- 24-hour *Pimephales promelas* (fathead minnow) survival test

Marine receiving water (salinity ≥ 2 ppt):

- 24-hour *Americamysis bahia* (mysid shrimp) survival test
- 24-hour *Menidia beryllina* (inland silverside) survival test

Permittees may substitute other EPA-approved tests and species if they obtain approval from the TCEQ before or during the permit application process (see the sections in this document entitled "Toxicity Attributable to Dissolved Salts" on page 122 and "Site-Specific Standards for Total Toxicity" on page 207).

Typically, if the segment TDS criterion or site-specific TDS concentration in the receiving water is too high to support *Ceriodaphnia dubia* or *Daphnia pulex*, *Daphnia magna* (water flea) is substituted as the invertebrate test organism. However, draft permits with alternate tests, alternate species, or testing requirements that exclude a species are subject to EPA review and approval.

Test Acceptability Criterion

The permittee will have to repeat any toxicity test if the mean survival of the control is less than 90%. Any toxicity test that fails to meet the acceptability criterion is considered invalid.

Test Frequencies

The standard frequency for 24-hour acute WET testing is once per six months unless otherwise specified.

Toxicity Reduction Evaluations (TREs)

Failing a 24-hour acute WET test (demonstrating 50% or greater mortality) necessitates two retests over consecutive weeks (unless retesting concurrently with chronic test failure; in such a case, the permittee may defer to the chronic monthly retest schedule). If both retests pass (demonstrate greater than 50% survival), the permittee continues testing at the original frequency designated in the permit.

If one or both of the retests fail, the permittee has demonstrated persistent significant mortality, and the permittee is required to perform a TRE. From the date that persistent mortality is confirmed, the permittee has three years to comply with 30 TAC § 307.6(e)(2)(B) of the Standards.

TRE Purpose and Content

The purpose of the TRE is to determine the cause and source of toxicity, and to determine methods to reduce or eliminate the toxicity. Components of a TRE are the same as described in the chronic/48-hour acute section.

TRE Plan

The permit requires the discharger to submit a general outline for performing a TRE within 45 days of the retest that confirms persistent mortality. The outline should describe the preparations the permittee will take to develop and implement a TRE.

Within 90 days of the retest that confirms persistent mortality, the permit requires the discharger to submit a detailed TRE plan. The TRE plan should describe the specific approach and methodology the permittee will use during the TRE and include schedules for chemical and biological testing, specific activities, a sampling plan, a quality assurance plan, and project organization. The TRE schedule and approach may be modified as necessary during the process.

Toxicity attributable to dissolved salts and ammonia are discussed in the sections of this document entitled:

- "Toxicity Attributable to Dissolved Salts" (see page 122)
- "Ammonia Toxicity" (see page 128)

Quarterly Reports

The permittee must submit quarterly reports to TCEQ that describe TRE progress and results. The permit also requires the permittee to complete the TRE and submit a final report within 18 months of the retest that confirms lethality. Permittees may request an extension to the 18-month time limit. The extension, however, must be warranted, and approval is contingent upon permittees demonstrating (1) due diligence in pursuit of the TRE and (2) the existence of circumstances beyond their ability to control.

Ceasing a TRE

Permittees may cease TRE activities if they demonstrate to the executive director that the effluent no longer causes significant mortality to the test organisms. The permit defines a cessation of significant mortality as no test failures for a period of 12 consecutive weeks with at least weekly testing. This permit language accommodates situations where operational errors and upsets, spills, or sampling errors triggered the TRE, in contrast to a situation where a single toxicant or group of toxicants cause lethality.

When a permittee ceases TRE activities under the cessation of significant mortality provision, that permittee continues WET testing as required in the permit. This provision is not applicable if the significant mortality ceases for 12 consecutive weeks as a result of the permittee taking corrective action. Corrective actions include source reduction or elimination, process changes, housekeeping improvements, changes in chemical use, and/or modification to wastewater treatment.

Toxicity Control Measures

After the TRE, the TCEQ will amend the permit to include a chemical-specific (CS) limit, a best management practice (BMP), or a whole effluent toxicity (WET) limit.

If appropriate, the permittee may apply for a permit amendment to remove the WET limit by replacing it with a chemical-specific limit or a BMP prior to the end of the compliance period (see below). If there are no further demonstrations of mortality during the compliance period, the WET limit does not become effective. If the WET limit does become effective, the permittee may, after three years of compliance, submit a major amendment application to request removal of the WET limit and resumption of routine WET testing.

Chemical-Specific Limit

In order to be eligible for a chemical-specific limit in lieu of a WET limit, the permittee has to demonstrate that one or more known pollutants caused the mortality and should attempt to determine a specific concentration of the pollutant that will not cause mortality. A chemical-specific limit may be inadequate to address mortality in the following situations:

- failure to identify the toxicant or toxicants;
- presence of multiple toxicants; or
- lack of a routine test method capable of detecting a pollutant at levels causing persistent significant mortality.

BMP

In terms of WET testing, BMPs are defined as a practice or combination of practices that remove toxicity from the effluent by eliminating the source of toxicity. In order to be eligible for a BMP in lieu of a WET limit, the permittee has to demonstrate that such a provision can adequately address mortality. If successful, the BMP becomes an enforceable part of the permit. A BMP does not include making changes to operations or housekeeping practices to reduce toxicity. In these cases, the source of toxicity still remains.

WET Limit

Failure to identify the toxicant or toxicants, presence of multiple toxicants, or lack of a routine test method capable of detecting a pollutant at levels causing toxicity, are examples of cases where a CS limit or BMP may be inadequate to address toxicity. In such cases, where no other appropriate toxicity control measure has been identified, the permit will be amended to add a WET limit with a compliance period, if appropriate.

WET Limit Violations

If the permittee fails a WET test while the limit is in effect, the testing frequency for the species increases to monthly until the permittee passes (does not demonstrate significant mortality) three consecutive tests, after which the permittee may resume the specified testing frequency.

Test Substitution

The TCEQ normally requires permittees to conduct the chronic or 48-hour acute WET tests and the 24-hour acute (100% end-of-pipe) WET tests as separate permit requirements. If the chronic or 48-hour acute WET test includes a test of 100% effluent in the dilution series, the permit allows the results from that test (after 24 hours of exposure) to fulfill the requirements in the 24-hour acute tests. The permittees then report the survival of organisms in the 100% effluent concentrations after 24 hours.

The permit stipulates that the 24-hour acute WET testing provision applies whether the test results submitted are for this requirement, the 48-hour acute requirements, or the chronic requirements. The permittee may add a 100% effluent dilution to chronic or 48-hour acute tests and submit the results after 24 hours to fulfill the 24-hour acute testing requirements.

Toxicity Attributable to Dissolved Salts

Permittees may be exempt from compliance with the total toxicity provisions in the Standards if they demonstrate that dissolved salts are causing the effluent to be toxic. This exemption is allowed under the definition of toxicity in the Standards and under the 24-hour, 100% end-of-pipe acute toxicity provisions (*See* § 307.6(e)(2)(B) of the Standards).

The definition of toxicity in the Standards excludes adverse effects caused by concentrations of dissolved salts when the salts originate in a permittee's source water. This exemption would affect compliance with the chronic and 48-hour acute WET testing provisions.

According to § 307.3(a)(65) of the Standards, "Source water is defined as surface water or groundwater that is used as a public water supply or industrial water supply (including cooling water supply). Source water does not include brine water that is produced during the extraction of oil and gas, or other sources of brine water that are substantially uncharacteristic of surface waters in the area of the discharge."

Also, dischargers that exhibit 24-hour acute toxicity caused by: (1) concentrations of dissolved salts that originate from the source water or (2) an excess, deficiency, or imbalance of dissolved salts in the effluent are exempted from compliance with the 24-hour, 100% end-of-pipe acute toxicity provision. These exemptions, which are specified in § 307.6(e)(2)(B) of the Standards, do not include instances where individually toxic components (for example, the pollutants listed in Table 1 of the Standards) have formed a salt compound that is causing the effluent to be toxic.

The following two sections further explain the exemptions for dissolved salts.

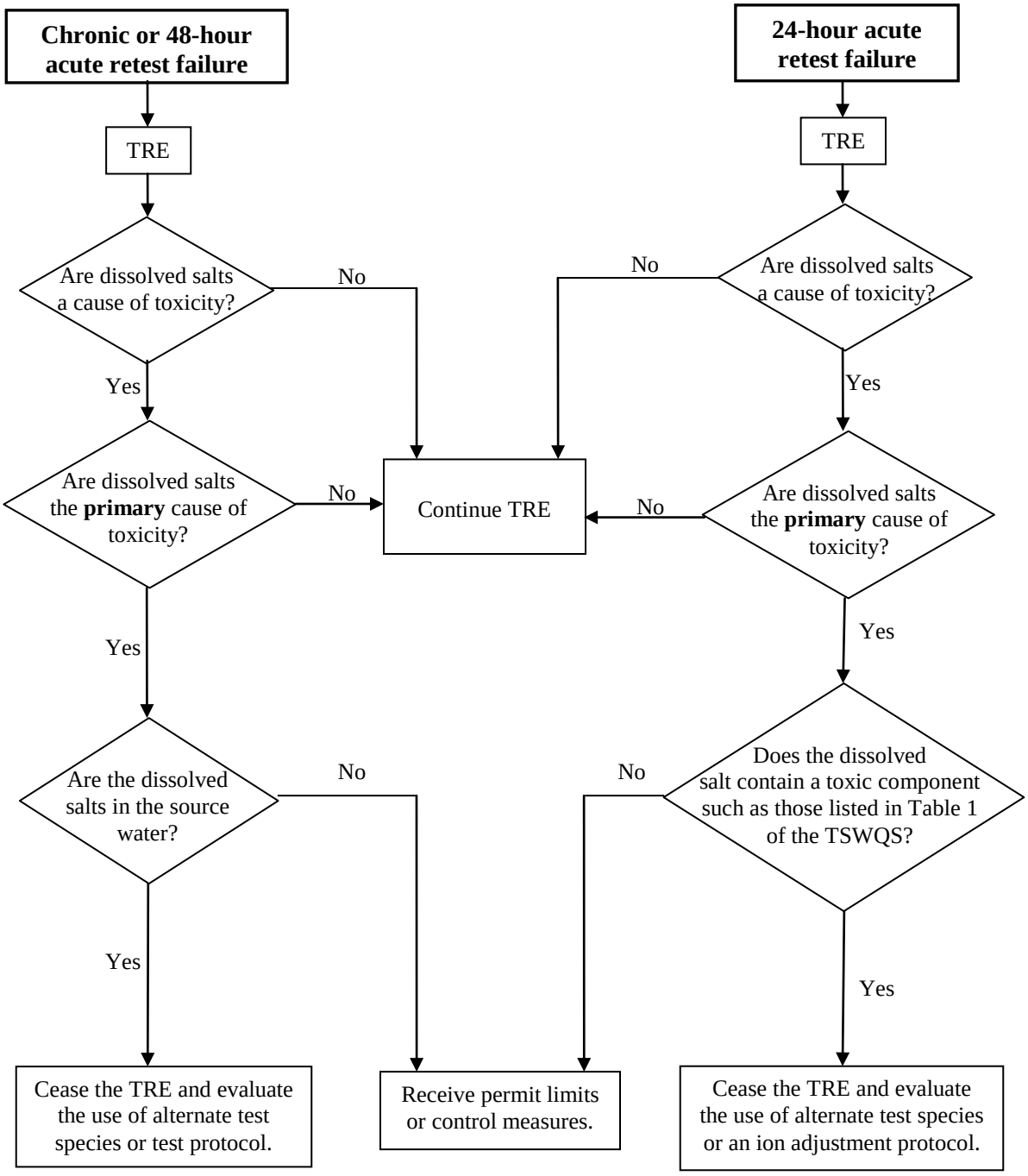

Figure 6. Procedure for Exemption from Total Toxicity Requirements because of Dissolved Salts

TDS Exemption—24-Hour Acute (100% End-of-Pipe) Tests

When a permittee believes failure of the 24-hour acute tests occurred because of dissolved salts and seeks an exemption for that demonstration of toxicity, the permittee will have to demonstrate that dissolved salts are a cause of toxicity in the effluent. Because the effluent may have multiple toxicants, the permittee then has to prove that dissolved salts are the **primary** cause of toxicity. The following paragraphs describe the process in more detail.

Are Dissolved Salts a Cause of Toxicity?

To confirm that dissolved salts are a cause of toxicity in the effluent, the permittee is required to conduct at least one set of toxicity identification evaluation (TIE) characterization tests including an ion-exchange procedure.

- If the TIE tests fail to prove that dissolved salts are a cause of toxicity, the permittee should continue with the TRE to identify the toxicant or toxicants and to reduce or eliminate the acute toxicity.

- If the TIE tests show that dissolved salts are a cause of toxicity in the effluent, the permittee then has to prove that they are the **primary** cause of acute toxicity.

Are Dissolved Salts the Primary Cause of Toxicity?

The permittee should use a combination of the following techniques to show that dissolved salts are the primary cause of acute toxicity:

- conduct WET tests using an alternate species that is more tolerant of dissolved salts.

- conduct side-by-side WET tests using the toxic effluent as well as a mock effluent formulated to mimic the ionic composition of the effluent.

- perform measurements of high levels of dissolved salts in the effluent.

- perform an analysis of the ionic components of the dissolved salts.

- use computer models that predict the acute toxicity of saline waters.

- perform WET tests using sea salts that are formulated to correct ionic imbalances.

The permittee may suggest other methods to demonstrate that dissolved salts are the primary cause of toxicity for the TCEQ's review and consideration.

- If these techniques show that dissolved salts are not the primary cause of acute toxicity, the permittee will continue with the TRE to address the toxicity.

- If the techniques prove that dissolved salts are the primary cause of toxicity, the TRE requirements cease.

Evaluating the Use of an Alternative Test Species

When the TRE ceases because dissolved salts are the primary source of acute toxicity, the TCEQ evaluates or requires the permittee to evaluate the use of an alternative test species or modified test protocol.

The permittee may be required to continue conducting the 24-hour acute tests if an alternate test protocol successfully resolves the acute toxicity caused by the dissolved salts in the effluent. The TCEQ then initiates an amendment of the permit to include these measures.

If an alternate species is unavailable, or if test protocol modifications such as ionic adjustments are unsuccessful, the permittee will most likely be required to continue testing with the standard test species that is unaffected by the dissolved salts.

TDS Exemption—Chronic and 48-Hour Acute Tests

When a permittee believes effluent toxicity evidenced by a chronic or 48-hour acute WET test is caused by dissolved salts and seeks an exemption for that demonstration of toxicity, the permittee should follow an approach similar to that described in the previous subsection. EPA will review any protocol that could affect permits or other regulatory actions that are subject to EPA approval.

First, permittees have to show that dissolved salts are a cause of toxicity in the effluent. Since the effluent may contain multiple toxicants, permittees have to prove that dissolved salts are the **primary** source of toxicity. Next, permittees have to show that the dissolved salts are coming from their source water. Permittees need to complete each step in this process to receive the exemption for dissolved salts. The following paragraphs describe this process in more detail.

Are Dissolved Salts a Cause of Toxicity?

To confirm that dissolved salts are a cause of effluent toxicity, the permittee will conduct at least one set of TIE characterization tests including an ion-exchange procedure. If the TIE tests show that dissolved salts are not a cause of effluent toxicity, the permittee should continue with the TRE to identify the toxicant or toxicants and to reduce or eliminate the toxicity.

If the TIE tests show that dissolved salts are a cause of effluent toxicity, the permittee then has to prove that they are the primary cause of toxicity.

Are Dissolved Salts the Primary Cause of Toxicity?

The permittee may use the techniques described in the previous section "TDS Exemption—24-Hour Acute (100% End-of-Pipe) Tests" on page 125 to prove that dissolved salts are the primary cause of toxicity. If these techniques fail to do so, the permittee should continue with the TRE to address the toxicity. If the techniques prove that dissolved salts are the primary cause of toxicity, the permittee then has to prove that the dissolved salts are coming from the source water.

Are Dissolved Salts Coming from Source Water?

To help prove that dissolved salts originate from the source water, the permittee should sample the facility's intake water and/or raw water source and compare its dissolved salt concentration and ionic composition with those of the effluent. Increases in the dissolved salt content of the effluent due to process evaporation should also be evaluated where appropriate. In any case, if the effluent's TDS concentration is greater than that of the source water or if the effluent's ionic composition varies significantly from that of the source water, effluent limits or control measures may be included in the permit.

- If the dissolved salts are not from the source water, the permittee has to comply with the total toxicity provisions of the Standards. If a protocol for an instream biological survey is approved by EPA, it may be possible for the permittee to attempt to demonstrate that aquatic life in the receiving water is not adversely affected by the TDS levels in the proposed permit.

- If the dissolved salts are from the source water, the permittee may cease the TRE. Upon cessation of the TRE, TCEQ staff will, in conjunction with the permittee, evaluate the use of an alternative test species or a modified test protocol. The permittee may be required to continue testing if modifying the test protocol or using an alternate species resolves the toxic effect of the dissolved salts in the effluent. The TCEQ will then amend the permit to include these measures.

If an alternate species is unavailable or tests using a modified test protocol still demonstrate toxicity due to dissolved salts, the permittee will most likely be required to continue testing with the standard test species that is unaffected by the dissolved salts.

Discharges to marine waters are reviewed on a case-by-case basis and are subject to EPA review and approval in accordance with the MOA between the TCEQ and EPA concerning the TPDES program.

Ammonia Toxicity

Controlling Potential Ammonia Toxicity

Ammonia, a common component of domestic wastewater, has been shown to be toxic to aquatic organisms. Models used to determine effluent limits for oxygen-demanding constituents do not account for the toxicity that ammonia can exert. Therefore, to preclude receiving water toxicity, permits for certain types of facilities that have either

- ammonia limits to maintain instream dissolved oxygen criteria; or

- categorical ammonia limits that exceed 4 mg/L at the edge of the mixing zone will now include either modified limits for total ammonia or a chronic WET limit for the more sensitive species with a WET testing frequency of six times a year.

The modified ammonia limit or WET limit applies to the following types of facilities that discharge to perennial waters or within 3 miles of perennial waters:

- major domestic facilities (design flow ≥ 1 MGD)

- minor domestic facilities (design flow < 1 MGD) that discharge to a water body that:
  - contains a threatened or endangered species or
  - is listed for ammonia on an EPA-approved 303(d) list

- industrial facilities that have WET testing requirements
- industrial facilities that discharge to a water body that:
  - contains a threatened or endangered species or
  - is listed for ammonia on an EPA-approved 303(d) list

By following these guidelines, the TCEQ will ensure that it is not authorizing the discharge of toxic amounts of ammonia.

Toxicity Attributable to Ammonia

TCEQ recognizes that the technology-based daily average ammonia-nitrogen limit of 3.0 mg/L included in most major domestic discharge permits generally precludes chronic toxicity to test species. Therefore, the TCEQ will implement this limit to address chronic toxicity attributable to ammonia in domestic discharge permits. The ammonia limit will be implemented in domestic discharge permits as follows:

- For those facilities whose permits contain interim or final effluent phases that include a daily average ammonia-nitrogen limit of 3.0 mg/L, the persistent toxicity requirements are suspended until the effective date of the limit.

- For those facilities whose permits do not contain interim or final effluent phase that include a daily average ammonia-nitrogen limit of 3.0 mg/L, TCEQ staff will amend the permits to include this limit.

The 3.0 mg/L ammonia-nitrogen limit is normally implemented in lieu of a chronic WET limit. However, should this limit prove ineffective in precluding toxicity, TCEQ staff will amend the permit to include an alternative limit and/or corrective measures protective of the receiving waters.

For those domestic facilities with seasonal ammonia limits and for industrial facilities with ammonia limits, such limits will not exceed 4.0 mg/L at the edge of the mixing zone (or 10 mg/L at the edge of the ZID for those permittees with 48-hour acute testing) unless the permittee agrees to a WET limit for the more sensitive species and a testing frequency for that species of six times per year (November, December, January, February, March, and July).

Toxicity Attributable to Diazinon

The Standards previously contained a special provision (§ 307.6(e)(2)(E)) for those domestic wastewater facilities entering TREs due to Diazinon toxicity. However, since Diazinon can no longer be sold to the public, the previous conditions granting the TRE exemption (primary cause of toxicity and ubiquitous within the wastewater collection system) can no longer be met, so the special provision is no longer included in the Standards. Diazinon will now be treated as any other toxicant and will be subject to effluent limits.

Toxic Pollutants

General Provisions

The Standards for toxic pollutants include general provisions, specific numerical criteria, and total (whole effluent) toxicity criteria. As stated in § 307.6 of the Standards:

- Water in the state shall not be acutely toxic to aquatic life. Although acute criteria may be exceeded in a zone of initial dilution (ZID), there shall be no lethality to aquatic organisms that move through the ZID.

- Water in the state shall not be chronically toxic to aquatic life except in mixing zones, below critical low-flow, and where there are only minimal aquatic life uses.

- Water in the state shall be maintained to preclude adverse toxic effects on human health resulting from water recreation, consumption of aquatic organisms, or consumption of drinking water after reasonable treatment. Specific human health concentration criteria apply to water in the state with sustainable fisheries and/or designation or use as a public drinking water supply. These criteria do not apply within human health mixing zones.

- Water in the state shall be maintained to preclude adverse toxic effects on aquatic life, terrestrial wildlife, livestock, or domestic animals, resulting from contact, consumption of aquatic organisms, or consumption of water.

Permits for discharges into intermittent streams are designed to protect against acute toxicity at the point of discharge. Permits for discharges into classified segments or unclassified water bodies determined to be perennial, intermittent with perennial pools, or within three miles of any water body that is perennial or intermittent with perennial pools are designed to protect against acute and chronic toxicity and to protect human health. Permits for discharges to the Houston Ship Channel and its tidal tributaries (Segments 1006 and 1007) are also designed to protect against acute and chronic toxicity and to protect human health.

In order to prevent toxicity due to chlorine, domestic dischargers who either: (1) request a new permit or amended permit (for increased flow)with permitted flow ≥ 0.5 MGD or (2) request a new, amended, or renewed permit with permitted flow ≥ 1 MGD will dechlorinate their effluent or use another form of disinfection. Domestic dischargers who renew a permit with a permitted flow ≥ 0.5 MGD but < 1 MGD will not be required to dechlorinate. The TCEQ does not require facilities discharging directly to the Rio Grande to dechlorinate.

Specific Numerical Criteria

The numerical criteria for the protection of aquatic life (§ 307.6(c) of the Standards) are expressed for freshwater acute, freshwater chronic, saltwater acute, and saltwater chronic conditions. The numerical criteria for the protection of human health (§ 307.6(d) of the Standards) are expressed as receiving water concentrations to prevent contamination of drinking water, fish, and other aquatic life to ensure safe levels for human consumption. The two categories of human health criteria given in the standards are: (1) water and fish and (2) fish only. These standards apply whether or not they are addressed specifically in a wastewater discharge permit.

When submitting a permit application, the following types of facilities are required to include effluent data for those elements and compounds that have established standards and that the TCEQ believes likely to be present in the effluent:

- domestic facilities requesting a permitted average flow equal to or greater than 1.0 million gallons per day (MGD) and/or with an approved pretreatment program.

- domestic facilities requesting a permitted average flow less than 1.0 MGD on a case-by-case basis when facility inspection or other information provides reasonable potential to expect the presence of toxic pollutants in the receiving water or effluent.

- industrial facilities.

Deriving Permit Limits for Aquatic Life Protection

General Approach

In order to determine the effluent concentration of a toxic pollutant necessary to protect instream water quality criteria, TCEQ staff uses the general approach found in the EPA publication entitled *Technical Support Document for Water Quality-based Toxics Control*, EPA/505/2-90-001.

- TCEQ staff applies acute criteria for discharges into intermittent streams with minimal aquatic life uses and assume a critical low-flow of 0.0 ft^3/s.

- Discharges into intermittent streams that flow into perennial waters (including perennial wetlands) within a moderate distance downstream (normally 3 miles) are analyzed using acute criteria in the intermittent stream and acute and chronic criteria; and the critical low-flow of the perennial waters to determine whether more stringent requirements are needed to protect the perennial waters.

- Permit limits are developed to ensure that intermittent streams with seasonal aquatic life uses of limited, intermediate, high, or exceptional will meet chronic toxic criteria during the seasons; and typical flow conditions in which these uses occur.

- TCEQ staff applies chronic criteria at critical mixing conditions for other water bodies with limited, intermediate, high, or exceptional aquatic life uses (lakes, bays, estuaries, tidal rivers, perennial wetlands), unless acute criteria are more protective.

Water Quality Parameters That Affect Aquatic Life Criteria

For certain substances, water quality criteria are a function of one or more of the following receiving water parameters:

- hardness
- pH
- chloride
- total suspended solids.

Fifteenth percentile values of segment hardness, pH, and TSS data are considered critical conditions (see the tables in Appendix D of this document). Basin values are used when there is insufficient segment data.

The fiftieth percentile value of segment chloride data is used to implement the freshwater silver standard for aquatic life protection (see Appendix D). Basin values are used when there is insufficient segment data.

TCEQ staff usually obtains this information from Appendix D, but may also use information in the TCEQ's Surface Water Quality Monitoring (SWQM) database. The permittee may also supply site-specific data. The procedures to collect site-specific data for hardness, pH, chloride, TSS, and partition coefficients are outlined in the section of this document entitled "Collecting Site-Specific Data" on page 155.

The numerical standards for toxic pollutants apply to total recoverable concentrations, except for designated metals. For these metals, the numerical standards apply to dissolved concentrations. Saltwater and freshwater metals criteria listed in Table 1 of the Standards were derived by multiplying the current standard by the appropriate listed conversion factor to obtain a percent dissolved standard. The resultant value is the percent dissolved metal in the tests used by EPA to derive the criteria.

In order to determine instream compliance with the numerical standards for dissolved concentrations, TCEQ staff use partition coefficients based on the information shown in Table 6 (on page 159) and/or on site-specific data. The use of partition coefficients determines how much metal is dissolved in the receiving water. Guidelines for developing a site-specific partition coefficient are given in the section of this document entitled "Collecting Site-Specific Data" on page 155.

The TCEQ evaluates metals not included in Table 6 by assuming the dissolved concentration equals the total recoverable concentration unless sufficient additional information and data are presented that justify a different fraction of dissolved metal.

Calculating Effluent Fractions

The first step in developing effluent limits based on water quality criteria for aquatic life protection is to calculate the effluent fraction at the edge of the mixing zone and ZID. Unless available information shows otherwise, complete mixing is assumed at the edge of the mixing zone, allowing the fraction of effluent at this location to be calculated.

Perennial Freshwater Streams and Rivers and Some Narrow Tidal Rivers

For discharges to perennial streams and rivers and narrow tidal rivers (that are < 400 feet across and have upstream flow data), 25% of the 7Q2 is used to calculate the effluent fraction (E_F) at the edge of the ZID as follows:

$$E_F \ at\ edge\ of\ MZ = \frac{Q_E}{[Q_S + Q_E]}$$

$$E_F \ at\ edge\ of\ ZID = \frac{Q_E}{[(0.25)(Q_S) + Q_E]}$$

where: Q_E = effluent flow
Q_S = 7Q2 stream flow

Lakes, Bays, Wide Tidal Rivers, and Some Narrow Tidal Rivers

For discharges to lakes, bays, wide tidal rivers (≥ 400 feet across), and narrow tidal rivers (< 400 feet across) that do not have upstream flow data, the fraction of effluent used in each WLA is the amount of effluent at the edge of the ZID or mixing zone as predicted by empirical models. A more complete discussion of the mixing assumptions and exceptions and corresponding effluent fractions is provided in the section of this document entitled, "Critical Conditions for Aquatic Life Protection" on page 72.

Effluent Flow

The effluent flow that is used for dilution calculations is determined on a case-by-case basis. In general, however:

- Domestic wastewater discharge assessments are based upon the final average permitted flow.

- Industrial wastewater discharge assessments for renewals are based upon the highest monthly average discharge of the preceding two-year period. Other flows may be used if the highest monthly average discharge does not reflect normal operating conditions. For proposed new or increased discharges, the requested average flow is used. The effluent flow used to calculate the WLA is also used to calculate the final mass limits.

Calculating Waste Load Allocations

The next step in developing effluent limits based on water quality criteria for aquatic life protection is to calculate a waste load allocation from the acute criteria (WLAa) and a waste load allocation from the chronic criteria (WLAc).

- The **WLAa** equals the effluent concentration that will not cause instream criteria to be exceeded outside the zone of initial dilution (ZID).

- The **WLAc** equals the effluent concentration that will not cause instream criteria to be exceeded outside the mixing zone (MZ).

This calculation requires the use of the appropriate effluent fraction as well as the bioavailable fraction of the pollutant. (For more information on calculating the bioavailable fraction, see the subsection of this document entitled "TSS, Partition Coefficients, and Bioavailable Fractions of Metals" on page 159.) The proportion of effluent at the edge of the mixing zone is used to calculate the WLAc, and the proportion of effluent at the edge of the ZID is used to calculate the WLAa. The following equations are used to calculate the waste load allocations:

$$WLAc = \frac{Chronic\ Criterion}{(Bioavailable\ Fraction)(E_F\ at\ edge\ of\ MZ)}$$

$$WLAa = \frac{Acute\ Criterion}{(Bioavailable\ Fraction)(E_F\ at\ edge\ of\ ZID)}$$

where:

WLAa =	waste load allocation based on acute criterion
WLAc =	waste load allocation based on chronic criterion
Acute Criterion =	aquatic life acute numerical criterion
Chronic Criterion =	aquatic life chronic numerical criterion
Bioavailable Fraction =	fraction of the pollutant that is defined to be available to organisms
E_F *edge of ZID* =	proportional contribution of effluent to receiving water at the edge of the ZID
E_F *edge of MZ* =	proportional contribution of effluent to receiving water at the edge of the mixing zone

Calculating the Long-Term Average

Once the WLAa and the WLAc are calculated, the TCEQ determines the long-term average (LTAa and LTAc) of the treatment system performance that is necessary to meet the respective WLA with a given probability. The TCEQ bases its calculation on a lognormal probability distribution that is known to describe treatment system performance. Figure 7 shows the general shape of a lognormal probability distribution. The LTAa and the LTAc are calculated with equations that describe this function. See the Technical Support Document for Water Quality-based Toxics Control, EPA/505/2-90-001, March 1991, for more information.

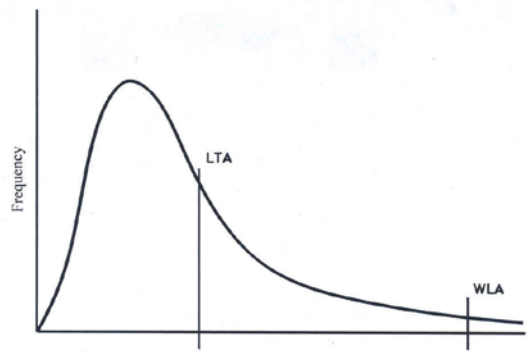

Figure 7. Probability Distribution that Describes Treatment System Performance

The final equations used to calculate the LTAa and the LTAc are:

LTAa =	0.32 *WLAa*	(99% probability)
LTAa =	0.573 *WLAa*	(90% probability)
LTAc =	0.61 *WLAc*	(99% probability)
LTAc =	0.770 *WLAc*	(90% probability)

While the derivation of these equations is quite complex (see Figure 8 on page 138), the important thing to recognize is that the equations are driven by the values that are assumed for n (averaging period), CV (coefficient of variation), and Z (probability distribution factor). The values that TCEQ assumes for these variables are:

n =	7	(7-day average, for chronic criteria)
	1	(24-hour average, for acute criteria)
Z =	1.282	(90% probability for discharges to freshwater streams, rivers, and narrow tidal rivers with upstream flow data)
	2.326	(99% probability for discharges to lakes, reservoirs, bays, estuaries, wide tidal rivers, and narrow tidal rivers without upstream flow data)
CV =	0.6	

Calculating Daily Average and Daily Maximum Permit Limits

The calculated values of LTAa and LTAc are compared. The smaller LTA is limiting and is used to calculate the daily average and daily maximum concentration limits (DLY AVG and DLY MAX, respectively) using the following equations:

DLY AVG =	1.47 *LTA*	(n = 12)
DLY MAX =	3.11 *LTA*	(n = 1)

These equations are driven by the values for Z (2.326), CV (0.6), and n, where n is now the number of sample events per month. For the daily average concentration limit, the TCEQ assumes n = 12 for consistency, even if the sampling frequency defined in the permit is not 3 per week. For the daily maximum concentration limit, the TCEQ uses n = 1. See Figure 9 on page 139 for detailed derivations of these equations. Once the daily average and daily maximum concentration limits are determined, a mass limit is calculated using the same effluent flow used to calculate the WLA.

$$LTA = \exp(u_n + 0.5s_n^2)$$
$$u_n = \ln(WLA) - Zs_n$$
$$s_n^2 = \ln [1 + (CV^2/n)]$$

Acute Criteria

$$s_n^2 = \ln [1 + (0.6^2/1)] = 0.307$$
$$s_n = 0.555$$

For Z = 2.326 (99% probability):

u_n = ln(WLAa) - (2.326)(0.555)
u_n = ln(WLAa) - 1.291
LTAa = exp[ln(WLAa) - 1.291 + 0.5(0.307)]
LTAa = exp[ln(WLAa) -1.137]
LTAa = WLAa/$e^{1.137}$
LTAa = 0.32 × WLAa

For Z = 1.282 (90% probability):

u_n = ln(WLAa) - (1.282)(0.555)
u_n = ln(WLAa) - 0.712
LTAa = exp[ln(WLAa) - 0.712 + 0.5(0.307)]
LTAa = exp[ln(WLAa) - 0.558]
LTAa = WLAa/$e^{0.558}$
LTAa = 0.573 × WLAa

Chronic Criteria

$$s_n^2 = \ln [1 + (0.6^2/7)] = 0.050$$
$$s_n = 0.224$$

For Z = 2.326 (99% probability):

u_n = ln(WLAc) - (2.326)(0.224)
u_n = ln(WLAc) - 0.521
LTAc = exp[ln(WLAc) - 0.521 + 0.5(0.050)]
LTAc = exp[ln(WLAc) -0.496]
LTAc = WLAc/$e^{0.496}$
LTAc = 0.61 × WLAc

For Z = 1.282 (90% probability):

u_n = ln(WLAc) - (1.282)(0.224)
u_n = ln(WLAc) - 0.287
LTAc = exp[ln(WLAc) - 0.287 + 0.5(0.050)]
LTAc = exp[ln(WLAc) - 0.262]
LTAc = WLAc/$e^{0.262}$
LTAc = 0.770 × WLAc

Figure 8. Derivation of Equations Used to Calculate the Long-Term Average

$$LIMIT = \exp(u_n + Zs_n)$$
$$u_n = \ln(LTA) - 0.5s_n^2$$
$$s_n^2 = \ln [1 + (CV^2/n)]$$

Daily Average

$$s_n^2 = \ln [1 + (0.6^2/12)] = 0.030$$
$$s_n = 0.173$$
$$u_n = \ln(LTA) - (0.5)(0.030)$$
$$u_n = \ln(LTA) - 0.015$$
$$\text{DLY AVG} = \exp[\ln(LTA) - 0.015 + (2.326)(0.173)]$$
$$\text{DLY AVG} = \exp[\ln(LTA) + 0.387]$$
$$\text{DLY AVG} = LTA \times e^{0.387}$$
$$\text{DLY AVG} = 1.47 \times LTA$$

Daily Maximum

$$s_n^2 = \ln [1 + (0.6^2/1)] = 0.307$$
$$s_n = 0.555$$
$$u_n = \ln(LTA) - (0.5)(0.307)$$
$$u_n = \ln(LTA) - 0.154$$
$$\text{DLY MAX} = \exp[\ln(LTA) - 0.154 + (2.326)(0.555)]$$
$$\text{DLY MAX} = \exp[\ln(LTA) + 1.137]$$
$$\text{DLY MAX} = LTA \times e^{1.137}$$
$$\text{DLY MAX} = 3.11 \times LTA$$

Figure 9. Derivation of Equations Used to Calculate Daily Average and Daily Maximum Concentration Limits

Deriving Permit Limits for Human Health Protection

General Approach

In order to calculate the effluent concentration of a toxic pollutant necessary to protect instream water quality criteria, TCEQ staff use the general approach found in the EPA publication entitled *Technical Support Document for Water Quality-based Toxics Control*, EPA/505/2-90-001, March 1991.

- The human health criteria in Table 2 of the Standards apply to all water bodies with (1) a designation or use as a public drinking water supply and/or (2) sustainable fisheries, including:
  - all designated segments.
  - perennial streams with a stream order of three or greater.
  - lakes having a volume equal to or greater than 150 acre-feet and/or a surface area equal to or greater than 50 acres.
  - all bays, estuaries, and tidal rivers.
  - permanently inundated wetlands (including tidal wetlands).
  - any other waters that potentially have sufficient fish production or fishing activity to create significant long-term (sustainable) human consumption of fish.
- Human health criteria are applied to any discharge located within three miles upstream of the types of water bodies listed above.
- Waters with a limited, intermediate, high, or exceptional aquatic life use but no sustainable fishery are considered to have an incidental fishery. Numerical criteria applicable to waters with incidental fisheries are ten times higher than for sustainable fisheries because the consumption rates assumed in the Standards for incidental fisheries are ten times lower than those for sustainable fisheries. This level of human health protection applies to discharges directly to or within three miles upstream of waters with an incidental fishery.
- Specific human health criteria are applied as long-term average exposure criteria designed to protect populations over a lifetime.

Calculating the Effluent Fraction

The first step in developing effluent limits based on water quality for human health protection is to calculate the effluent fraction at the edge of the human health mixing zone. Unless available information shows otherwise, complete mixing is assumed at the edge of the mixing zone, allowing the fraction of effluent at this location to be calculated.

Perennial Freshwater Streams and Rivers, Intermittent Streams with Perennial Pools, and Some Narrow Tidal Rivers

For discharges to perennial freshwater streams and rivers, intermittent streams with perennial pools, and narrow tidal rivers (that are < 400 feet across and have upstream flow data), the proportion of effluent used in WLAh is calculated as follows:

$$E_F \; at\, edge\, of \; HH\; MZ = \frac{Q_E}{[Q_{HM} + Q_E]}$$

where: Q_E = effluent flow

Q_{HM} = harmonic mean stream flow

TCEQ staff use data from the nearest stream gaging station or available site-specific information to determine the harmonic mean flow.

Lakes, Bays, Wide Tidal Rivers, and Some Narrow Tidal Rivers

For discharges to lakes, bays, wide tidal rivers (≥ 400 feet across), and narrow tidal rivers (< 400 feet across) that do not have upstream flow data, the fraction of effluent used in the WLAh is the amount of effluent at the edge of the human health mixing zone as predicted by empirical models. A discussion of the mixing assumptions and exceptions and corresponding effluent fractions is given in the section of this document entitled “Mixing Zones and Critical Conditions for Human Health Protection” on page 78.

Effluent Flow

The effluent flow that is used for dilution calculations is determined on a case-by-case basis. In general, however:

- Domestic wastewater discharge assessments are based upon the final average permitted flow.

- Industrial wastewater discharge assessments for renewals are based upon the average of monthly average flow values over the preceding two-year period. For proposed new or increased discharges, the requested average flow is used.

Calculating the Waste Load Allocation

The next step in developing effluent limits based on water quality criteria for human health protection is to calculate a waste load allocation (WLAh). The WLAh equals the effluent concentration that will not cause criteria to be exceeded outside the human health mixing zone. This calculation requires the use of the appropriate effluent fraction as well as the bioavailable fraction of the pollutant. (For more information on calculating the bioavailable fraction, see the subsection of this document entitled "TSS, Partition Coefficients, and Bioavailable Fractions of Metals" on page 159.) The proportion of effluent at the edge of the human health mixing zone is used to calculate the WLAh. The following equation is used to calculate the waste load allocation:

$$WLAh = \frac{HH\ Criterion}{(Bioavailable\ Fraction)(E_F\ at\ edge\ of\ HH\ MZ)}$$

where:

HH Criterion =	appropriate human health numerical criterion
Bioavailable Fraction =	fraction of the pollutant that is defined to be available to organisms
EF at edge of HH MZ =	proportional contribution of effluent to receiving water at the edge of the human health mixing zone

Calculating the Long-Term Average and Permit Limits

The WLAh is considered to be an annual average (n = 365 days). The long-term average (LTAh), daily average concentration (DLY AVG), and daily maximum concentration (DLY MAX) are calculated at 99% probability (Z = 2.326) using the same process that was used for the aquatic life calculations (see Figure 8 on page 138 and Figure 9 on page 139). The final equations are as follows:

$$LTAh = 0.930\ WLAh \quad (n = 365)$$

$$DLY\ AVG = 1.47\ LTAh \quad (n = 12)$$

$$DLY\ MAX = 3.11\ LTAh \quad (n = 1)$$

Establishing Permit Limits for Toxic Pollutants without Criteria

In some instances, potentially toxic materials for which no specific numerical criteria have been developed are used in a treatment process or are present in an effluent. Where necessary, permit limits are developed for these materials using available toxicity data and the method described in this section. For substances without standards that are reported in the permit application, TCEQ staff screen the reported value against the agency-specified minimum analytical level (MAL). Parameters less than the MAL are screened out with no further action necessary. Numerical criteria and permit limits are developed, if appropriate, for parameters exceeding the MAL. For substances that commonly occur naturally at concentrations above the MAL, alternative screening criteria are used.

Aquatic Life Criteria

The TCEQ develops permits that protect against acute and chronic toxicity in receiving waters at and above critical conditions, as appropriate. Critical conditions in receiving waters are established using methods discussed in the chapter of this document entitled "Mixing Zones and Critical Conditions" beginning on page 70. As stated in § 307.6(c)(7) of the Standards, water quality criteria for the protection of aquatic life are established using the methods described in this subsection.

Specific numerical criteria are calculated using the method outlined in the following documents if toxicity data requirements outlined in these documents are met:

- Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and Its Uses (45 FR 79341-79347 November 28, 1980).

- Summary of Revisions to "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" (50 FR 30792-30793, July 29, 1985).

Acute Criteria

If the data requirements in the documents cited above are not met, acute water quality criteria are calculated as follows:

$$\textit{ACUTE CRITERIA} = 0.30 \times \textit{LC50} \text{ of most sensitive species}$$

where: *LC50* = the concentration of a toxicant that is lethal (fatal) to 50% of the organisms tested in a specified time period

Chronic Criteria

The derivation of chronic water quality criteria for the protection of aquatic life depends on the persistence and bioaccumulative capacity of the material. A pollutant's potential to bioaccumulate can be expressed by any of the following:

- the bioaccumulation factor (BAF)
- the bioconcentration factor (BCF)
- the octanol-water partition coefficient (K_{ow}).

The BAF and the BCF measure the concentration of a substance in a living organism relative to the concentration of the substance in the surrounding medium. The BAF accounts for substance intake from both food and the surrounding medium, while the BCF accounts for intake from the surrounding medium only. The K_{ow} estimates the tendency of a substance to partition from water to organic media, such as lipids present in living organisms. The K_{ow} can be used in place of the BCF or BAF when limited experimental data are available.

For the purposes of this section, the TCEQ will use the following criteria to determine whether a chemical is persistent or bioaccumulative:

- A chemical is **persistent** if it has a soil, sediment, or water half-life of 60 days or greater. It is **highly persistent** if it has a soil, sediment, or water half-life of six months or greater. Half-life is defined as the time required for 50% of a chemical to degrade or to be removed from the local environment by some physical process.[12]

- A chemical is **bioaccumulative** if its BAF or BCF is 1,000 or greater. It is **highly bioaccumulative** if either its BAF or BCF is 5,000 or greater.

The following methods for deriving chronic criteria are consistent with § 307.6(c)(7) of the Standards.

Nonpersistent toxic compounds:

$$\textit{CHRONIC CRITERIA} = 0.10 \times \textit{LC50} \text{ of most sensitive species}$$

Persistent toxic compounds:

$$\textit{CHRONIC CRITERIA} = 0.05 \times \textit{LC50} \text{ of most sensitive species}$$

Bioaccumulative toxic compounds:

$$\textit{CHRONIC CRITERIA} = 0.01 \times \textit{LC50} \text{ of most sensitive species}$$

[12] Rand, Gary M. (ed.), 1995. *Fundamentals of Aquatic Toxicology (Second Edition)*. CRC Press.

Data Considerations

- Toxicity data used in these equations should be derived from tests using the most sensitive native species.

- If no LC50 data are available for native species, non-native species data may be used.

- LC50s are selected that have appropriate end points (mortality), appropriate duration (96 hours for vertebrates and 48 hours for invertebrates), and appropriate species (freshwater or saltwater).

- LC50 data based on a freshwater species are not appropriate for saltwater criteria development and vice versa.

- Data from flow-through tests is preferred over static renewal tests.

- Where more than one acceptable test endpoint is available for a given species, a geometric mean of the LC50 data should be used for the criteria calculation.

- Toxicity tests using aquatic plants are not considered at this time.

- When evaluating BAFs and BCFs for a persistence determination, lab-derived BAFs/BCFs are preferred over $\log K_{ow}$-based regression equations.

- When multiple BAF/BCF data points are available for similar taxa (same genus), the geometric mean of these values should be used as opposed to one single data point.

There may be instances when toxicity data are only available for species not representative of the receiving waters, test durations are varied, or other undesirable circumstances exist. In this instance, it may be more appropriate to rely on a quantitative structure-activity relationship (QSAR) model for LC50 prediction or to use a method that differs from the one described in this section.

If acute or chronic criteria need to be derived for biocides, other water treatment chemicals, or other constituents present in the effluent for which water quality standards are not established, the methods just described are used. The following information is typically needed to determine these criteria:

- product information sheet
- material safety data sheet (MSDS) if available
- product toxicity data
- permitted discharge volume
- expected concentration of product in effluent
- discharge location.

Human Health Criteria

Water quality criteria for human health protection are derived as stated in § 307.6(d)(8) and (9) of the Standards.

- For known or suspected carcinogens, a cancer risk of 10^{-5} (1 in 100,000) is applied to the most recent numerical criteria adopted by EPA and published in the *Federal Register*.

- For toxic materials not defined as carcinogens, the most recent numerical criteria adopted by EPA and published in the *Federal Register* are applicable.

- Criteria calculations for noncarcinogens are based on childhood exposure, and criteria calculations for carcinogens are based on a lifetime of exposure.

- In both cases, if a maximum contaminant level (MCL) applies and is less than the resulting criterion, then the MCL applies to public drinking water supplies as stated in § 307.6(d)(3)(G) of the Standards.

- Numerical criteria for pollutants that bioconcentrate are derived in accordance with the general procedures in the EPA guidance document entitled *Assessment and Control of Bioconcentratable Contaminants in Surface Waters* (March 1991).

In the absence of available criteria, numerical criteria may be derived from available information and calculated using the following formulas:

WATER AND FISH, CARCINOGENS

$$HH\ CRITERIA\ (\mu g / L) = \frac{(RL)(BW)(U)}{CPF\,[WI + (FC)(LC)(BCF)]}$$

FISH TISSUE ONLY, CARCINOGENS

$$HH\ CRITERIA\ (\mu g / L) = \frac{(RL)(BW)(U)}{(CPF)(FC)(LC)(BCF)}$$

where:

RL = risk level (1 in 100,000, or 10^{-5})

BW = body weight of average adult (70 kg)

U = unit conversion factor to express criteria in µg/L (1000 µg/mg)

CPF = carcinogenic potency factor (oral slope factor, kg-day/mg)

WI = amount of water consumed per day (2 L/day)

FC = amount of fish tissue consumed (0.0175 kg/day)

LC = lipid correction factor to adjust BCFs normalized to 7.6% lipids to represent a 3% lipid content (3% ÷ 7.6%)

BCF = bioconcentration factor (L/kg)

WATER AND FISH, NONCARCINOGENS

$$HH\ CRITERIA\ (\mu g / L) = \frac{(RfD)(BW)(U)}{WI + (FC)(LC)(BCF)}$$

FISH TISSUE ONLY, NONCARCINOGENS

$$HH\ CRITERIA\ (\mu g / L) = \frac{(RfD)(BW)(U)}{(FC)(LC)(BCF)}$$

where:

RfD = reference dose (mg toxicant/kg human body weight/day)

BW = body weight of average child (15 kg)

U = unit conversion factor to express criteria in µg/L (1000 µg/mg)

WI = amount of water consumed per day (0.64 L/day)

FC = amount of fish tissue consumed (0.0056 kg/day)

LC = lipid correction factor to adjust BCFs normalized to 7.6%

lipids to represent a 3% lipid content (3% ÷ 7.6%)

BCF = bioconcentration factor (L/kg)

These formulas convert BCFs that are normalized to 7.6% lipid content to represent a 3% lipid content. The majority of recently developed BCFs have been normalized to represent a 3% lipid content; therefore, it is essential to research the BCF being used in the equation to ascertain what lipid content the BCF represents. When using a BCF that is already normalized to 3% lipid content, the lipid correction factor (LC) equals one.

Correcting for Background Concentrations

In developing effluent limits based on water quality criteria, the preferred method of accounting for background concentrations of toxic pollutants is through total maximum daily load (TMDL) allocations. However, until TMDLs are approved and available for particular assessment units (AUs) and toxic pollutants of concern, the procedure discussed in this section is used to screen applications and develop permit limits.

For purposes of this section, the following definitions apply:

Background concentration: the water quality in a particular water body that would occur if that water body were relatively unaffected by human activities.

Ambient concentration: the existing water quality in a particular water body.

Procedure for Developing Permit Limits

The procedure for screening application data and developing permit limits is shown in Figure 10 on page 151. If an approved TMDL exists for a particular pollutant and AU, the permit incorporates a limit as established by the TMDL procedure. In the absence of an approved TMDL, application data is screened using reliable background concentration data, if such data exist.

Table 5 on page 150 lists reliable background concentration data that are used routinely in application screening. Data are added to Table 5 as they become available.

When reliable background concentration data are not available, data are screened with the assumption that the background concentration is zero. The assumption of a zero background concentration may be reconsidered on a case-by-case basis as new information becomes available.

When the background concentration is less than the instream criterion, a mass balance approach is used to determine waste load allocations for affected parameters. This approach is applicable for calculating permit limits for both aquatic life and human health protection.

The following equation is used to calculate the waste load allocation (WLA):

$$WLA = \frac{Criterion - [(1 - E_F)(C_B)(Bioavailable\ Fraction)]}{(Bioavailable\ Fraction)(E_F)}$$

where:

WLA =	waste load allocation (total concentration)
Criterion =	appropriate numerical criterion (dissolved, free ion, or total concentration as specified in Table 1 or 2 of the Standards)
E_F =	proportional contribution of effluent to receiving water
C_B =	background concentration of pollutant (total concentration)
Bioavailable Fraction =	fraction of the pollutant that is defined to be available to organisms

When the background concentration is assumed to be zero, the equation above reduces to those shown in the sections of this document entitled "Deriving Permit Limits for Aquatic Life Protection" on page 131 and "Deriving Permit Limits for Human Health Protection" on page 140.

When the background concentration is equal to or greater than the instream criterion, then effluent permit limits are developed to ensure that no degradation of water quality will occur, in accordance with the procedures to protect existing uses (see the chapter of this document entitled "Antidegradation" on page 55).

Table 5. Background Concentrations of Toxic Metals in Texas Estuaries

Segment Number	Water Body	Total Copper (µg/L)	Total Lead (µg/L)	Total Silver (µg/L)	Total Zinc (µg/L)
1401	Colorado Estuary	0.99	0.27	0.003	1.76
2412	Sabine Estuary	1.00	0.19	0.004	1.20
2421	Galveston Estuary	0.75	0.21	0.004	1.90
2439	Galveston Estuary	0.75	0.21	0.004	1.90
2451	Lavaca-Matagorda Estuary	0.57	0.12	0.002	1.25
2453	Lavaca-Matagorda Estuary	0.57	0.12	0.002	1.25
2462	San Antonio Estuary	1.23	0.20	0.003	2.18
2481	Corpus Christi Estuary	0.70	0.14	0.003	4.04

Notes: Background concentrations represent the geometric mean of the data set.

Data compiled from Benoit, G. and P. H. Santschi, 1991; *Trace Metals in Texas Estuaries*; Prepared for the Texas Chemical Council; Texas A&M University at Galveston, Department of Marine Science.

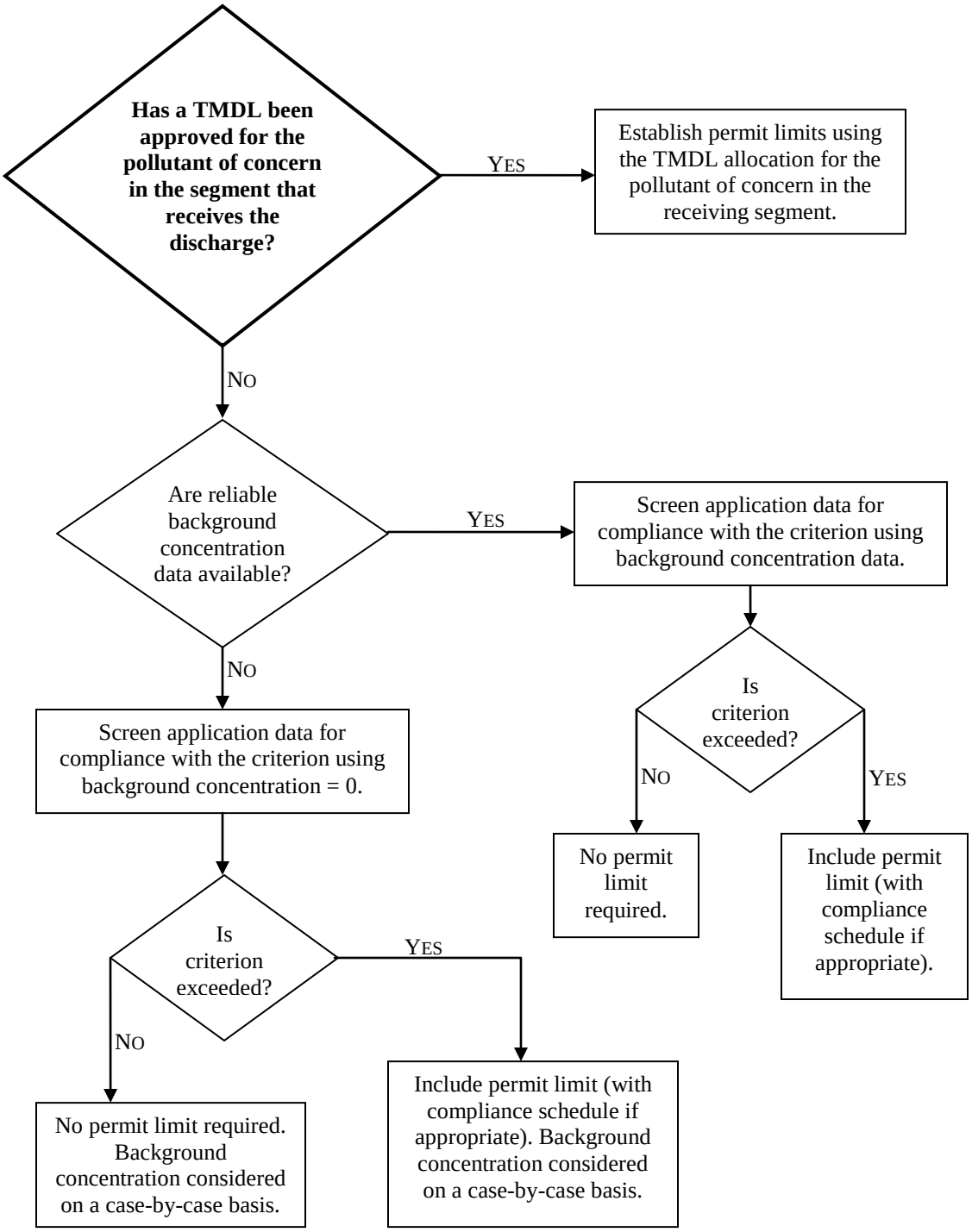

Figure 10. Protocol for Including Background Concentrations in Permit Limit Calculations

Obtaining Reliable Water Quality Data

Reliable background concentration data are needed for application screening. Samples should be collected, analyzed, and handled as follows:

1. Collect and preserve samples using techniques that conform with EPA-approved methods. Collect and preserve samples for metals using clean techniques (see item 3a below) or equivalent.

2. Analyze samples using EPA-approved methods. Analyses should meet agency-specified minimum analytical levels (MALs) (see Tables E-1 and E-2 in Appendix E) for the pollutant or pollutants of concern.

3. Sample collection, preservation, handling, storage, analysis, quality assurance, and quality control procedures should be comparable to those specified in the following documents:

   a. *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue* , RG-415, Texas Commission on Environmental Quality, December 2003 (or latest revision).

   b. Work Plan/Quality Assurance Project Plan for Near Coastal Waters Project, Sec. 104(b)(3), Grant No. X-006559-01-0, *Total Maximum Daily Loads of Selected Heavy Metals in the Houston Ship Channel, San Jacinto River (Tidal) and Upper Galveston Bay*, Texas Water Commission, Environmental Assessment Division, August 1993.

   c. Benoit, G. and P. H. Santschi, 1991; *Trace Metals in Texas Estuaries*; Prepared for the Texas Chemical Council; Texas A&M University at Galveston, Department of Marine Science.

4. Collect freshwater samples during moderate or low stream flow conditions. Collect marine or tidally influenced water samples during low freshwater inflow conditions. Such flow conditions should prevail for at least one week prior to data collection.

5. When gathering data for metals, measure TSS and hardness at each freshwater sample site. When gathering data for silver, measure chloride at each sample site.

Once-Through Cooling Water Discharges

Applicability

As stated in § 307.8(d) of the Standards, the TCEQ does not require effluent limits based on water quality criteria for those pollutants discharged in once-through cooling water where no measurable increase of the pollutant concentration occurs in the effluent as compared to the intake water.

This exemption applies exclusively to once-through cooling water discharges. It excludes facilities withdrawing from one water body and subsequently discharging the cooling water into a different water body; such facilities have to maintain and protect water quality and applicable water quality standards in the receiving water. Exceptions to this exclusion are considered on a case-by-case basis (for example, intake is in a tidal water body and discharge is to a downstream bay or estuary).

Permit Action

A permittee should request a once-through cooling water exemption during the wastewater permit application process. The terms and conditions of the new permit may vary depending on existing permit conditions and the amount of data available.

- If an existing permit has final effluent limits based on water quality criteria for the pollutant of concern, these limits will remain in the reissued permit until sufficient monitoring has been conducted to support the exemption.

- If an existing permit does not include effluent limits based on water quality criteria for the pollutant of concern, interim effluent limits or monitoring requirements may be included in the permit. The permit will be issued for a term of up to three years to allow time for the permittee to perform a statistical study and source evaluation.

  Language will also be included in the “Other Requirements” section of the permit that outlines what the permittee must do and the time frame (up to three years) in which it must be done. Included in this language will be a statement as follows: “If the permittee does not conduct or complete the study at least 180 days prior to the permit expiration date, the following effluent limits for (pollutant of concern) will become effective immediately in a reissued permit.”

The TCEQ will coordinate with the EPA on case-by-case reviews for these situations.

The permit will contain a special provision stating that the exemption will be approved or denied based upon the findings of the statistical study and the findings of the source investigation.

Statistical Study

To demonstrate that no measurable increase in the pollutant of concern occurs through the once-through cooling water outfall, the applicant needs to perform a statistical analysis to determine whether a pollutant's average concentration demonstrates a statistically significant increase at the 95 percent confidence level. All applicants considering an exemption are urged to work with TCEQ staff to determine an acceptable work plan.

Data Collection

The applicant should collect at least 10 paired grab samples, where the term "paired" refers to both intake and discharge samples being collected within one hour of each other. In cases where the hydraulic retention time in the cooling system exceeds one hour, the paired samples may be collected more than one hour apart. Information regarding the hydraulic retention time should be included in the study report.

Each intake sample should be depth integrated from the water surface down to the depth of the intake pipe. For discharges to a marine water body, samples should be collected during slack tide. Samples should be collected at least 10 days apart from each other and be representative of normal operating conditions. Clean techniques for field and analytical procedures should be considered when determining trace metal levels in noncontact cooling water (USEPA Method 1669 - April 1995).

Statistical Analysis

To demonstrate that no measurable increase in a pollutant occurs through the once-through cooling water outfall, the applicant should perform a statistical analysis to determine whether the pollutant's average concentration demonstrates a statistically significant increase at the 95 percent confidence level. The two-tailed Student's t-test should be used to compare the influent concentrations to the effluent concentrations. The applicant should calculate the mean and standard deviation for each paired data set using a lognormal distribution. When portions of a data set are at concentrations less than the MAL, the applicant should adjust the mean and standard deviation calculation with appropriate methodology.

Examples of appropriate methods include the delta lognormal approach as described in the *Technical Support Document for Water Quality-based Toxic Control*, EPA/505/2-90-001, and the Cohen test method described in the *Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities*, NTIS No. PB89-151047.

Source Investigation

A source investigation of the pollutant will also be performed by the applicant requesting the exemption. All applicants performing source investigations are urged to work with TCEQ staff to determine appropriate sampling locations. Potential sources include but are not limited to:

- current and historical sources of the pollutant in question (such as metal cleaning waste)
- cooling tubes
- pollutants in tributaries entering the reservoir
- pollutants in the soils surrounding the reservoir.

This information can be used to support the applicant's contention that the discharge of once-through cooling water does not contribute to the pollutant concentration in the reservoir. Low-volume waste streams are addressed by:

- demonstrating that the pollutant of concern cannot be added by the waste stream; or

- establishing a permit limit to attain water quality standards at the internal outfall.

Exemption Approval or Denial

Based on the results of the statistical analysis and the source investigation, TCEQ staff recommends granting or denying the exemption.

- If the exemption is approved, the permit is issued without effluent limits based on water quality criteria for the pollutant of concern. A statement is included in the "Other Requirements" section of the permit that a once-through cooling water exemption for the pollutant of concern has been approved for the appropriate outfall. Long-term monitoring for the exempted pollutant is also included in the "Other Requirements" section of the permit.

- If the exemption is not approved, the permit is amended to include appropriate effluent limits based on water quality criteria, including any appropriate compliance period.

Note that if the receiving water body does not attain water quality standards for the pollutant in question, the exemption can still be granted, but the applicant may be required to submit additional data.

Collecting Site-Specific Data

Permittees may collect data on site-specific hardness, pH, chloride, TSS, or metals to support calculation of some water quality criteria and site-specific partition coefficients or bioavailable fractions of metals.

- **Hardness**—water quality criteria for certain metals (cadmium, trivalent chromium, copper, lead, nickel, and zinc) depend on hardness.

- **pH**—water quality criteria for pentachlorophenol depend on pH.

- **Chloride**—the percentage of dissolved silver that is in free ionic form depends on chloride.

- **TSS**—partition coefficients, and hence, bioavailable fractions of metals, depend on TSS.

- **Metals**—the bioavailable fractions of metals can be determined directly by measuring dissolved concentrations and total recoverable concentrations.

The TCEQ usually uses segment or basin values for hardness, pH, chloride, and TSS from the tables in Appendix D of this document. Permittees who think that these default values do not adequately reflect conditions in their receiving water may collect site-specific data and submit it to the TCEQ for review.

Guidelines for collecting hardness, pH, and chloride data are presented in the next subsection, entitled "Hardness, pH, and Chloride." Guidelines for collecting TSS and metals data and for developing site-specific partition coefficients and bioavailable metals fractions are presented in the subsection entitled "TSS, Partition Coefficients, and Bioavailable Fractions of Metals" on page 159.

Hardness, pH, and Chloride

Hardness

In general, most metals are more toxic in water that has low hardness values (soft water). Therefore, water quality criteria are more stringent for receiving waters having a low hardness value. The TCEQ uses the 15th percentile of basin or segment hardness data (ranked from lowest to highest value) to calculate hardness-dependent criteria. Before collecting any site-specific data, it is advisable for the permittee to determine what default value was used in the TCEQ's calculations.

The following items outline acceptable procedures for collecting site-specific hardness data:

- Collect samples from the receiving water upstream of the discharge, if available, and outside of the regulatory mixing zone. For more information about mixing zones, see § 307.8(b) of the Standards and the section of this document entitled "Mixing Zones and ZIDs for Aquatic Life Protection" on page 70.

  If no water is present upstream of the discharge, samples may be taken from a nearby perennial stream or from the nearest downstream perennial stream. Samples should occur above the confluence with the receiving stream so that samples are not affected by the effluent hardness.

- Collect a minimum of 30 samples from the receiving water to represent a range of seasonal conditions. The applicant is responsible for providing a minimum of 30 valid data points to obtain a statistically reliable estimate of the 85th percentile value of the dissolved-to-total ratio. Samples should typically be taken a minimum of one week apart from one another.

- Measure hardness as mg/L of $CaCO_3$.

- If the permit includes whole effluent toxicity (WET) testing requirements **and** receiving water is used as the control, control hardness values may also be used to supplement any site-specific data that is collected. Laboratory dilution water may not be used to provide hardness data.

pH

Pentachlorophenol is more toxic in water that has low pH (acidic). Therefore, the permit limit for pentachlorophenol is more stringent for facilities whose receiving water has low pH. The TCEQ uses the 15th percentile of basin or segment pH data (ranked from lowest to highest value) to calculate freshwater criteria for pentachlorophenol. Before collecting any site-specific data, it is advisable for the permittee to determine what default value was used in the TCEQ's calculations.

The following items outline acceptable procedures for collecting site-specific pH data:

- Collect samples from the receiving water upstream of the discharge, if available, and outside of the regulatory mixing zone. For more information about mixing zones, see § 307.8(b) of the Standards and the section of this document entitled, "Mixing Zones and ZIDs for Aquatic Life Protection" on page 70.

  If no water is present upstream of the discharge, samples may be taken from a nearby perennial stream or from the nearest downstream perennial stream. Be sure to sample above the confluence with the receiving stream so that samples are not affected by the effluent pH.

- Collect a minimum of 30 samples from the receiving water to represent a range of seasonal conditions. The applicant is responsible for providing a minimum of 30 valid data points to obtain a statistically reliable estimate of the 85th percentile value of the dissolved-to-total ratio. Samples should typically be taken a minimum of one week apart from one another.

Chloride

More silver is present in free ionic form (and is therefore more toxic) in water that has low chloride concentrations. Therefore, the permit limit for silver is more stringent for facilities whose receiving water has low chloride concentrations. The TCEQ uses the 50th percentile of basin or segment chloride data to calculate the percentage of dissolved silver that is in free ionic form. Before collecting any site-specific data, it is advisable for the permittee to determine what default value was used in the TCEQ's calculations.

The following items outline acceptable procedures for collecting site-specific chloride data:

- Collect samples from the receiving water upstream of the discharge, if available, and outside of the regulatory mixing zone. For more information about mixing zones, see § 307.8(b) of the Standards and the section of this document entitled, "Mixing Zones and ZIDs for Aquatic Life Protection" on page 70.

  If no water is present upstream of the discharge, samples may be taken from a nearby perennial stream or from the nearest downstream perennial stream. Be sure to sample above the confluence with the receiving stream so that samples are not affected by chloride concentration in the effluent.

- Collect a minimum of 30 samples from the receiving water to represent a range of seasonal conditions. The applicant is responsible for providing a minimum of 30 valid data points to obtain a statistically reliable estimate of the 85th percentile value of the dissolved-to-total ratio. Samples should typically be taken a minimum of one week apart from one another.

TSS, Partition Coefficients, and Bioavailable Fractions of Metals

For most metals, with the exceptions of mercury and selenium, the water quality criteria for aquatic life protection are expressed as dissolved concentrations. The dissolved concentration of a metal is the bioavailable fraction of the total metal concentration. The ratio of the dissolved concentration to the total recoverable concentration is expressed in terms of the partition coefficient (K_p) and TSS concentration:

$$\frac{C_d}{C_T} = \frac{1}{1 + (K_p \times TSS \times 10^{-6})}$$

where:
C_d = dissolved metal concentration
C_T = total metal concentration
K_p = partition coefficient (L/kg)
TSS = total suspended solids (mg/L)

The partition coefficient is itself a function of TSS concentration:

$$K_p = 10^b \times (TSS)^m$$

where:
K_p = partition coefficient (L/kg)
b = intercept (found in Table 6)
TSS = total suspended solids (mg/L)
m = slope (found in Table 6)

Table 6 lists the slope (m) and intercept (b) values for the relationship between TSS and the partition coefficient for most metals. The TCEQ typically uses the segment-specific TSS values from the tables in Appendix D of this document along with the values and equations in Table 6 to calculate the bioavailable fraction of a metal. The bioavailable fraction is then used in the waste load allocation (WLA). For more information on WLAs, see the subsection of this document entitled "Calculating Waste Load Allocations" on page 134.

Table 6. Slope (m) and Intercept (b) Values Used to Calculate Partition Coefficients for Metals in Streams, Lakes, and Estuarine Systems

METAL	STREAMS [1]		LAKES [1]		ESTUARINE SYSTEMS [2]	
	b	m	b	m	b	m
Arsenic	5.68	-0.73	Assumed equal to streams		—	—
Cadmium	6.60	-1.13	6.55	-0.92	—	—
Chromium	6.52	-0.93	6.34	-0.27	—	—
Copper	6.02	-0.74	6.45	-0.90	4.85	-0.72
Lead	6.45	-0.80	6.31	-0.53	6.06	-0.85
Mercury	6.46	-1.14	6.29	-1.17	—	—
Nickel	5.69	-0.57	6.34	-0.76	—	—
Silver [3]	6.38	-1.03	Assumed equal to streams		5.86	-0.74
Zinc	6.10	-0.70	6.52	-0.68	5.36	-0.52

1 Attachment I in *Technical Guidance Manual for Performing Waste Load Allocations. Book II: Streams and Rivers. Chapter 3: Toxic Substances*, EPA-440/4-84-022, June 1984.

2 Benoit, G., S.D. Oktay-Marshall, A. Cantu II, E.M. Hood, C.H. Coleman, M.O. Corapcioglu, and P.H. Santschi.1994. Partitioning of Cu, Pb, Ag, Zn, Fe, Al, and Mn Between Filter-Retaining Particles, Colloids, and Solution in Six Texas Estuaries. *Marine Chemistry*, 45:307-336.

3 Wen, L., P.H. Santschi, G.A. Gill, C.L. Paternostro, and R.D. Lehman. 1997. Colloidal and Particulate Silver in River and Estuarine Waters of Texas. *Environmental Science & Technology*, 31:723-731.

Permittees have some options available to them for modifying the calculation of bioavailable fractions:

- Collect site-specific TSS data—this allows the partition coefficient to be calculated using a site-specific TSS value in place of the 15th percentile of the basin or segment values. The resulting bioavailable fraction will also be modified.

- Collect site-specific total and dissolved metals concentrations—this allows the ratio of C_d to C_T to be measured directly without calculating a revised partition coefficient.

Both of these options are discussed in more detail below.

Collect Site-Specific TSS Data

The TCEQ uses the 15th percentile of basin or segment TSS data (ranked from lowest to highest value) to calculate partition coefficients. Before collecting any site-specific data, it is advisable for the permittee to

determine what default value was used in the TCEQ's calculations. The following items outline acceptable procedures for collecting site-specific TSS data:

- Collect samples from the receiving water upstream of the discharge, if available, and outside of the regulatory mixing zone. For more information about mixing zones, see § 307.8(b) of the Standards and the section of this document entitled, "Mixing Zones and ZIDs for Aquatic Life Protection" on page 70.

  If no water is present upstream of the discharge, samples may be taken from a nearby perennial stream or from the nearest downstream perennial stream. Be sure to sample above the confluence with the receiving stream so that samples do not include TSS from the effluent.

- Collect a minimum of 30 samples from the receiving water to represent a range of seasonal conditions. The applicant is responsible for providing a minimum of 30 valid data points to obtain a statistically reliable estimate of the 85th percentile value of the dissolved-to-total ratio. Samples should typically be taken a minimum of one week apart from one another.

- If the permit includes whole effluent toxicity testing requirements **and** receiving water is used as the control, control TSS values may also be used to supplement any site-specific data that is collected. Laboratory dilution water may not be used to provide TSS data.

Collect Site-Specific Total and Dissolved Metals Concentrations

Where slopes and intercepts to calculate a partition coefficient are not available in Table 6, or where a permittee wishes to develop a site-specific bioavailable fraction for a metal (but not a site-specific TSS value), the TCEQ has established the following guidelines:

- Collect samples from the receiving water **upstream of the discharge** and outside the regulatory mixing zone. These samples should be mixed with the effluent at the proportion representative of the critical dilution. The critical dilution can be obtained from the TCEQ. If upstream water is not available, the critical dilution is 100%.

- Collect a minimum of 30 valid samples from the receiving water to represent a range of seasonal conditions. The applicant is responsible for providing a minimum of 30 valid data points to obtain a statistically reliable estimate of the 85th percentile value of the dissolved-to-total ratio. Samples should typically be taken a minimum of one week apart from one another.

- Collect samples to reflect different receiving water characteristics that exist at various times of the day and week. This may require collecting samples for a full year. If a shorter study duration is acceptable, there should be a minimum of one week between each sampling event.

- Measure both dissolved and total recoverable metal concentrations.

- Use clean techniques for all metals sampling and analytical procedures to avoid contamination.

- Collect site-specific TSS data according to the procedures outlined previously.

- Collect effluent TSS data. If effluent TSS exceeds ambient conditions, a correction factor will be applied to remove the influence of the effluent TSS on the dissolved metal concentration.

- Once the data are collected and the ratios of the dissolved concentration to the total recoverable concentration are calculated, the ratios are ranked from lowest to highest, and the 85th percentile value is used as the bioavailable fraction when calculating the waste load allocation. (For more information on WLAs, see the subsection of this document entitled "Calculating Waste Load Allocations" on page 134.)

Aluminum

The total amount of aluminum reported in a facility's effluent is assumed to be 100% bioavailable (*i.e.*, the partition coefficient is assumed to be 1.0) unless a permittee conducts a site-specific partition coefficient study that demonstrates otherwise. Many site-specific studies have demonstrated that aluminum in effluent is not all bioavailable (*i.e.*, toxic to aquatic life).

To demonstrate that aluminum in the effluent is not all bioavailable, the permittee should determine the no observable effects concentration (NOEC) for total aluminum-spiked effluent using, at a minimum, three standard 48-hour acute toxicity tests employing an appropriately sensitive test species (a species from one of the three genera in the family *Daphnidae*, preferably *Ceriodaphnia dubia*).

Once a mean total-aluminum NOEC is determined, it will be compared to the proposed effluent limits calculated by using the site-specific partition coefficient in the WLA acute criteria equation. A mean NOEC significantly greater than the proposed effluent limits meets the requirement to demonstrate that the proposed aluminum effluent limits will not cause instream effects.

Aluminum in Storm Water Discharges

Facilities that commingle storm water with their effluent prior to discharge or that discharge only storm water may have elevated levels of aluminum due solely to their location. The following procedure for evaluating aluminum in storm water discharges is not used for other metals because: (1) no partition coefficient is used when screening a facility's effluent for aluminum for permitting purposes and (2) aluminum often occurs naturally in storm water discharges. If a facility experiences elevated concentrations of other metals in storm water, the permittee may pursue either a partition coefficient study or water-effect ratio study to address the issue.

If storm water is believed to be the only source of aluminum in a discharge, permittees may, after providing all of the following information, request the TCEQ to reconsider the need for aluminum limits.

- Clearly demonstrate that aluminum is not used in the facility's processes or added to the facility's waste streams.

- If storm water is commingled with facility wastewater, collect samples of storm water alone to demonstrate that aluminum levels in the storm water are directly responsible for aluminum levels reported in the commingled discharge. The number of data points needed for this demonstration will be determined on a case-by-case basis.

- Determine the ratio of the dissolved aluminum concentration to the total recoverable aluminum concentration for the facility. If the dissolved portion of the metal is greater than 50%, the permittee may need to pursue a more traditional method (*i.e.*, partition coefficient study or water-effect ratio study) to address the potential toxicity of aluminum in the discharge. For further information on determining dissolved-to-total ratios for metals, see the section of this document entitled "TSS, Partition Coefficients, and Bioavailable Fractions of Metals" on page 159. The number of data points necessary will be determined on a case-by-case basis.

If the information provided indicates: (1) that process water is not the source of aluminum in the storm water and (2) that the aluminum in the storm water is primarily particulate, an aluminum limit is not needed. Best management practices may be included in the permit. Permittees that prefer not to provide the information outlined above still retain the option to pursue a site-specific partition coefficient study or water-effect ratio study to determine the bioavailability of aluminum in their discharge.

Calculating Permit Limits for Specific Toxic Pollutants

Calculating Permit Limits for Mercury, PCBs, Dioxins/Furans, DDT, DDD, and DDE

Converting Tissue Criteria to Water Column Criteria

The water quality criteria for the protection of human health for highly bioaccumulative pollutants such as mercury, PCB, and DDT (including metabolites) are expressed as fish tissue concentrations (µg/kg) rather than as water column concentrations. In order to determine if a facility needs effluent monitoring or limits for these pollutants, the tissue criteria must be converted to water column values. This is accomplished by first converting the tissue criterion from µg/kg to mg/kg (by dividing by 1,000) and then dividing by either a BAF or BCF.

$$\text{Water Column Criterion (mg/L)} = \frac{\text{Tissue Criterion (mg/kg)}}{BAF \text{ or } BCF \text{ (L/kg)}}$$

In accordance with EPA's 2000 guidance for developing human health criteria,[13] a BAF is preferred over a BCF because the BAF includes an organism's exposure from both diet and water, whereas the BCF includes only the organism's exposure to water. However, EPA has used the BAF in only a few current national criteria calculations. Therefore, a BCF value may be used if no scientifically accepted BAF value is available. The table that follows lists pollutants and their assumed BCFs that will be used to translate tissue criteria to water column criteria for purposes of TPDES permitting.

Pollutant	BCF (L/kg)
DDT	5.36×10^4
DDD	5.36×10^4
DDE	5.36×10^4
Dioxin	5.0×10^3
Mercury	3.3×10^4
PCB	3.12×10^4

While the 2001 final EPA methylmercury criteria document[14] does develop a national BAF, Appendix A of that document explains that the scientific community did not have confidence in the BAF. The BCF of 3.3×10^4, which is also discussed in the final EPA criteria document, will

[13] *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health*, U.S. Environmental Protection Agency, Office of Science and Technology, EPA-822-B-00-004, October 2000.
[14] *Water Quality Criterion for the Protection of Human Health: Methylmercury*, U.S. Environmental Protection Agency, Office of Science and Technology, EPA-823-R-01-001, January 2001.

be used in place of the BAF until a more reliably developed BAF can be determined.

Permittees may pursue a site-specific BAF study for any of the pollutants discussed in this section in order to better reflect conditions specific to their discharge location. Upon EPA approval, a site-specific BAF will be added to Appendix E of the Water Quality Standards. Because Texas is a very diverse state with varying geology, water chemistry, and water body types, each site-specific study would need to be discussed in detail with the TCEQ before the study is begun.

Once the tissue-based criterion has been translated to a water-column based criterion, permit limits are calculated according to the method outlined previously in the section of this document entitled "Deriving Permit Limits for Human Health Protection" on page 140.

Dioxin/Furan Congeners

The TCEQ addresses the differences in the relative toxicity of dioxin/furan congeners in comparison to 2,3,7,8 TCDD and 1,2,3,7,8 PeCDD (most toxic dioxin/furan congeners) with the use of toxic equivalency factors (TEFs). The World Health Organization updated TEFs for dioxin/furans in 2005 and also included TEF values for dioxin-like PCBs. The Standards contain TEFs for fifteen congeners. The compounds and their TEFs as adopted by the TCEQ are given in the table that follows.

Compound	TEF
2378 TCDD	1
12378 PeCDD	1
2378 HxCDDs	0.1
1234678 HpCDD	0.01
OCDD	0.0003
2378 TCDF	0.1
12378 PeCDF	0.03
23478 PeCDF	0.3
2378 HxCDFs	0.1
23478 HpCDFs	0.01
OCDF	0.0003
PCB 77	0.0001
PCB 81	0.0003
PCB 126	0.1
PCB 169	0.03

The concentration of each dioxin/furan compound in an effluent analysis is multiplied by the compound's TEF. The sum of these products of concentrations and TEFs is the toxic equivalence (TEQ) of the mixture, expressed as if the toxicity were due entirely to a congener with a TEF equal to 1.0 such as 2,3,7,8 TCDD. The potential additive effects of various forms of dioxin/furans with different relative toxicities are thereby taken into account. The TCEQ evaluates compliance with appropriate dioxin/furan permit limits based on this TEQ method. Permittees that are required to monitor their effluent for dioxin/furans may also be required to sample receiving water fish tissue and/or sediments for dioxin/furans.

Calculating Permit Limits for Silver

The Standards express the freshwater criterion for silver in terms of the free ionic form, which is considered to be the most biologically toxic component of dissolved silver. This section describes how the free ionic criterion is translated into a total recoverable permit limit.

Before applying the translation method, the fraction of total silver that is in the dissolved form is calculated using a partition coefficient. (For more information on calculating and using partition coefficients, see the subsection of this document entitled "TSS, Partition Coefficients, and Bioavailable Fractions of Metals" on page 159.)

For silver, the TCEQ uses partition coefficient slopes and intercepts (see Table 6 on page 159) derived from data collected by the Texas Environmental Advisory Council. In 1994, the TEAC conducted statewide sampling of various water bodies and analyzed for both total and dissolved silver concentrations and total suspended solids (TSS). This information has since been published.[15]

Once the partition coefficient has been calculated, the percentage of dissolved silver in free ionic form is calculated. Data collected from a variety of water bodies throughout the United States show that a correlation exists between the dissolved chloride concentration and the percent free ionic silver.[16] Using this data, the following regression equation (r^2 of 0.87) was developed to calculate the percentage of dissolved silver in free ionic form:

$$Y = e^{e^{\left(\frac{1}{0.6659+0.0044Cl}\right)}}$$

[15] Wen, L., P.H. Santschi, G.A. Gill, C.L. Paternostro, and R.D. Lehman. 1997. Colloidal and Particulate Silver in River and Estuarine Waters of Texas. *Environmental Science & Technology*, 31:723-731.
[16] *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Part 1*, U.S. Environmental Protection Agency, EPA 600/6-85-002a, 1985.

where: Y = % of dissolved silver in free ionic form
e = the base of natural logarithms
Cl = dissolved chloride concentration (mg/L)

In this equation, the TCEQ uses the 50th percentile value of dissolved chloride concentrations for each segment (shown in Appendix D) or for each basin if there is insufficient segment data. Site-specific data may also be used (see the subsection of this document entitled "Hardness, pH, and Chloride" on page 156).

When the 50th percentile chloride value exceeds 140 mg/L (the upper extent of the regression's data range), the percentage of silver in the free ionic form is set at 8.98%.

Finally, the proportion of dissolved silver that is in the free ionic form is multiplied by the proportion of total silver that is dissolved to obtain the fraction available as follows (see page 159 for definitions of C_d and C_T):

$$Fraction\ Available = \frac{C_d}{C_T} \times \frac{Y}{100}$$

The fraction available is used in the waste load allocation equation. For example, if 30% of the silver is dissolved and 50% of the dissolved silver is in free ionic form, the fraction available used in the WLA equation is 0.15 (0.3 multiplied by 0.5).

Calculating Permit Limits for Chromium

The Standards for the protection of aquatic life are expressed as dissolved concentrations for hexavalent chromium (Cr^{+6}) and trivalent chromium (Cr^{+3}). The method to calculate permit limits for total recoverable concentrations of Cr^{+3} and dissolved concentrations for Cr^{+6} is described in this section.

As part of the permit application, permittees analyze their effluent for dissolved Cr^{+6} and total recoverable chromium. Total recoverable chromium is the sum of dissolved Cr^{+6}, adsorbed Cr^{+6}, dissolved Cr^{+3}, and adsorbed Cr^{+3}:

$$\text{total recoverable Cr} = \text{dissolved } Cr^{+6} + \text{adsorbed } Cr^{+6} + \text{dissolved } Cr^{+3} + \text{adsorbed } Cr^{+3}$$

The analytical method for Cr^{+6} measures only for the dissolved form. The TCEQ assumes that the amount of adsorbed Cr^{+6} is negligible. Therefore, total Cr^{+3} is calculated by subtracting dissolved Cr^{+6} from the total recoverable chromium:

$$\text{total } Cr^{+3} = \text{total recoverable Cr} - \text{dissolved } Cr^{+6}$$

The slope and intercept values for chromium, listed in Table 6 on page 159, are not applicable to Cr^{+6} because dissolved concentrations alone are measured. Therefore, the Cr^{+6} permit limit is calculated using standard procedures and assuming 100% of Cr^{+6} is dissolved. The effluent concentration is compared to the calculated permit limit to determine whether monitoring or permit limits are needed.

The slope and intercept values in Table 6 and standard procedures are used to calculate Cr^{+3} permit limits. The calculated permit limit is compared to the total Cr^{+3} concentration in the effluent to determine whether monitoring requirements or permit limits are needed.

The slope and intercept values in Table 6 and standard procedures are used to calculate chromium limits for the protection of human health. The permit limit is expressed as total recoverable chromium.

Establishing Permit Limits for Toxic Pollutants

Application Screening

TCEQ staff calculate daily average and daily maximum effluent limits required to maintain the surface water quality standards based upon the instream criteria established in § 307.6 (c) and (d) of the Standards. During the application review, the effluent data provided in the application are compared to the calculated daily average effluent limits.

- If the effluent data are based on one sample and the effluent concentration for a pollutant equals or exceeds 70% of the calculated daily average effluent limit, the TCEQ may request the applicant to either: (1) submit historical data or; (2) resample and conduct additional analysis for that particular pollutant using four effluent samples. Samples should either be all composites or all grabs, as appropriate.

- If the effluent data submitted with the application are based on four samples, additional sampling is not typically requested.

Sometimes the effluent analysis contains one or more samples that have reported nondetectable levels of a pollutant. (Nondetectable levels are the "<" values in laboratory reports.) When this occurs in all four resamples and the reported nondetectable levels are equal to or less than the TCEQ's minimum analytical level (MAL), the TCEQ will use a zero for each value. If the four retests have both detectable and nondetectable concentrations at or below the TCEQ's MAL, then the nondetectable

concentrations are averaged as one-half the reported nondetectable levels, and the detectable concentrations are averaged as their reported values.

The average concentration of the effluent data is then compared to the daily average effluent limit.

- If the average of the effluent data equals or exceeds 70%, but is less than 85% of the calculated daily average limit, monitoring for the toxic pollutant will usually be included as a condition in the permit.

- If the average of the effluent data is equal to or greater than 85% of the calculated daily average limit, the permit will generally contain effluent limits for the toxic pollutant. The permit may specify a compliance period to achieve this limit if necessary.

If a toxic pollutant is quantified below the MAL and equals or exceeds 70% of the calculated daily average permit limit, the applicant may be required to submit historical data or to retest as described above. The applicant may also be required to establish a site-specific MAL for the effluent.

Analytical Procedures and MALs

As required by 30 TAC § 319.11, all analyses of effluents must meet the requirements specified in the regulations published in 40 CFR Part 136 or the latest edition of *Standard Methods for the Examination of Water and Wastewater* (Standard Methods). If any regulated pollutant is not included in 40 CFR Part 136 or Standard Methods, the permittee may use a TCEQ-recommended analytical method or a method approved for the specific compound in water or wastewater by the EPA. All quality assurance/quality control practices must strictly adhere to those outlined in each EPA-approved analytical method.

Applicants and Permittees may transfer an analyte from one EPA-approved method to another EPA-approved method as described on pages 6-2 and 6-3 of the EPA document Analytical Method Guidance for the Pharmaceutical Manufacturing Point Source Category, EPA 821-B-99-003 (August 1999) (See Appendix G). Such authorization is not intended to be limited to pharmaceutical manufacturing and may be undertaken by any applicant or permittee for any analyte as long as applicable NELAC accreditation for the analyte is obtained.

The following terms are used to quantify sensitivity of analytical test procedures:

In 40 CFR Part 136 Appendix B, the **method detection limit (MDL)** is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater

than zero; it is determined from the analysis of a sample in a given matrix containing the analyte.

In the Standards, the **minimum analytical level (MAL)** is defined as the lowest concentration at which a particular substance can be quantitatively measured with a defined accuracy and precision level, using approved analytical methods. The MAL is not the published MDL for an EPA-approved analytical method, which is based on a single laboratory analysis of the substance in reagent (distilled) water. The MAL is based on analyses of the analyte in the matrix of concern (that is, wastewater effluents).

The TCEQ will establish general MALs that are applicable when information on matrix-specific MALs are unavailable. General MALs are established in this document for use in effluent testing. See Table E-1 in Appendix E for general MALs for permit application screening. See Table E-2 in Appendix E for MALs and analytical methods for the determination of pollutants regulated by § 307.6 of the Standards.

The MALs were developed by the TCEQ to establish a benchmark for analytical procedures for measuring the toxic pollutants regulated by § 307.6 of the Standards. One of the goals of establishing the MALs is to provide consistent analytical data for industrial and domestic wastewater permit applicants and compliance monitoring of their discharges. The MALs serve as a measure of the analytical sensitivity of each laboratory procedure performed on standard laboratory equipment by qualified personnel.

The MALs developed in Tables E-1 and E-2 were derived by evaluating all of the 40 CFR Part 136 EPA-approved methods and selecting the most stringent detection level achievable from each approved method in reagent water. The purpose of establishing TCEQ-approved MALs is to identify the minimum detectable concentration for which an analytical method exists. The methods identified in Tables E-1 and E-2 are the methods used to develop the corresponding MAL.

By establishing MALs, TCEQ is not requiring use of the corresponding analytical test method, nor is TCEQ requiring analytical results to be submitted where the laboratory test was run to achieve this MAL. For permitting and compliance purposes, MALs are used to allow an applicant or permittee to submit analytical results as nondetect. Nondetect analytical results are assumed to represent a concentration of zero (0) mg/L (or µg/L as appropriate).

When an MAL in Table E-1 or E-2 cannot be achieved with the analytical method identified in Table E-1 or E-2 for that analyte due to matrix interferences that are documented by the laboratory and identified as limitations in the analytical method (for example, when a metals sample must be diluted because the inorganic TDS concentration exceeds 2,000 mg/L), the TCEQ may approve use of the higher MAL as the lowest achievable MAL for that effluent matrix. In such cases, a permit would allow reporting nondetect analytical results as zero (0).

Applicants and permittees may apply for a matrix-specific MAL when they cannot achieve the MAL in Table E-1 or E-2 and the specific matrix interference is not identified in the approved analytical method (see page 172). An example of when a matrix-specific MAL may be requested is for one or all of the cyanide methods identified in Table E-1 or E-2. Cyanide species are a method-defined analyte, and as such, may be subject to unidentifiable interferences which elevate the MAL above the applicable Table E-1 or E-2 concentrations. When a matrix-specific MAL that is greater than the MAL in Table E-1 or E-2 is approved by the TCEQ for an analyte, the permit will allow the permittee to report nondetect analytical results as zero (0). A permittee may apply for a matrix-specific MAL when it files its application or at any time during the life of the permit.

The MALs in Tables E-1 and E-2 are not applicable to untreated, or partially treated, municipal and industrial wastewaters. Untreated and partially treated process-type wastewaters often have high concentrations of pollutants that require dilution of samples prior to analysis.

For various pollutants in the Standards, the hazardous metals limits at 30 TAC 319, Subchapter B, and in the EPA's national categorical effluent limitations guidelines and pretreatment standards, permitting and compliance decisions may not require submittal of analytical results at the MALs identified in Tables E-1 and E-2. Applicants and permittees may use any analytical method approved in 40 CFR Part 136 that is sufficiently sensitive to demonstrate compliance with their numeric permit limits (mass and concentration). Analytical test results that are submitted as nondetect at a laboratory reporting level higher than the MAL in Tables E-1 or E-2 will be treated and evaluated as if the analyte was detected at one-half the reported LOQ value.

The following example discusses a typical situation where using an analytical test method that does not achieve the MAL identified in Tables E-1 or E-2 would be acceptable and result in no adverse permitting or compliance issues for an applicant/permittee.

Example:

For aluminum, the TCEQ has established a freshwater acute criterion of 991 µg/L. Assuming no instream dilution and using procedures previously discussed in this chapter, the permit writer calculates a daily average effluent limit of 834.73 µg/L. The TCEQ screening procedures (see page 168) evaluate the need for monitoring a pollutant at 70% of the calculated daily average effluent limit, resulting in a screening level of 584.31 µg/L.

The test method established for aluminum in Table E-1 or E-2, EPA Method 200.8, has an associated MAL of 5 µg/L. However, test method SM3113B* exists and can achieve a Level of Quantitation (LOQ) of 20 µg/L. Test method SM3113B is used and the laboratory reports nondetect at the associated LOQ of 20 µg/L. The TCEQ will evaluate this analytical result as a detection at one-half the LOQ, 10 µg/L. Comparing the 10 µg/L reported result against the 584.31 µg/L screening level would result in no monitoring requirement or effluent limit for aluminum in this permit.

*SM = Standard Methods for the Examination of Water and Wastewater

Effective Date of Revised MALs

MALs and Suggested Analytical Methods listed in Appendix E, will be implemented on the 365th day following commission approval of this document for reissuance of any TPDES permit, wastewater application screening, or pretreatment program monitoring.

Alternate Test Procedures

Because of interferences and matrix problems associated with the analysis of toxic pollutants in wastewater, the TCEQ has received requests for the use of alternate analytical test method procedures. The procedures may range from an alteration of an EPA-approved reference method to a completely new or “candidate” method. Guidelines are given below for accepting or rejecting those alternate test procedures for compliance monitoring of TPDES permits.

If a permittee wishes to initiate the evaluation process for an alternate analytical test method procedure, the permittee may send a written request for authorization to the Quality Assurance Manager and/or the Section Manager of the Wastewater Permitting Section. The request must include details required by 30 TAC § 319.12 and may be subject to accreditation requirements in 30 TAC Chapter 25, Subchapters A and B, as amended. The information required in 40 CFR Part 136.4(c) (Application for Alternate Test Procedures) should also be submitted. All candidate methods should undergo a comparability study. A comparability study should compare the performance of the alternate or candidate analytical method to an EPA-approved reference method.

If the permittee cannot attain the MAL for a specific pollutant and has exhausted all available techniques to solve interference and matrix problems, the permittee may apply for an alternate MAL through the same procedure used to request an alternate analytical test method, provided that all documentation of attempted solutions to the interference/matrix problems is included with the application. This documentation needs to include all quality assurance/quality control data. Alternate test procedures are subject to review and approval by EPA.

Defining Permit Limits

Permit limits are normally developed from total recoverable concentrations. The permit limit is expressed as the calculated daily average and daily maximum concentration and/or the daily average and daily maximum mass loading.

If the permit limit is lower than the MAL, it is still included in the permit, but a level of compliance based on the MAL is also included except where a substance is of particular concern (for example, if the toxicant has a high bioconcentration factor). If the TCEQ believes it is necessary to establish a permit level of compliance below the MAL, the permittee will be required to develop an effluent-specific MDL.

When necessary, the permit applicant may request an opportunity to demonstrate an alternative site-specific MAL for the effluent to account for interfering factors associated with the wastewater in question. See the discussion for requesting an alternate MAL through the alternate analytical test method procedure in the previous subsection of this document entitled “Alternate Test Procedures” (see page 172).

When establishing monitoring frequencies, TCEQ staff use 30 TAC 319 and TCEQ guidance established in document number 98-001.000-OWR-WQ, “Guidance Document for Establishing Monitoring Frequencies for Domestic and Industrial Wastewater Discharge Permits,” May 1998.

Screening Procedures and Permit Limits for Total Dissolved Solids

Introduction

Concentrations and relative ratios of dissolved minerals such as chloride and sulfate that compose total dissolved solids (TDS) will be maintained to protect existing and attainable uses. The aquatic life attributes in § 307.7(b)(3)(A) of the Standards are used to assign the aquatic life use categories.

Applicability

The screening procedure will be applied to all domestic dischargers that have an average permitted flow of ≥ 1 MGD, all industrial majors, and industrial minors on a case-by-case basis.

Discharges to Freshwater

For discharges to freshwater, a screening procedure is used to determine whether either a TDS permit limit or further study of the receiving water is required. Screening may also be performed for individual components of TDS, including chloride and sulfate, since these anions have specific numerical criteria in the Standards. If screening demonstrates elevated levels of TDS, then appropriate permit limits are calculated.

Discharges to Saltwater

For discharges to saltwater, TDS is evaluated on a case-by-case basis. Even though salinity criteria have not been established, the absence of numerical criteria does not preclude evaluations and regulatory actions based on estuarine salinity. Careful consideration is given to all activities that may detrimentally affect estuarine salinity gradients.

Wastewater Recycling

Certain facilities reduce water consumption by recycling their wastewater before discharge, which may increase the effluent TDS concentration. The procedures in this chapter will be applied to such facilities to ensure protection of water quality.

Overview of Procedures

The general procedure for screening TDS concentrations in permit applications and then developing permit limits is as follows:

1. Select the appropriate screening procedure for the receiving water type. A detailed discussion begins on page 175 in the section entitled "Screening Procedures for TDS."

2. Perform the screening calculation or calculations.

3. If the screening criteria are exceeded, calculate effluent TDS concentrations using the appropriate method for the receiving water type. A detailed discussion begins on page 182 in the section entitled "Establishing Permit Limits for TDS."

4. Compare the effluent TDS concentrations obtained in step 3 with the calculated effluent limits using the 70%, 85% procedure (see the section of this document entitled "Application Screening" on page 168) to determine whether a monitoring requirement or effluent limit is needed in the permit.

5. If necessary, place monitoring or effluent limits in the permit.

Screening Procedures for TDS

The following screening procedures are typically used by TCEQ staff to assess TDS in wastewater discharges to various water body types. See Table 7 on page 185 for a summary of screening methods as they apply to different types of water bodies. Screening using TDS will normally be sufficient to address dissolved minerals. In unusual situations where ionic ratios are substantially skewed, screening can also be conducted for chloride or sulfate.

1a. Unclassified Intermittent Stream—TDS

Use Equation 1a (below) to determine the TDS screening value, C_{SV}, for a discharge to an unclassified intermittent stream without perennial pools. The effluent TDS concentration, C_E, as reported in the permit application, will be compared to the screening value to determine whether a TDS permit limit is needed.

Equation 1a

where: C_{TDS} = TDS concentration (mg/L) used to determine the TDS screening value

C_C = TDS criterion (mg/L) at the first downstream segment

500 mg/L = median concentration of TDS in Texas streams

2,500 mg/L = minimum TDS screening value

If the value of C_{TDS} in Equation 1a is less than 2,500 mg/L, then 2,500 mg/L is used as the screening value. If C_{TDS} is between 2,500 mg/L and 6,000 mg/L, then C_{TDS} is used as the screening value. If C_{TDS} is greater than 6,000 mg/L, then 6,000 mg/L is used as the screening value unless the applicant demonstrates that a higher TDS value is more representative of the receiving stream. The following table summarizes the conditions in this paragraph.

If C_{TDS}	**then C_{SV} =**
≤ 2,500 mg/L	2,500 mg/L
> 2,500 mg/L but ≤ 6,000 mg/L	C_{TDS}
> 6,000 mg/L	6,000 mg/L

In addition, some specific types of intermittent streams have alternative default screening values. These stream types and screening values are summarized in the following table:

Other Specific Types of Intermittent Streams	**If C_{TDS}**	**then C_{SV} =**
Intermittent streams that are demonstrated to be dry except for very short-term flow in immediate response to rainfall	< 4,000 mg/L ≥ 4,000 mg/L	4,000 mg/L C_{TDS}
Constructed ditches that convey storm water and/or wastewater effluent that are considered water in the state	< 4,000 mg/L ≥ 4,000 mg/L	4,000 mg/L C_{TDS}
Intermittent streams that enter tidal waters within three miles of the discharge point	—	6,000 mg/L

TDS screening guidelines for intermittent streams are intended to protect livestock, wildlife, shoreline vegetation, and aquatic life during periods when the stream is flowing; the screening is also intended to preclude excessive TDS loading in watersheds that could eventually impact distant downstream perennial waters.

1b. Unclassified Intermittent Stream—Chloride and Sulfate

Chloride (Cl) and sulfate (SO_4) will not typically be screened for discharges to intermittent streams because the TDS screening should be adequately protective. However, for situations where TDS screening alone may not provide adequate protection, similar screening may be performed for chloride and sulfate. After determining the TDS screening value as discussed in 1a, use Equation 1b (below) to determine the chloride and sulfate screening values (C_{SV}). The effluent chloride and sulfate concentrations reported in the permit application will be compared to the screening values to determine whether a chloride or sulfate permit limit or monitoring is needed.

Equation 1b

$$Cl \text{ or } SO_4 \; C_{SV} = \frac{TDS \; C_{SV}}{TDS \text{ Criterion}} \times Cl \text{ or } SO_4 \text{ Criterion}$$

2. Unclassified Perennial Stream or River

Screen for TDS using Equation 2 (below), which compares the concentration of TDS at the edge of the human health mixing zone downstream of the discharge (right side of equation) with the TDS criterion (C_C) for the first downstream segment (left side of equation). A permit limit is usually not required when Equation 2 is satisfied (that is, $C_C \geq$ right side of equation).

Equation 2

$$C_C = \frac{Q_S C_A + Q_E C_E}{Q_E + Q_S}$$

where:

C_C = segment TDS criterion (mg/L)

Q_S = harmonic mean flow (ft^3/s) of the perennial stream or river

C_A = ambient TDS concentration (mg/L)

Q_E = effluent flow (ft^3/s)

C_E = effluent TDS concentration (mg/L)

The following items explain the variables used in Equation 2:

C_C The TDS criterion for the first downstream segment is found in Appendix A of the Standards. If the permittee wishes to change the segment TDS criterion, an intensive study is needed. Such a study involves sampling the entire classified segment during different seasons. A site-specific amendment to the Standards is then needed to change the TDS segment criterion.

Q_S The harmonic mean flow is determined as described in the section of this document entitled "Determining the Harmonic Mean Flow" on page 80.

C_A The ambient TDS concentration is the median (50th percentile) concentration of TDS for the first downstream segment. Sources for determining the median TDS concentration include: (1) the tables in Appendix D of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database; or (3) other available data. The permittee may supply site-specific data if the median TDS concentration for the first downstream segment does not appear to be representative of the TDS concentration in the receiving water.

Q_E The effluent flow used is generally the average permitted flow for domestic discharges and the average of the monthly average flows for the last two years for industrial discharges.

C_E The effluent TDS concentration is based on the average effluent data provided in the permit application.

3. Classified Stream or River

Screen for TDS using Equation 2. Use the harmonic mean flow (Q_S) of the classified segment, and use the median TDS value for the classified segment as the ambient concentration (C_A). A permit limit is usually not required when Equation 2 is satisfied (that is, $C_C \geq$ right side of equation).

4. Unclassified Intermittent Stream within 3 Miles of a Perennial Freshwater Body

a. Screen for TDS at the intermittent stream as described in item 1.
b. Screen for TDS at the perennial freshwater body using the appropriate protocol described in item 2, 3, 6, or 7.
c. Compare the screening values from (a) and (b) and use the more stringent one.

Freshwater bodies more than 3 miles downstream of the discharge may be evaluated if they contain a drinking water supply or aquatic life that is particularly sensitive to increases in TDS.

5. Unclassified Intermittent Stream with Perennial Pools

a. Screen for TDS as described in item 1.
b. Screen for TDS using Equation 2 using the harmonic mean flow (Q_S) for the intermittent stream with perennial pools.
c. Compare the screening values from (a) and (b) and use the more stringent one.

6. Classified Lake

Screen for TDS using Equation 3 (below), which compares the concentration of TDS at the edge of the human health mixing zone (right side of equation) with the TDS criterion (C_C) for the segment (left side of equation). A permit limit is usually not required when Equation 3 is satisfied (that is, $C_C \geq$ right side of equation).

Equation 3 $$C_C \geq (E_F)(C_E) + (1 - E_F)(C_A)$$

where:

C_C = segment TDS criterion (mg/L)

E_F = effluent fraction at the edge of the human health mixing zone

C_E = effluent TDS concentration (mg/L)

C_A = ambient TDS concentration (mg/L)

The following items explain the variables used in Equation 3:

C_C The TDS criterion for the segment is found in Appendix A of the Standards. If the permittee wishes to change the segment TDS criterion, an intensive study is needed. Such a study involves sampling the entire classified lake during different seasons. A site-specific amendment to the Standards is then needed to change the TDS segment criterion.

E_F The effluent fraction at the edge of the human health mixing zone is calculated as described in the section of this document entitled "Mixing Zones and Critical Conditions for Human Health Protection" on page 78.

C_E The effluent TDS concentration is based on the average effluent data provided in the permit application.

C_A The ambient TDS concentration is the median (50th percentile) concentration of TDS for the segment. Sources for determining the median TDS concentration include (1) the tables in Appendix D of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database; or (3) other available data. The permittee may supply site-specific data if the median TDS concentration for the entire segment does not appear to be representative of the TDS concentration in the vicinity of the discharge.

The secondary maximum contaminant levels for drinking water (given at 30 TAC §§ 290.101 - 290.119) are considered for use as C_C if the lake is a public water supply.

7. Unclassified Lake

Screen for TDS using Equation 3. Differences between screening procedures for unclassified lakes compared to classified lakes are as follows:

C_C The criterion for TDS from the nearest **appropriate** segment is used.

C_A TDS or converted conductivity data (using a conversion factor of 0.65) from the unclassified lake may be used to determine C_A. If such data are unavailable, use the ambient TDS concentration (median) from the nearest appropriate segment. Sources for determining the median TDS concentration include (1) the tables in Appendix D of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database; or (3) other available data. The permittee may supply site-specific data if the median TDS concentration from the nearest appropriate segment does not appear to be representative of the TDS concentration in the receiving water.

The secondary maximum contaminant levels for drinking water (given at 30 TAC 290.101 - 290.119) are considered for use as C_C if the lake is a public water supply.

8. Bay or Wide Tidal River

Compare the effluent TDS concentration to the segment TDS median and maximum. Sources for determining the median and maximum TDS concentrations include: (1) the tables in Appendix D of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database; or (3) other available data. Tidal waters will be protected from the adverse effects of excessively high or excessively low salinities (compared to the normal salinity range of the receiving water). The absence of numerical criteria will not preclude evaluations and regulatory actions to protect estuarine salinity.

Determining Site-Specific Ambient TDS Values

High levels of TDS in an **existing** discharge may be justified occasionally due to elevated levels of TDS in the receiving water. In this case, the permittee has the option to submit information demonstrating that higher ambient levels of TDS exist in the receiving water and/or segment. This information can then be used to derive a site-specific ambient TDS concentration (C_A).

In order to satisfy the statistical requirements for site-specific data collection, 50 TDS values should be collected over the course of one year. TCEQ staff may allow applicants to monitor conductivity and convert it to TDS using a factor of 0.65. In streams and rivers, samples should be collected upstream of an existing discharge or in a separate, nearby reference stream. In lakes and reservoirs, samples should be collected at least 500 feet from any discharge point. Equation 2 or 3 is re-evaluated if a site-specific ambient TDS concentration (C_A) is approved (see Figure 11 on page 182).

If the permittee wishes to change the segment TDS criterion, a more intensive study is needed. Such a study involves sampling the entire segment under various flow regimes and seasons. A site-specific amendment to the Standards is then needed to change the TDS segment criterion.

Establishing Permit Limits for TDS

If the screening criteria are exceeded and site-specific data are either not proposed or not justified, a TDS permit limit is calculated for the discharge. Similar procedures may be followed for individual constituents of TDS (that is, sulfate and chloride) if they are determined to be of concern. See Table 7 on page 185 for a summary of permit limit calculation methods as they apply to different types of water bodies.

Unclassified Intermittent Streams

For discharges to unclassified intermittent streams, if the average effluent concentration of TDS in the permit application (or other available effluent data) is greater than the screening value determined using Equation 1a, then TCEQ staff considers effluent control measures for TDS.

When a limit is appropriate, the screening value or other appropriate site-specific value may be used as the daily average effluent limit for TDS. The daily maximum effluent limit for TDS is generally 2.12 times the daily average limit. The 2.12 multiplier is the ratio of the multipliers used to convert the human health LTA to daily maximum and daily average permit limits. *See* the section of this document entitled “Deriving Permit Limits for Human Health Protection” on page 140.

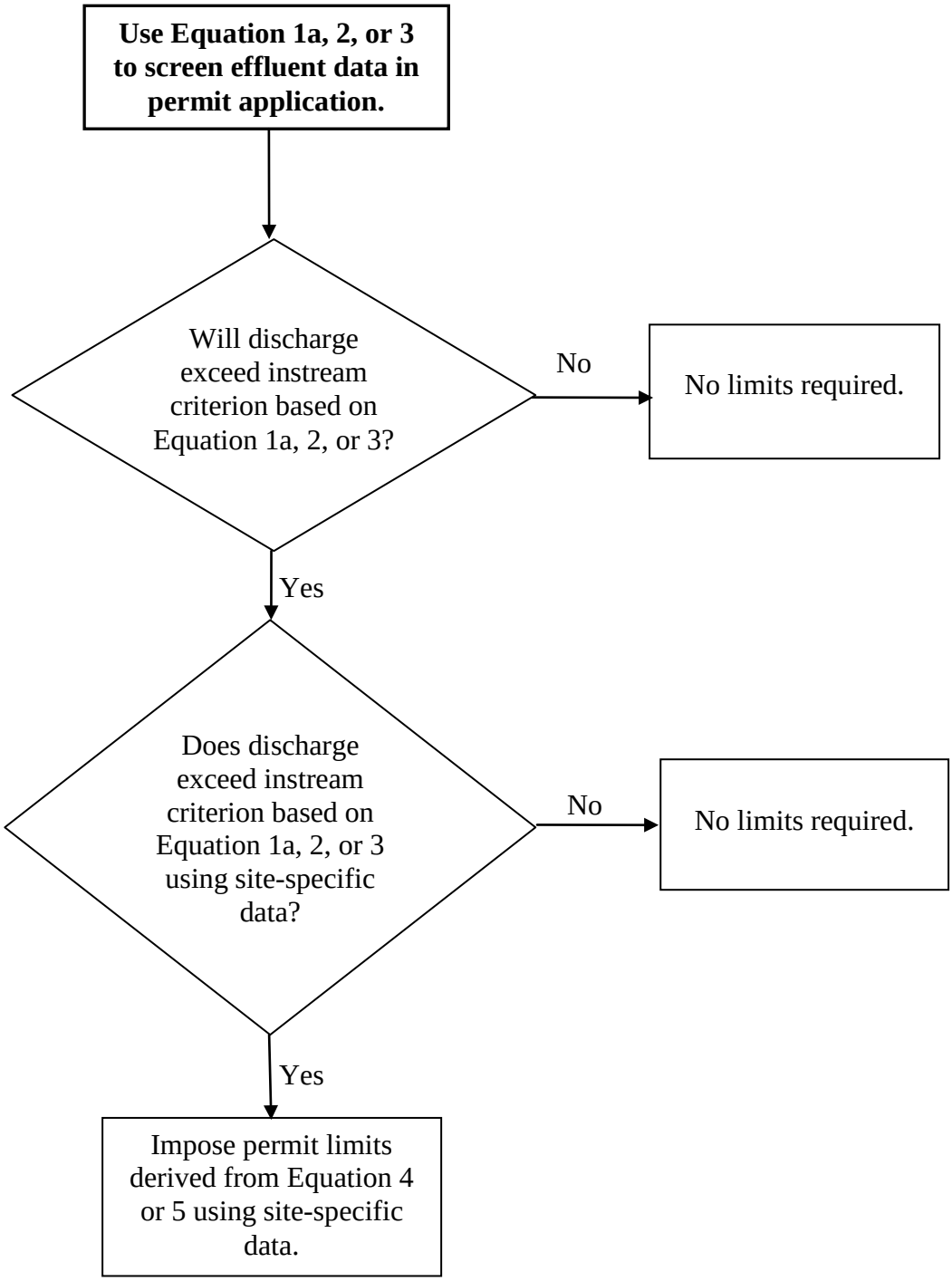

Figure 11. Establishing Permit Limits for Total Dissolved Solids

Perennial Streams and Rivers and Intermittent Streams with Perennial Pools

For discharges to perennial streams and rivers or to intermittent streams that have perennial pools, Equation 4 is used to calculate the effluent TDS concentration that is used to determine TDS permit limits:

Equation 4

$$C_E = \frac{(C_C)(Q_E + Q_S) - (Q_S)(C_A)}{Q_E}$$

where:

C_E = calculated effluent TDS concentration (mg/L)

C_C = segment TDS criterion (mg/L)

Q_E = effluent flow (ft^3/s)

Q_S = harmonic mean flow (ft^3/s) of the receiving water or first perennial water body downstream of the discharge

C_A = ambient TDS concentration (mg/L)

Lakes

For discharges to lakes, Equation 5 is used to calculate the effluent TDS concentration that is used to determine TDS permit limits:

Equation 5

$$C_E = \frac{C_C - (1 - E_F)(C_A)}{E_F}$$

where:

C_E = calculated effluent TDS concentration (mg/L)

C_C = segment TDS criterion (mg/L)

E_F = effluent fraction at the edge of the human health mixing zone

C_A = ambient TDS concentration (mg/L)

If either Equation 4 or 5 produces a negative value for C_E, then C_E is set equal to the segment TDS criterion (C_C) in the absence of additional information.

Final Calculations for Lakes, Perennial Streams and Rivers, and Intermittent Streams with Perennial Pools

The calculated effluent TDS concentration (C_E) from Equation 4 or 5 is the annual average TDS concentration from which daily average and daily maximum permit limits may be determined. These limits are calculated by considering C_E to be a waste load allocation (WLA) averaged over 365 days and calculating a long-term average (LTA) effluent concentration. This procedure is outlined in the section of this document entitled "Deriving Permit Limits for Human Health Protection" on page 140.

In cases where the TDS concentration can be controlled by the process, such as in cooling tower operations, the usual permitting assumption that the coefficient of variation (CV) equals 0.6 may be evaluated and adjusted as appropriate.

Final Evaluation and Additional Considerations for TDS

Preliminary effluent limits are evaluated to determine whether monitoring requirements, specific effluent limits, or other permit conditions are needed to address TDS (or sulfate or chloride).

Measured effluent concentrations are compared to the calculated daily average effluent limit as described in the section of this document entitled "Establishing Permit Limits for Toxic Pollutants" on page 168. Monitoring requirements are established if the measured effluent concentration exceeds 70% of the calculated daily average limit. Effluent limits are established if the measured effluent concentration exceeds 85% of the calculated daily average limit, unless **all** of the following conditions are met:

- The effluent concentration of TDS is comparable to the water supply source; or, for domestic discharges, any elevations of salinity are small and typical of such discharges.

- The water supply source is typical of TDS concentrations of surface waters in the area but does not include brine water that is produced during the extraction of oil and gas, or other sources of brine water that are substantially uncharacteristic of surface waters in the area of discharge.

- For industrial discharges, there are no internal discharges of process water that result in a significant elevation of TDS in the external discharge compared to source water. For domestic discharges, there are no identifiable industrial discharges to the sewerage system that cause a significant elevation of TDS compared to source water.

- The discharge will not result in significant increases in instream concentrations of chloride that would exceed EPA's aquatic life toxic criteria for chloride (as of December 1, 1999), which are 860 mg/L acute criteria and 230 mg/L chronic criteria. This condition does not apply when EPA's criteria are lower than: (1) applicable numerical criteria in the Standards or (2) typical concentrations of surface waters in the area.

If the above conditions are met, the permit will require instream monitoring if the discharge at permitted discharge flow is predicted to cause numerical criteria for TDS, chloride, or sulfate to be exceeded in a classified segment listed in Appendix A of the Standards. Instream

monitoring will typically consist of monthly sampling at: (1) a site in the receiving water body that is not affected by the discharge (for example, upstream of the discharge); and (2) a site in the receiving water that is affected by discharge (for example, downstream of the designated mixing zone).

If the above conditions are met for a domestic discharge, but the elevation in TDS in the effluent (compared to source water) is greater than "typical," then the permit will contain a requirement for the permittee to develop and implement a plan to identify and reduce sources of TDS to the extent practical consistent with a sound environmental management program. However, the resolution may not cause or contribute to a violation of the TCEQ narrative criteria for the protection of aquatic life.

Additional general considerations that might indicate an effluent limit for TDS is not required include (but are not limited to) the following:

- For a water body that does not attain numerical criteria for TDS, the discharge does not contribute to the nonattainment. For example, the source water for the discharge is from the same water body, and the discharge does not increase the source water concentration.

- The discharge is intermittent (such as a wet-weather discharge), and the anticipated instream impacts may be evaluated using more applicable screening calculations.

- Reductions in TDS are not economically attainable, and the discharge does not result in a violation of numerical criteria for TDS for the appropriate classified segment in Appendix A of the Standards.

- The discharge is demonstrated to not adversely affect aquatic life and other applicable uses. This provision is only applicable if a protocol for this demonstration is approved by the TCEQ. EPA will review any protocol for this demonstration that could affect permits or other regulatory actions that are subject to EPA approval.

When a discharge exceeds the screening criteria, the general considerations in this subsection that preclude an effluent limit are noted in the permit's fact sheet, statement of basis/technical summary, or other publicly available information. More stringent TDS limits may be required to protect unclassified spring-fed streams, streams with unique uses, or other unclassified water bodies where the aquatic life is particularly sensitive to increases in TDS. The antidegradation provisions in § 307.5 of the Standards and in the chapter of this document entitled "Antidegradation" (see page 55) are also applicable.

Table 7. Summary of TDS Screening and Limit Calculation Methods

Water Body Type	Screening Method	Limit Calculation Method
Intermittent stream (see page 175)	If $C_E < C_{SV}$, a TDS limit is usually not required, where: C_{SV} = 2,500 mg/L if $C_{TDS} \leq$ 2,500 mg/L, $C_{SV} = C_{TDS}$ if 2,500 mg/L < $C_{TDS} \leq$ 6,000 mg/L, C_{SV} = 6,000 mg/L if C_{TDS} > 6,000 mg/L. $C_{TDS} = \frac{(C_C)\,(2{,}500\ \text{mg/L})}{500\ \text{mg/L}}$ See page 176 for exceptions to these values.	$C_E = C_{SV}$, or C_E = other appropriate site-specific value.
Perennial stream (see page 177 and page 178)	If $C_C \geq \frac{Q_S C_A + Q_E C_E}{Q_E + Q_S}$, a TDS limit is usually not required.	$C_E = \frac{(C_C)(Q_E + Q_S) - (Q_S)(C_A)}{Q_E}$
Intermittent stream within three miles of a perennial stream (see page 178) or **Intermittent stream with perennial pools** (see page 178)	If $C_E < C_{SV}$ and $C_C \geq \frac{Q_S C_A + Q_E C_E}{Q_E + Q_S}$, a TDS limit is usually not required, where: C_{SV} = 2,500 mg/L if $C_{TDS} \leq$ 2,500 mg/L, $C_{SV} = C_{TDS}$ if 2,500 mg/L < $C_{TDS} \leq$ 6,000 mg/L, C_{SV} = 6,000 mg/L if C_{TDS} > 6,000 mg/L. $C_{TDS} = \frac{(C_C)\,(2{,}500\ \text{mg/L})}{500\ \text{mg/L}}$ See page 176 for exceptions to these values.	$C_E = C_{SV}$, or $C_E = \frac{(C_C)(Q_E + Q_S) - (Q_S)(C_A)}{Q_E}$ or C_E = other appropriate site-specific value, whichever is smaller.
Lake (see page 179 and page 180)	If $C_C \geq (E_F)(C_E) + (1 - E_F)(C_A)$, a TDS limit is usually not required.	$C_E = \frac{C_C - (1 - E_F)(C_A)}{E_F}$
Bay or wide tidal river (see page 180)	Compare C_E to median and maximum segment TDS concentrations.	Avoid adverse effects of excessively high or excessively low effluent TDS concentrations.

TPDES Storm Water Permits

General Provisions

This chapter describes storm water discharges subject to TPDES permit requirements, which include discharges associated with industrial activities, discharges from construction activities, and discharges from municipal separate storm sewer systems (MS4s). These types of discharges are identified by state and federal regulation (30 TAC § 281.25(4) and 40 CFR Part 122).

Currently, the TCEQ has not developed routine procedures for setting chemical-specific effluent limits on storm water discharges, based upon the Standards. In certain circumstances such as industrial storm water discharges, technology-based effluent limits for storm water discharges will be applied in individual permits and general permits. The TCEQ may require an operator of an industrial facility, authorized by a general permit, to apply for an individual TPDES permit because of:

- a total maximum daily load (TMDL) and TMDL implementation plan;
- the anti-backsliding policy—see 40 CFR Part 122.44(l);
- a history of substantive noncompliance; or
- other site-specific considerations.

Reviewing Permit Applications

Permit application review procedures for storm water discharge activities are described in this section. These procedures are different from the permit application review procedures associated with wastewater discharges (discussed in the subsection of this document entitled "Application Screening" on page 168) because storm water discharges are normally intermittent and occur during wet weather conditions.

As stated in § 307.8(e) of the Standards, controls on the quality of permitted storm water discharges are largely based on implementing best management practices and/or technology-based limits in combination with instream monitoring to assess standards attainment and to determine whether additional controls on storm water are needed. Consistent with the approach described in the EPA's Interim Permitting Approach guidance (61 FR 43761, November 6, 1996), incorporation of effluent limits based on water quality criteria in storm water permits is based on the following items:

- Specific conditions or limitations are incorporated as conditions of the discharger's TPDES permit, as necessary and appropriate, based upon surface water quality data or other acceptable information.

- Where data are not available to characterize the quality of storm water and the receiving water, the TPDES permit may include specific conditions for instream and outfall monitoring. In this situation, data collection will supplement the implementation of necessary controls. This data will be used to make any necessary permit modifications. Additionally, the data will be used to consider necessary permit revisions at the time of permit renewal. In subsequent permit actions, the TCEQ may continue to require instream and monitoring requirements, as appropriate.

Special circumstances may warrant a review similar to that applied to wastewater discharges. Some examples include:

- Storm water management systems designed to retain water and to discharge during static or low-flow conditions.

- Storm water management systems designed to commingle storm water with other waste streams, such as process, utility, or sanitary wastewater.

The Clean Water Act (CWA) §§ 301, 304, and 401 (33 United States Code (U.S.C.) 1331, 1314 and 1341) provide that National Pollutant Discharge Elimination System (NPDES) permits must include effluent limitations requiring authorized discharges to:

- meet standards reflecting levels of technological capability;

- comply with EPA-approved state water quality standards; or

- comply with other state requirements adopted under authority retained by states under CWA § 510, 33 U.S.C. § 1370.

In general, TPDES storm water permits do not contain numerical effluent limits based on water quality criteria. Instead, they emphasize requirements that facilities must prevent or effectively reduce exposure of storm water to pollution (for example, by building shelters that protect materials and activities in general from exposure to the elements, including rainfall and rainfall runoff). Such permit requirements are similar to those of previously issued NPDES storm water permits that are based on a strategy of reducing pollution at the source, as opposed to treatment before discharge. However, nothing in this document precludes the TCEQ from assigning effluent limits based on water quality criteria to a storm water discharge.

Site-Specific Information

Site-specific information may be used to develop unique storm water management practices associated with a storm water drainage system. Conditions and effluent limits may be based on, but are not limited to, the following considerations:

- the existing storm water system design;
- local climatic conditions;
- the water body being listed on the state's Clean Water Act Section § 303(d) List;
- assessments of habitat and biological integrity of receiving waters;
- extent of success already achieved in preventing and minimizing storm water pollution;
- preferences and alternatives provided by the permit applicant; and
- economically achievable and feasible measures for pollution reduction, including application of structural controls, treatment facilities, management practices and operational methods, and similar considerations.

Such information may be found in a storm water pollution prevention plan (SWP3), a storm water management plan, or a storm water management program (SWMP) for TPDES applicants. These plans or programs are documents prepared by the permit applicant describing how the site will be managed to prevent or significantly reduce discharge of pollutants from the site. These plans will be updated when necessary and made readily available to TCEQ personnel upon request.

Antidegradation Review of Storm Water Permits

Antidegradation reviews of TPDES permit applications for storm water discharges are conducted in accordance with § 307.5 of the Standards. Antidegradation reviews are conducted both for individual permits (such as MS4s and specific industrial facilities) and for general permits developed to address storm water discharges from small MS4s and categories of industrial activity (including construction activity).

Discharges to Impaired Waters

New sources or new discharges of the constituent or constituents of concern to impaired waters may not be authorized by a general storm water permit unless otherwise allowable under 30 TAC Chapter 305

("Consolidated Permits") and applicable state law. For discharges not eligible for coverage under a general storm water permit, the discharger must apply for and receive an individual or other applicable general TPDES permit authorization prior to discharging.

Impaired waters are those that do not meet one or more of the applicable water quality standards and that are listed on the state's § 303(d) List.

Constituents of concern are those for which the water body is listed as impaired.

A discharge of the constituent or constituents of concern to impaired water bodies for which there is a TMDL or TMDL implementation plan is only eligible for coverage under a general storm water permit if:

- it is consistent with the approved TMDL or TMDL implementation plan; **and**

- the discharger incorporates the limitations, conditions, and requirements applicable to its discharge, including monitoring frequency and reporting required by TCEQ rules, into its SWP3 or storm water management plan unless these limitations, conditions, and requirements are already reflected directly in the general permit itself.

Even if a TMDL has not yet been developed and implemented for the constituent or constituents of concern, discharges to impaired water bodies must not cause or contribute to the impairment (*See* 30 TAC Chapter 305 Consolidated Permits).

Discharges to the Edwards Aquifer Recharge Zone

Discharges of storm water associated with industrial activity, and other non-storm water discharges, cannot be authorized where those discharges are prohibited by 30 TAC Chapter 213 (Edwards Aquifer). New discharges located within the Edwards Aquifer Recharge Zone, or within that area upstream from the recharge zone and defined as the Contributing Zone, must meet all applicable requirements of, and operate according to, 30 TAC Chapter 213.

Discharges to Specific Watersheds and Water Quality Areas

Discharges of storm water associated with industrial activity, and other non-storm water discharges, cannot be authorized where prohibited by provisions of 30 TAC Chapter 311 (Watershed Protection) for water quality areas and watersheds.

Site-Specific Standards and Variances

General Provisions

As stated in § 307.2(d)(3) of the Standards, the narrative provisions, the designated uses, the presumed uses, and the numerical criteria of the Standards may be amended to account for local conditions. Adoption of a site-specific standard is an explicit amendment to the Standards that requires EPA approval and an opportunity for public hearing.

In cases where site complications require substantial additional time to justify, review, and approve a site-specific standard, a temporary variance (variance) for an **existing** facility may be requested before or during the permit application process to allow the permittee time to gather information to support a site-specific standard. A variance is not equivalent to a site-specific standard, which is a rule change. Variance procedures are defined in § 307.2(d)(5) of the Standards. **Preliminary evidence indicating that a site-specific standard may be appropriate should be submitted to the TCEQ to show that a variance is warranted.**

The information necessary to justify a variance is only a part of the process of justifying a site-specific standard. The applicant should continue to develop more comprehensive information to support the site-specific standard. Technical guidance to support a site-specific standard is given in the following sections of this document: “Site-Specific Standards for Aquatic Life Use” (see page 195), “Site-Specific Standards for Recreational Use” (see page 199), “Site-Specific Numerical Standards for Aquatic Life” (see page 202), and “Site-Specific Standards for Total Toxicity” (see page 207).

Interim Permit with a Variance

A variance may be requested before or during the permit application process. The TCEQ includes all variance requests in the Notice of Application and Preliminary Decision, and the public is given the opportunity to request a hearing on both the variance and the TPDES permit. A variance for a TPDES permit also requires EPA approval. The TCEQ’s approval of a variance along with the TPDES permit formally recognizes that a site-specific standard may be justified based on preliminary evidence provided by the applicant. The variance is approved by the TCEQ as conditions in the permit that provide interim effluent

limits or monitoring requirements. Permit conditions for the pollutant or pollutants of concern are normally the same as in the previous permit. However, the application of a variance cannot impair an existing, attainable, or designated use. As stated in § 307.2(d)(5)(D) of the Standards, the permit must preclude degradation. A TPDES permit that contains an approved variance is issued for up to a three-year term.

The variance consists of special provisions in the TPDES permits, which establish a schedule for the permittee to submit a work plan to study the stream characteristics, aquatic life uses, or other site-specific information about the receiving water. Upon approval of the work plan, the permittee performs the study in accordance with the approved work plan. Final effluent limits based upon the existing standard are not applied in the permit, since the appropriateness of the existing standard is in question and under study. However, the permit will specify the effluent limits that would be applied in the next permit if the permittee does not comply with the requirements of the variance or if the existing standard is not revised.

The variance provisions in the short-term permit allow the permittee time to gather information necessary to fully support a site-specific standard. With this information, the applicant should request the site-specific standard in writing and submit the approved study to the TCEQ at least 180 days before the expiration date of the permit.

A permittee may also request a variance where an **existing** permit already includes a compliance period to meet the Standards. In this case, the existing permit (which includes a compliance period for the pollutant of concern) is amended to recognize the variance request. If granted, the variance will expire no later than three years following the issue date for the permit that previously specified a compliance period.

Variance Extensions

When the TCEQ receives the permit renewal application and the study of stream characteristics, aquatic life uses, or other site-specific information about the receiving water, a technical review of this information is conducted. A recommendation on the effluent limits for the succeeding permit is made, based upon the permittee's fulfillment of the variance requirements and whether the TCEQ agrees the site-specific standard is warranted.

Recommend that the Standard be Revised

In this situation, the TCEQ determines that the proposed site-specific standard is appropriate, and EPA determines that it is technically approvable. If the revision to the Standards can be processed and completed before the TPDES permit is renewed, then the permit is issued

with final effluent limits based upon the revised standard. Otherwise, the succeeding permit is renewed with a variance extension. The interim effluent limits will be extended from the previous permit to allow additional time for a site-specific standard to be adopted into the Standards and approved by EPA.

Once the site-specific standard is adopted and approved by EPA, the permittee can seek to have the TPDES permit amended to include or remove effluent limits to reflect the new standard. If this new standard requires an upgrade in treatment, the permit may include a compliance schedule to achieve the effluent limits needed to meet the final standard. As described in § 307.2(f) of the Standards, up to three years from the effective date of the permit's issuance is provided to allow sufficient time for the permittee to modify the effluent quality.

Recommend that the Standard not be Revised

In this situation, the TCEQ (or the EPA) does not believe the study supports the site-specific standard. The succeeding permit may include a compliance schedule to achieve the effluent limits needed to meet the existing standard. As described in § 307.2(f) of the Standards, up to three years from the effective date of the permit's issuance is provided to allow sufficient time for the permittee to modify the effluent quality.

When the permittee has not complied with the conditions in the variance, then the succeeding permit is issued with final effluent limits based upon the existing standard, effective immediately. The TCEQ does not grant a compliance period with interim effluent limits in this situation, since the permittee did not perform the required study or otherwise fulfill the requirements of the variance.

Coordinating with EPA

In the memorandum of agreement (MOA) with EPA delegating the NPDES program to the state, the TCEQ agreed that EPA would review all draft TPDES permits that include a recommendation of a variance. The TCEQ routes draft permits with a variance or variance extension to EPA, along with the technical information that the permittee provides to support the variance request. EPA reviews the variance request within 45 days and may confer with the USFWS on endangered species issues during this review period. By the end of the 45-day review, EPA either (1) approves the variance and draft permit or (2) specifies any interim objections. Any interim objections have to be resolved before the TCEQ can proceed.

Further details of procedures for federal review of TPDES permits can be found in the TPDES MOA, which is available on the agency's Web site (see footnote 2 on page 21).

Temporary Standards

Where a criterion is not attained and cannot be reasonably attained for one or more of the reasons listed in 40 CFR Part 131.10(g), then a temporary standard for a specific water body may be adopted as part of § 307.10 of the Standards as an alternative to downgrading uses. Reasons for a temporary standard are as follows:

- Naturally occurring pollutant concentrations prevent the attainment of a use;
- Natural, ephemeral, intermittent, or low-flow conditions or water levels prevent the attainment of the use;
- Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;
- Dams, diversions, or other types of hydrological modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or operate such modification in a way that would result in the attainment of a use;
- Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
- Controls more stringent than those required by §§ 301(b) and 306 of the federal Clean Water Act would result in substantial and widespread economic and social impact.

In accordance with § 307.2(g) of the Standards, the following provisions apply to temporary standards:

- A criterion that is established as a temporary standard must be adopted as stated in the provisions of § 307.2(d)(3) of the Standards.
- A temporary standard must identify the water body or water bodies where the criterion applies.

- A temporary standard will identify the numerical criteria that will apply during the existence of the temporary standard, and a remediation plan to address compliance with designated uses and criteria will be provided for approval by the EPA.

- A temporary standard does not exempt any discharge from compliance with applicable technology-based effluent limits.

- A temporary standard must expire no later than the completion of the next triennial revision of the Standards.

- When a temporary standard expires, subsequent discharge permits will be issued to meet the applicable existing water quality standards.

- If sufficiently justified as stated in the provisions of § 307.2(d)(3) of the Standards, a temporary standard can be renewed during revision of the Standards.

- A temporary standard cannot be established that would impair an existing use.

Permits including a limit based on a temporary standard typically: (1) are issued for three years, (2) are amended by staff after three years, or (3) include another option that precludes allowing limits to be based on the temporary standard for an extended (five-year) period if the temporary standard is removed from the Standards.

Site-Specific Standards for Aquatic Life Use

For unclassified water bodies, aquatic life uses are assessed as described in the chapter of this document entitled "Determining Water Quality Uses and Criteria" on page 14. In cases where the preliminary assessment indicates that the attainable aquatic life use for a particular unclassified water body might be lower than the presumed aquatic life use, an aquatic life use-attainability analysis (UAA) is conducted as discussed in this section. UAAs are also conducted on classified streams where the attainable aquatic life use has become lower than the designated use.

The rest of this section explains:

- the procedures used to review and approve UAAs;

- how to conduct UAAs for typical sites on unclassified streams; and

- the kinds of site complications that require additional analysis.

Aquatic Life UAA Review and Approval

TCEQ staff review each UAA in order to ensure conformance with the basic protocol. If the UAA indicates that the attainable use is lower than the designated use for a classified stream or if the TCEQ decides a lower aquatic life use designation is justified for an unclassified stream, then the TCEQ sends the UAA to EPA Region 6 for review and preliminary approval. The TCEQ sends the results of the UAA to the EPA as a summary report with the presentation of results in the appropriate format as described in Appendix C of TCEQ's *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data*, RG-416. After reviewing the UAA, the EPA sends a response to the TCEQ.

Aquatic Life UAAs for Unclassified Streams

Within 30 days after receiving a UAA for a "typical site" on an unclassified stream, the EPA reviews the UAA in accordance with the protocol entitled "UAA for Typical Sites" on page 197 and provides a response to the TCEQ. Additional time may be needed for EPA review of streams with "site complications" (see page 199 for more information). Preliminary approval of a UAA for an unclassified stream by the EPA constitutes a finding that the requested aquatic life uses and criteria for the stream are "approvable" for a site-specific designation in the Standards.

The TCEQ will designate site-specific aquatic life uses in Appendix D of the Standards. To the extent possible, the public notification and public hearing requirements for adopting a site-specific standard may be conducted in conjunction with the public participation procedures for any permit actions that affect the particular site.

After the TCEQ and EPA final approval of the revised Standards, TPDES discharge permits are issued with effluent limits based upon the new site-specific standard designation. The new site-specific standard is also included in the TCEQ's Water Quality Management Plan (WQMP).

Aquatic Life UAAs for Classified Streams

For classified streams, the EPA may need more than 30 days to review the UAA. Lowering a designated aquatic life use on a classified water body takes a more extensive study than for lowering the presumed aquatic life use of an unclassified stream. A UAA for a classified stream requires that representative sites throughout the segment be evaluated rather than one typical site as for an unclassified stream.

Preliminary approval of a UAA by the EPA for classified streams constitutes a finding that the lowered aquatic life use is "approvable" as the new designated use for the classified stream. The change in the designated use is placed in the next revision of the Standards.

Aquatic Life UAAs for Typical Sites

Data collection, compilation, and analysis may be conducted by the TCEQ, an applicant, river authorities, or governmental or other entities. Any person or entity planning to conduct a UAA should coordinate with the TCEQ. In addition, regional staff of the Texas Parks and Wildlife Department and the TCEQ, the Texas State Soil and Water Conservation Board, and local stakeholders in the watershed should be notified about the proposed UAA project.

Classified Streams

Procedures to conduct a UAA on a classified stream are described in the most recent version of the TCEQ's Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data, RG-416. In addition, procedures for conducting instantaneous field measurements, 24-hour dissolved oxygen monitoring, and conventional water chemistry sampling for a UAA are contained in the most recent version of the TCEQ's Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, RG-415. Results of a UAA for a classified stream should be submitted in the appropriate format (described in Appendix C of RG-416) to the TCEQ for review.

Unclassified Streams—Applicability

The aquatic life UAA procedures in this section may be used under the following conditions:

- A sample site unimpacted by a pollutant source is available (or data already exists for a reference area), such as in the projected area of impact for a new permit, or upstream of an existing permit.

- The attainable use is not impaired by other sources of pollution at critical conditions.

- The characteristic aquatic life use in unimpacted reference areas is lower than the statewide or region-wide presumed use. This corresponds to one or more of the following reasons for lowering a designated use listed in 40 CFR Part 131:

- Naturally occurring poor water quality prevents the attainment of the use.
- Natural stream flow conditions prevent the attainment of the use.
- Physical characteristics of the stream channel (morphometry) preclude attainment of aquatic life uses.
- Hydrologic modifications (dams, spillways, intake structures, etc.) preclude the attainment of the use, and the impacts cannot be reasonably mitigated.

Unclassified Streams—Summary of Aquatic Life UAA Procedures

The following items summarize the aquatic life UAA procedures for typical sites:

- Conduct the UAA in accordance with the appropriate biological fact sheet in the most recent version of the TCEQ's *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data*, RG-416.
- Identify reference areas and define stream reach or reaches to be included in the assessment.
- Summarize stream morphometry, flow characteristics, and habitat characteristics in the reference area in accordance with:
  - a standardized stream characteristics form (from a TCEQ wastewater permit application), which also contains a description of the proposed or existing discharge; or
  - the most recent version of the TCEQ's *Surface Water Quality Monitoring Procedures, Volumes 1 and 2*, RG-415 and RG-416. This document is available on the agency's Web site (www.tceq.state.tx.us); follow the link for "Publications."
- Conduct fish sampling (or in some cases macroinvertebrate sampling) in the reference area in accordance with the RG-416 (see preceding bulleted item).
- Apply quantitative indices in accordance with the RG-416, cited above.
- Conduct instantaneous field measurements, 24-hour dissolved oxygen monitoring, and conventional water chemistry sampling in accordance with RG-415 and the appropriate biological fact sheet in RG-416.

- Submit the results of the UAA in the appropriate format, as described in Appendix C of RG-416, to the TCEQ's Water Quality Standards Group in the Water Quality Planning Division for review.

Site Complications Requiring Additional Justification

In unusual situations, there may be site-specific complications that indicate more information is needed to justify an aquatic life use that is less than the presumed use for an unclassified water body. Examples of such situations and the types of additional information that may be appropriate are listed below.

Examples of Site-Specific Complications

- The reasonably attainable uses in the receiving waters are impacted by an existing discharge and are considered to be lower than the naturally occurring uses in an appropriate reference area (for example, upstream).

- No suitable reference areas are available for sampling.

- Dissolved oxygen criteria for a particular aquatic life use are inappropriate for the site.

Examples of Additional Analyses

- Water quality modeling simulations to evaluate treatment options.

- Additional investigation of pollutant sources and instream impacts.

- Sampling and evaluation of additional parameters, such as diel measurements of dissolved oxygen.

- Technical and economic feasibility of attaining the presumed use.

Site-Specific Standards for Recreational Use

Categories of recreational uses and applicable criteria are established in §§ 307.4(j) and 307.7(b)(1) of the Standards. In cases where site- specific information indicates that the attainable recreational use for a particular unclassified water body might be lower than the presumed recreational use, a Basic Recreational UAA Survey or Comprehensive Recreational UAA can be conducted as discussed in this section. Comprehensive Recreational UAAs can also be conducted on classified water bodies where there is an indication that the attainable recreational use is lower than the designated use.

The remainder of this section explains:

- the procedures used to review and approve recreational UAAs.
- how to conduct Basic Recreational UAA Surveys and Comprehensive Recreational UAAs.

Recreational UAA Review and Approval

The TCEQ reviews each UAA in order to ensure conformance with the TCEQ recreational UAA procedures and to determine if a lower recreational use is justified. If the UAA indicates that the recreational use is less stringent than the designated or presumed use, the TCEQ submits the UAA to EPA Region 6 for review and preliminary approval. The TCEQ sends the results of the UAA to the EPA as a summary report with a copy of the recreational UAA report attached. After reviewing the UAA, the EPA sends a response to the TCEQ.

Recreational UAAs for Unclassified Water Bodies

Within 30 days after receiving a UAA for an unclassified water body, the EPA reviews the UAA in accordance with the TCEQ recreational UAA procedures and provides a response to the TCEQ. Additional time may be needed for EPA review of complex recreational UAAs. Preliminary approval of a recreational UAA by the EPA constitutes a finding that the requested recreational uses and criteria for a water body are “approvable” for a site-specific designation in the Standards. The change in the presumed use will be proposed for adoption in the next revision of the Standards.

Recreational UAAs for Classified Water Bodies

For classified water bodies, the EPA may need more than 30 days to review the UAA. Lowering a designated recreational use on a classified water body takes a more extensive study than for lowering the recreational use of an unclassified water body. Preliminary approval of a UAA by the EPA for classified water bodies constitutes a finding that the lowered recreational use is “approvable” as the new designated use for the classified water body. The change in the designated use is placed in the next revision of the Standards.

How to Conduct Recreational UAAs

Applicability

Data collection, compilation, and analysis may be conducted by the TCEQ, river authorities, or governmental or other entities. The recreational UAA procedures summarized in this section may be used under the following conditions:

- The attainable use is not impaired by sources of pollution.
- The attainable recreational use is lower than the presumed or designated use. This corresponds to one or more of the following reasons for lowering a designated use listed in 40 CFR Part 131:
    - Naturally occurring poor water quality prevents the attainment of the use. Sources of pollution cannot be reasonably controlled by existing regulations.
    - Natural, ephemeral, intermittent, or low stream flow conditions prevent the attainment of the use.
    - Physical characteristics of the stream channel (morphometry) preclude attainment of aquatic life uses.
    - Hydrologic modifications (dams, spillways, intake structures, etc.) preclude the attainment of the use, and the impacts cannot be reasonably mitigated.

Summary of Recreational UAA Procedures

Basic Recreational UAA Surveys and Comprehensive Recreational UAAs should be conducted in accordance with the TCEQ's Recreational UAA procedures. These procedures are available upon request from the TCEQ's Water Quality Standards Group in the Water Quality Planning Division. The following items summarize the UAA procedures for typical sites:

- Coordinate with local entities and the TCEQ.
- Identify the water body and select sites.
- Conduct the UAA during a normal dry/warm season (March-October) when water body recreation is most likely to occur.
- Summarize the following information in accordance with the TCEQ's *Recreational Use Attainability Analysis Procedures*:

- water body and flow characteristics
- watershed characteristics
- stream channel and substantial pool measurements
- weather conditions
- historical information
- observed uses
- indications of human use
- water quality data (air and water temperature)

Persons performing a recreational UAA are to complete the associated contact information form, field data sheets, Comprehensive Recreational UAA interview form, and Recreational UAA summary sheet included in the procedures.

- Submit Basic Recreational UAA Surveys or Comprehensive Recreational UAA reports as described in the recreational UAA procedures to the TCEQ for review.

Wildlife Sources of Bacteria

In situations where the weight of evidence obtained from sanitary surveys, bacteria source tracking, UAAs, or similar studies demonstrate that sources of bacteria are unavoidably high (e.g. in wildlife preserves with very large waterfowl populations and limited aquatic recreational potential), site-specific uses, such as secondary contact recreation, may be designated for individual water bodies in the Standards.

Site-Specific Numerical Standards for Aquatic Life

A permittee may pursue a standards modification where local site-specific factors suggest that the numerical criteria are inappropriate for a particular water body. These factors are defined in § 307.6(c)(10) of the Standards.

The following paragraphs discuss these factors in more detail. Information that may establish the presence of these factors should be submitted as part of a permit application. Based on the existence of these factors, a permittee may seek a permit amendment to modify final effluent limits. An application to amend a permit does not delay the effective date of final effluent limits as established in an existing permit; therefore, an amendment application should be submitted well in advance of the effective date of the final effluent limits to allow full TCEQ consideration and final decision. The remainder of this section discusses each factor and how TCEQ staff evaluates information submitted by a permit applicant.

Where an applicant believes that a metal standard is inappropriate, the applicant should carefully evaluate recent effluent analytical data to ensure that effluent metals concentrations do in fact exceed levels necessary to comply with existing standards. The applicant should employ clean techniques for all sample-handling and analytical procedures to avoid sample contamination.

Background Concentrations of Specific Toxics

Through sampling of the receiving water in an area unimpacted by dischargers, the applicant should demonstrate that toxic pollutants exist naturally at concentrations higher than the instream criteria. *See* § 307.6(c)(10)(A) of the Standards. Where the background concentration is greater than the instream criteria, the TCEQ establishes effluent limits that will preclude further increase in the background concentration.

Persistence and Degradation Rate of Specific Toxics

The applicant may demonstrate that a specific toxic pollutant in the effluent has a short half-life within the defined mixing zone of the receiving water due to chemical reactions with naturally occurring compounds, degradation in ultraviolet light, and so forth. *See* § 307.6(c)(10)(B) of the Standards. This demonstration should be made using receiving water while simulating natural conditions as much as possible. The applicant may also use instream studies of existing discharges.

The applicant should provide proof of degradation and determine that receiving water concentrations of the toxic pollutants of concern do not exceed appropriate criteria. In addition, the applicant should determine the worst-case scenario or demonstrate that the degradation rate is independent of seasonal fluctuations in water chemistry (for example, temperature, pH, dissolved oxygen, and hardness).

Interactions of Toxic Substances with Other Toxic or Nontoxic Materials

A synergistic interaction is a situation in which the combined effect of two or more chemicals is greater than the sum of the effect of each substance alone. *See* § 307.6(c)(10)(C) of the Standards. An additive interaction is a situation in which the toxicity of a mixture of chemicals is approximately the same as that expected from a simple summation of the known toxicity of each of the individual chemicals in the mixture. An antagonistic interaction is a situation in which a mixture of toxicants exhibits a less-than-additive toxic effect.

The applicant may demonstrate that toxicity in an effluent is caused by a synergistic, antagonistic, or related interaction. By modifying the concentration of a certain chemical in the effluent, the applicant may be able to show that a reduction of effluent toxicity will result without the removal of other suspected toxicants. This demonstration should be made by performing whole effluent toxicity (WET) tests on effluent or in-situ, either from a working wastewater treatment system or a pilot project, using receiving waters. However, a synergistic interaction may necessitate stricter permit limits to protect the receiving waters.

Measurements of Total Effluent Toxicity

To demonstrate that a site-specific standard may be appropriate, an applicant may perform WET tests using indigenous receiving water species. *See* § 307.6(c)(10)(D) of the Standards. The WET tests should be conducted before submitting the permit application. The applicant should conduct an assessment of the receiving water to determine the species present. A diverse, representative, and sensitive group of species should be tested for short- and long-term impacts. The permittee should also demonstrate that sensitive, indigenous species will not be adversely affected, and aquatic life and other uses will not be impaired.

Effluent limits based on specific numerical criteria may not be raised if bioaccumulation or persistence in the food chain or the environment may produce long-term impacts that cannot be measured by WET tests. All alternate site-specific conditions related to chronic or 48-hour acute WET testing are subject to EPA review and approval.

Indigenous Aquatic Organisms

An applicant may demonstrate that indigenous aquatic organisms are not affected by the effluent at the same concentration as species used to develop the criteria in the standards. *See* § 307.6(c)(10)(E) of the Standards. This demonstration may be accomplished by performing a detailed survey of aquatic organisms in the water body in areas in and out of the effluent plume. The applicant should also prepare a statistical analysis of the impacts to the receiving water. In addition, the applicant should evaluate the relative sensitivities of indigenous organisms to particular toxicants of concern.

The permittee may calculate a site-specific criterion if the assemblage of indigenous aquatic organisms satisfies the minimum family and genus totals defined in *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* by the U.S. Environmental Protection Agency, Office of Research and Development, NTIS Accession Number PB85-227049, (Stephan et al.), 1985.

Technological or Economic Limits of Treatability for Specific Toxic Materials

If the permittee cannot achieve the required effluent limits (normally no lower than the MAL) by best available technology (BAT), then the permittee may apply for a modification of the effluent limit. *See* § 307.6(c)(10)(F) of the Standards. An applicant seeking an effluent limit modification due to treatment technology limitations should demonstrate, through the use of pilot tests, the level to which the specific toxic pollutant of concern can be treated using state-of-the-art treatment.

The permittee should submit an evaluation of the costs of treatment required to meet the water-quality based effluent limit and include a comparison of BAT or existing costs with estimated costs of state-of-the-art treatment. In this evaluation, the applicant should outline the incremental changes to the existing wastewater treatment facility to achieve state-of-the-art treatment. These changes might include alterations in raw materials, manufacturing processes, products produced, and energy requirements. Also, the applicant should demonstrate that improvements in best management practices or a simple raw material substitution would not achieve the treatment level required to meet effluent limits based on water quality criteria.

The applicant should show that existing or designated receiving water quality uses are not impaired due to the modified permit limits.

Bioavailability of Specific Toxic Substances

The applicant may demonstrate that the chemical species of a particular substance in the effluent does not induce toxic effects or has a much less toxic effect than another species of that substance. *See* § 307.6(c)(10)(G) of the Standards. The applicant should prove that the species present in the effluent does not convert chemically or biologically to a more toxic form upon entering and mixing with receiving waters. If the demonstration does not induce toxic effects, the permit limit may be established based on the combined toxicity of the chemical species in the effluent.

If, however, a toxic substance in an effluent converts chemically or biologically to a more toxic species upon entering or mixing with receiving waters, then the permit limit may be established based upon the toxicity of the more toxic chemical species.

When a permit limit based on an aquatic life criterion is proposed, the applicant may wish to develop a water-effect ratio (WER) to adjust the criterion. A WER accounts for the difference in the toxicity of a metal in laboratory water from the toxicity of metals in the permittee's receiving water. Permittees should follow the EPA's guidance document, *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals*,

EPA-823-B-94-001, 1994 (or most recent revision), when conducting these studies.

WERs obtained using the methods described in this EPA guidance document cannot be used to adjust aquatic life criteria that were derived for metals in other ways. Therefore, WERs using these methods cannot be used to adjust the residue-based chronic criterion for mercury, or the field-based selenium freshwater criteria.

Permit applicants may also develop WERs using the EPA's *Streamlined Water-Effect Ratio Procedure for Discharges of Copper*, EPA-822-R-01-005, March 2001. The streamlined procedure does not supersede the 1994 interim guidance; rather it provides an alternative approach for discharges of copper into a freshwater environment. Permittees in this situation may choose between using the 1994 interim guidance or the streamlined procedure. Some of the features of the streamlined procedure are as follows:

- The procedure applies to continuous discharges of copper into freshwater.
- A minimum of two sampling events should be performed at least one month apart.
- The site water should be prepared by mixing effluent and upstream receiving water to achieve the critical dilution.
- The WER for a single sampling event is calculated by dividing the site water LC50 by the greater of
    - the lab water LC50; or
    - the species mean acute value. The SMAV, which is usually found in EPA criteria documents, is the mean LC50 or EC50 from a group of published toxicity tests with laboratory water.
- A minimum of two WERs should be used to calculate the final WER.
- The final WER is the geometric mean of the two (or more) sampling event WERs.

New Information Concerning the Toxicity of a Substance

An applicant or other interested party may provide new or updated information that indicates that the toxicity of a substance is significantly different from the numerical criteria in the Standards. *See* § 307.6(c)(10)(H) of the Standards. This information will typically consist of additional or revised toxicity exposure testing. This testing should be

conducted in accordance with *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* by the U.S. Environmental Protection Agency, Office of Research and Development (Stephan, et al.), 1985.

Site-Specific Standards for Total Toxicity

Additional chemical-specific or whole effluent toxicity limits may be established in a permit as a result of confirming whole effluent toxicity at the critical dilution. These chemical-specific or whole effluent toxicity limits may be adjusted based on site-specific factors discussed in the following paragraphs. However, any discharge limit that fails to prevent significant toxicity to a test species at the designated critical dilution requires a demonstration that instream uses will not be impaired. *See* § 307.6(e)(2)(F) of the Standards. An effluent limit that could exceed the total toxicity requirements of the Standards requires a site-specific amendment to the rule.

The remainder of this section discusses each factor to be considered in establishing permit limits and how TCEQ staff evaluates information submitted by an applicant. All alternate site-specific conditions related to chronic or 48-hour acute WET testing are subject to EPA review and approval.

Background Toxicity of Unimpacted Receiving Waters

Where background instream toxicity exists, the TCEQ may establish whole effluent or chemical-specific limits that preclude further increase in the background receiving water toxicity. *See* § 307.6(e)(2)(F)(i) of the Standards. The applicant should demonstrate background toxicity by assessing toxicity in an area unimpacted by the discharge.

Persistence and Degradation Rate of Principal Toxic Materials

The applicant may demonstrate that chemicals responsible for toxicity in the effluent have a short half-life within the defined mixing zone of the receiving water due to chemical reactions with naturally occurring compounds, degradation in ultraviolet light, and so forth. *See* § 307.6(e)(2)(F)(ii) of the Standards. This demonstration should be made using receiving water while simulating natural conditions as much as possible. The applicant may also use instream studies of existing discharges. The applicant should provide proof of chemical degradation and determine that the receiving water's total toxicity measurements do not violate appropriate criteria.

Site-Specific Variables that may Alter the Impact of Toxicity

An applicant may demonstrate that existing receiving-water-specific variables alter the toxic impacts of an effluent. *See* § 307.6(e)(2)(F)(iii) of the Standards. The applicant should use receiving water biological studies or should perform whole effluent toxicity tests at critical conditions on receiving water samples collected immediately within the discharge plume to the end of the mixing zone.

Indigenous Aquatic Organisms

An applicant may demonstrate that indigenous aquatic organisms are not affected by the effluent at the same exposure concentration as the standard WET test species defined in the permit. *See* § 307.6(e)(2)(F)(iv) of the Standards. This may be accomplished by performing a detailed survey of aquatic organisms in the water body in areas in and out of the effluent plume coupled with a statistical analysis of the data. In addition, the applicant should evaluate the relative sensitivities of indigenous organisms to particular toxicants of concern using literature information or WET tests.

Technological, Economic, or Legal Limits of Treatability or Control for Specific Toxic Materials

If the permittee cannot achieve the required total toxicity or chemical-specific permit limits with best available technology, then the permittee may apply for a modification of the effluent limit. *See* § 307.6(e)(2)(F)(v) of the Standards. An applicant seeking an effluent limit modification because of the limitations of treatment technology should demonstrate, through the use of pilot tests, the level to which the specific toxic pollutant of concern can be treated using state-of-the-art treatment.

The permittee should submit an evaluation of the costs of treatment required to meet the effluent limit and include a comparison of BAT or existing costs with estimated costs of state-of-the-art treatment. In this evaluation, the applicant should outline the incremental changes to the existing wastewater treatment facility to achieve state-of-the-art treatment. These changes might include alterations in raw materials, manufacturing processes, products produced, and energy requirements.

Also, the applicant should demonstrate that improvements in best management practices, such as source control, public education, housekeeping, a simple raw material substitution, or a water treatment chemical substitution, would not achieve the treatment level required to meet effluent limits based on water quality criteria. The applicant should show that existing or designated receiving water quality uses are not impaired due to the modified permit limits.

Appendix A. Playa Lake Policy Statement

Playa Lake Policy Statement

Except as otherwise provided in this policy, a permit or order of the Commission, the discharge from any existing industrial or domestic wastewater treatment facility that is authorized to use and has used a playa lake, which does not feed into any surface water of the state, as a wastewater retention facility before July 10, 1991, the effective date of TNRCC adoption of related revisions to the Texas Surface Water Quality Standards, 30 TAC Chapter 307, shall not be subject to meeting such standards or other requirements for discharges to waters in the state. However, additional requirements may be imposed in existing permits so that such discharges shall not create a nuisance or otherwise impair public health, nor cause contamination of groundwater. Such requirements include, but are not limited to, the prohibition of the discharge of raw, untreated wastewater into a playa.

Accordingly, public access to the playa lake shall be limited (e.g., by fencing and/or "no trespassing" signs) and applicable buffer zones shall be required. Additionally, because of the uncertainty of the impermeability and durability of the natural clay liner found on the bottom of a playa lake, as well as the exact location and depth of the underlying water table, groundwater quality monitoring and reporting shall be a condition of the permit or permit renewal. If groundwater contamination from the discharge is detected, a corrective action plan shall be developed and remediation measures shall be required.

If the wastewater is used for irrigation, the discharge must also meet applicable treatment levels and application rates based upon soil depth and characteristics, topography, whether the land has been plowed, crop uptake rates, and other relevant factors.

New discharges to playa lakes not previously authorized to be used as wastewater treatment or retention facilities before July 10, 1991, shall meet applicable surface water quality standards in addition to the groundwater protection requirements above. Additionally, if a finding is made that a waste discharge into a playa of industrial or municipal waste (authorized before July 10, 1991) is subject to the TPDES program, any existing permit will be amended to include a reasonable compliance period, consistent with other agency rules. Such discharges are subject to the TPDES program if the playa is considered as waters of the United States. Unclassified playa shall be presumed to have the same standards as that for an unclassified intermittent water body until more specific standards are established for this water in the state.

Dan Pearson, Executive Director
TNRCC

10/20/97
Date

Appendix B. Locations of Federally Endangered and Threatened Aquatic and Aquatic-Dependent Species in Texas

Table B. Locations of Federally Endangered and Threatened Aquatic and Aquatic-Dependent Species in Texas

Segment No.	Common Name	County	Water Body
0101	Arkansas River shiner	Hemphill Hutchinson Roberts	Canadian River Below Lake Meredith
0103	Arkansas River shiner	Oldham Potter	Canadian River Above Lake Meredith
1202	Houston toad	Austin	Deep Creek
1209	Houston toad	Leon	Running Creek
1211	Houston toad	Burleson	Second Davidson Creek
1212	Houston toad	Bastrop	Marshy Branch
		Lee	Blue Branch
		Milam	Hills Branch
1242	Houston toad	Burleson	Sweet Gum Branch
1302	Houston toad	Colorado	Hayes Creek
1402	Houston toad	Colorado	Redgate Creek
1409	Concho water snake	Lampasas San Saba	Colorado River Above Lake Buchanan
1410	Concho water snake	Brown Coleman McCulloch Mills San Saba	Colorado River Below O. H. Ivie Reservoir
1411	Concho water snake	Coke	E. V. Spence Reservoir
1412	Concho water snake	Coke Mitchell	Colorado River Below Lake J. B. Thomas
1416	Clear Creek gambusia	Menard	Clear Creek Wilkinson Spring (headspring of Clear Creek)
1421	Concho water snake	Concho	Concho River Dry Hollow Kickapoo Creek
		Tom Green	Concho River
1426	Concho water snake	Coke	Colorado River Below E. V. Spence Reservoir
		Runnels	Colorado River Below E. V. Spence Reservoir Ballinger Municipal Lake Bluff Creek Coyote Creek Elm Creek
1427	Barton Springs salamander [1]	Blanco	Onion Creek
		Hays	Bear Creek Little Bear Creek Onion Creek

Segment No.	Common Name	County	Water Body
		Travis	Bear Creek Onion Creek Slaughter Creek Williamson Creek
1430	Barton Springs salamander [1]	Hays	Barton Creek
		Travis	Barton Creek Upper Barton Spring above Barton Springs Municipal Pool Barton Springs outflows in Travis County Eliza Springs Parthenia (= Main) Springs Sunken Garden Springs
1433	Concho water snake	Coleman Concho Runnels	O. H. Ivie Reservoir
1434	Houston Toad	Bastrop	Alum Creek Copperas Creek Gills Branch Piney Creek Price Creek Puss Hollow
1605	Houston toad	Lavaca	Laughlins Sandy Creek
1809	Comal Springs dryopid beetle[1]	Hays	Fern Bank Springs
1811	Peck's Cave amphipod [1]	Comal	Comal Springs
1811	Comal Springs dryopid beetle [1]	Comal	Comal Springs
1811	Comal Springs riffle beetle [1]	Comal	Comal Springs
1811	Fountain darter [1]	Comal	Comal River Landa Lake
1812	Peck's Cave amphipod [1]	Comal	Hueco Springs
1814	Comal Springs riffle beetle [1]	Hays	San Marcos Springs Spring Lake
1814	Fountain darter [1]	Hays	Upper San Marcos River Purgatory Creek San Marcos National Fish Hatchery refugium Sessom Creek Spring Lake Willow Spring Creek
1814	San Marcos gambusia [1]	Hays	Upper San Marcos River Spring Lake
1814	San Marcos salamander [1]	Hays	Upper San Marcos River San Marcos National Fish Hatchery refugium San Marcos Springs outflows San Marcos Springs Spring Lake

Segment No.	Common Name	County	Water Body
1814	Texas blind salamander [1]	Hays	Upper San Marcos River Ezell's Cave pool F. Johnson's fissure pool Primer's fissure pool Rattlesnake Cave pool San Marcos National Fish Hatchery refugium San Marcos Springs San Marcos Springs outflows SWTSU artesian well outlet
1814	Texas wild-rice [1]	Hays	Upper San Marcos River San Marcos National Fish Hatchery refugium Spring Lake
2109	Fountain darter [1]	Uvalde	Uvalde National Fish Hatchery refugium
2109	Comanche Springs pupfish	Uvalde	Uvalde National Fish Hatchery refugium
2109	Texas wild-rice [1]	Uvalde	Uvalde National Fish Hatchery refugium
2304	Devil's River minnow	Kinney	Las Moras Creek Las Moras Spring Pinto Creek Pinto Spring Sycamore Creek
		Val Verde	Sycamore Creek
2306	Big Bend gambusia	Brewster	Spring 1 (Rio Grande Village, Big Bend NP) Big Bend National Park refugium
2309	Devil's River minnow	Val Verde	Devils River Dolan Creek Finegan Spring Pecan Springs Phillips Creek
2311	Pecos gambusia	Jeff Davis	Phantom Lake Spring and canal system
		Pecos	Diamond Y Draw Diamond Y Spring Leon Creek
		Reeves	Balmorhea irrigation canals East Sandia Spring Giffin Spring and canal system San Solomon Spring (Balmorhea State Park) Toyah Creek
2311	Little Aguja pondweed	Jeff Davis	Little Aguja Creek
2311	Comanche Springs pupfish	Jeff Davis	Phantom Lake Spring and canal system
		Reeves	Balmorhea irrigation canals Giffin Spring and canal system San Solomon Spring (Balmorhea State Park)Toyah Creek
2311	Leon Springs pupfish	Pecos	Diamond Y Draw Diamond Y Spring Leon Creek

Segment No.	Common Name	County	Water Body
2311	Pecos assiminea snail	Pecos	Upper Pecos River Diamond Y Draw East Sandia Spring
2311	Puzzle sunflower	Pecos	Diamond Y Spring
2313	Devil's River minnow	Val Verde	San Felipe Creek
2411	Piping plover [2]	Jefferson	Sabine Pass
2421	Piping plover [2]	Chambers Galveston	Upper Galveston Bay
2422	Piping plover [2]	Chambers Galveston	Trinity Bay
2423	Piping plover [2]	Galveston	East Bay
2424	Piping plover [2]	Brazoria Galveston	West Bay
2432	Piping plover [2]	Brazoria	Chocolate Bay
2433	Piping plover [2]	Brazoria	Bastrop Bay/Oyster Lake
2434	Piping plover [2]	Brazoria	Christmas Bay
2435	Piping plover [2]	Brazoria	Drum Bay
2439	Piping plover [2]	Galveston	Lower Galveston Bay
2441	Piping plover [2]	Matagorda	East Matagorda Bay
2442	Piping plover [2]	Brazoria Matagorda	Cedar Lakes
2451	Piping plover [2]	Calhoun Matagorda	Matagorda Bay/Powderhorn Lakes
2452	Piping plover [2]	Matagorda	Tres Palacios Bay/Turtle Bay
2461	Piping plover [2]	Calhoun	Espiritu Santo Bay
2461	Whooping crane	Calhoun	Espiritu Santo Bay
2462	Piping plover [2]	Calhoun	San Antonio Bay/Hynes Bay/Guadalupe Bay
2462	Whooping crane	Calhoun	San Antonio Bay/Hynes Bay/Guadalupe Bay
2463	Piping plover [2]	Aransas	Mesquite Bay/Carlos Bay/Ayres Bay
2463	Whooping crane	Aransas	Mesquite Bay/Carlos Bay/Ayres Bay
2471	Piping plover [2]	Aransas	Aransas Bay
2471	Whooping crane	Aransas	Aransas Bay
2472	Piping plover [2]	Aransas Refugio	Copano Bay/Port Bay/Mission Bay
2472	Whooping crane	Aransas Refugio	Copano Bay/Port Bay/Mission Bay
2473	Whooping crane	Aransas	St. Charles Bay
2481	Piping plover [2]	Nueces	Corpus Christi Bay

Segment No.	Common Name	County	Water Body
2483	Piping plover [2]	Nueces	Redfish Bay
2485	Piping plover [2]	Nueces	Oso Bay
2491	Piping plover [2]	Cameron Kenedy Kleberg Nueces Willacy	Laguna Madre
2492	Piping plover [2]	Kenedy Kleberg	Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada
2493	Piping plover [2]	Cameron	South Bay
2494	Piping plover [2]	Cameron	Brownsville Ship Channel
2501	Piping plover [2]	Cameron	Gulf of Mexico

[1] Includes segments that cross the contributing and recharge zones of the southern section of the Edwards Aquifer (see Table 3 on page 23) as well as the Comal River (Segment 1811) and Lower San Marcos River (Segment 1808).

[2] Discharges from petroleum facilities are evaluated to determine if there is an affect on Piping Plovers. No other types of facilities are reviewed for potential affects to Piping Plovers.

Appendix C. Critical Low-Flows and Harmonic Mean Flows for Classified Segments

Table C. Critical Low-Flows and Harmonic Mean Flows for Classified Segments

Notes on table:

1) This table contains seven-day, two-year low-flow (7Q2) values, alternative critical low-flow values for streams/rivers that are dominated by springflow (footnoted in the crit. low-flow column), and harmonic mean flow values for USGS and IBWC gages.

2) Flows are listed in TCEQ stream segment order. If there is more than one gage within a stream segment, the flows are listed from downstream to upstream order. The listed county names provide the general location of the gaging stations. Specific gage locations can be found in USGS publications.

3) If there is a gap in the data record, multiple periods of record are indicated.

4) The flow values presented here are intended as guidelines and may be recalculated as additional data become available. Critical low-flows and harmonic mean flows used in conjunction with TCEQ regulatory actions (such as discharge permits) may be adjusted based on the relative location of a discharge to a gage. Flows may also be derived from data obtained at other USGS or IBWC gaging stations not presented in the table, TCEQ monitoring stations, drainage basin comparisons, interpolations, or best available information.

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
0101	Canadian River	07228000	Hemphill	1980	2007	5.8	2.0
0103	Canadian River	07227500	Potter	1978	2007	0.23	1.3
0104	Wolf Creek	07235000	Lipscomb	1979	2007	0.38	1.1
0201	Red River	07337000	Bowie	1979	2007	1714	5017
0202	Red River	07336820	Bowie	1974 2005	1998 2008	1108	4431
		07335500	Lamar	1980	2008	817	2895
		07331600	Grayson	1973 1997	1989 2008	143	479
0204	Red River	07316000	Cooke	1980	2008	268	672
		07315500	Montague	1979	2007	160	497
0205	Red River	07308500	Wichita	1979	2007	61	46
0206	Red River	07299570	Hardeman	1960	1982	0.11	0.57
0207	Prairie Dog Town Fork Red River	07299540	Childress	1979	2007	0.75	2.2
		07298500	Hall	2003	2007	0.10*	0.21
0211	Little Wichita River	07314900	Clay	1979	2007	0.10*	0.19
0214	Wichita River	07312700	Clay	1979	2007	43	110
		07312500	Wichita	1979	2007	18	53
		07312130	Wichita	1996	2002	2.4	5.1
0216	Wichita River	07312100	Baylor	1979	2007	0.44	1.4
0218	Wichita River	07311900	Baylor	1962 1997	1979 2007	1.6	6.2
0218	North Fork Wichita River	07311700	Knox	1979	2007	6.4	14
		07311600	Cottle	1961 1995	1982 2007	4.3***	8.8
0220	Pease River	07307800	Cottle	1979	2007	1.0	3.3

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
0222	Salt Fork Red River	07300000	Collingsworth	1979	2007	2.3	9.6
0224	North Fork Red River	07301300	Wheeler	1970 2001	1991 2007	0.10*	0.17
0226	South Fork Wichita River	07311800	Knox	1979	2007	0.10*	0.86
		07311783	King	1986	2005	0.10*	0.10*
		07311782	King	1985 1987	1986 2005	0.10*	2.5
0229	Prairie Dog Town Fork Red River	07297910	Armstrong	1979	2007	0.10*	0.61
0230	Pease River	07308200	Wilbarger	1970 1992	1982 2007	0.10*	0.67
0301	Sulphur River	07344200[a]	Bowie	1980 1982	1980 2008	57	82
0303	Sulphur River	07343200	Franklin	1993	2007	7.3	1.8
	South Sulphur River	07342500	Delta	1993	2007	1.8	2.6
0305	North Sulphur River	07343000	Delta	1979	2007	0.00	0.45
0306	South Sulphur River	07342465	Hunt	1992	2007	0.10*	0.17
0402	Big Cypress Creek	07346000	Marion	1980	2007	18	23
0404	Big Cypress Creek	07344493[b]	Camp	1968 2005	1989 2007	3.7	12
0409	Little Cypress Bayou (Creek)	07346070	Marion	1979	2007	0.53	0.95
		07346050	Upshur	1971	1999	0.10*	1.1
0410	Black Cypress Bayou (Creek)	07346045	Marion	1979	2007	0.10*	0.57
0502	Sabine River	08030500	Newton	1980	2008	1138	3298
0503	Sabine River	08028500	Newton	1980	2008	788	2323
		08026000	Newton	1980	2008	352	1226
		08025360	Newton	1980	2008	181	537
0505	Sabine River	08022040	Panola	1979	2007	79	262
		08020900	Gregg	1996	2007	89	207
0506	Sabine River	08020000	Gregg	1979	2007	59	190
		08019200	Wood	1998	2007	55	128
		08018500	Wood	1979	2007	6.2	8.3
		08017410	Van Zandt	1979	2007	0.30	0.89
0513	Big Cow Creek	08029500	Newton	1980	2008	34	65
0514	Big Sandy Creek	08019500	Upshur	1979	2007	12	31
0515	Lake Fork Creek	08019000	Wood	1986	2007	11	32
0602	Neches River	08041000	Jasper	1979	2007	2084	3387
		08040600[c]	Jasper	1979	2007	1854	2822
0604	Neches River	08033500	Tyler	1979	2007	123	415
		08032000	Anderson	1979	2007	82	179
0607	Pine Island Bayou	08041700	Hardin	1979	2007	3.7	18
0608	Village Creek	08041500	Hardin	1979	2007	79	253

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
0611	Angelina River	08036500	Cherokee	1979	2007	41	104
0612	Attoyac Bayou	08038000	Nacogdoches	1960	1985	26	67
0802	Trinity River	08066500	Liberty	1979	2007	775	2416
		08066250	Polk	1979	2007	728	2133
0804	Trinity River	08065350	Leon	1981	2008	825	2152
		08065000	Anderson	1982	2008	748	1812
		08062700	Henderson	1982	2007	722	1554
0805	Trinity River	08062500	Kaufman	1982	2007	678	1440
		08057410	Dallas	1975 2003	1998 2007	503	953
		08057000	Dallas	1989	2007	396	768
0806	West Fork Trinity River	08048543	Tarrant	1979	2007	13	38
		08048000	Tarrant	1979	2007	12	24
0810	West Fork Trinity River	08044500	Wise	1979	2007	7.0	3.9
0812	West Fork Trinity River	08042800	Jack	1979	2007	0.10*	0.14
0814	Chambers Creek	08064100	Navarro	1984	2007	0.10*	0.71
0819	East Fork Trinity River	08062000	Kaufman	1993	2007	64	138
		08061750	Kaufman	2003	2007	25	55
0822	Elm Fork Trinity River	08055500	Dallas	1979	2007	15	15
		08053000	Denton	1979	2007	61	98
0824	Elm Fork Trinity River	08050400	Cooke	1998	2007	0.10*	0.23
0825	Denton Creek	08055000	Denton	1966 2004	1990 2007	11	21
0829	Clear Fork Trinity River	08047500	Tarrant	1979	2007	4.4	5.6
		08047000	Tarrant	1979	2007	1.6	2.7
0831	Clear Fork Trinity River	08045850	Parker	1980 1991 1993 1998 2001	1985 1992 1996 1999 2005	0.20	0.90
0835	Richland Creek	08064550[d]	Freestone	1994	2008	5.0	6.5
0837	Richland Creek	08063100	Navarro	1979	2007	0.10*	0.25
0839	Elm Fork Trinity River	08051100[e]	Denton	1988	2008	2.0	5.9
0841	West Fork Trinity River	08049500	Dallas	1979	2007	140	270
0902	Cedar Bayou	08067500	Harris	1972 2002	1991 2007	0.27	1.1
1003	East Fork San Jacinto River	08070200	Montgomery	1984	2007	23	57
		08070000	Liberty	1979	2007	18	47
1004	West Fork San Jacinto River	08068090	Montgomery	1984	2007	26	77
		08068000	Montgomery	1979	2007	21	58
		08067650	Montgomery	1975 1998	1989 2000	0.10*	1.5
1008	Spring Creek	08068500[f]	Montgomery	1979	2007	18	48

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
		08068275	Montgomery	2000	2007	1.1	0.93
1009	Cypress Creek	08069000	Harris	1996	2007	27	57
		08068800	Harris	2002	2008	5.4	16
		08068740	Harris	1979	2007	0.33	0.85
		08068720	Harris	1979 1984	1983 2007	0.10*	0.31
1010	Caney Creek	08070500	Montgomery	1979	2007	14	30
1011	Peach Creek	08071000	Montgomery	1960 1999	1977 2007	11	21
1014	Buffalo Bayou	08073700	Harris	1985	2007	51	124
		08073600	Harris	1979	2007	44	106
		08073500	Harris	1979	2007	23	66
1016	Greens Bayou	08076000	Harris	1979	2007	22	39
		08075900	Harris	1984 2007	1992 2008	12	21
1017	Whiteoak Bayou	08074500	Harris	1980	2007	31	53
		08074020	Harris	2002	2007	14	26
1102	Clear Creek	08076997[g]	Harris	1965 2007	1992 2008	0.53	2.2
1108	Chocolate Bayou	08078000	Brazoria	1979	2007	1.7	5.7
1202	Brazos River	08116650	Fort Bend	1976 1984	1980 2007	689	1608
		08114000	Fort Bend	1979	2007	753	2041
		08111500	Waller	1979	2007	841	1863
1204	Brazos River	08091000	Somervell	1979	2007	16	50
1206	Brazos River	08090800	Parker	1979	2007	37	129
		08089000	Palo Pinto	1979	2007	32	96
		08088610[h]	Palo Pinto	1979	2007	25	62
1208	Brazos River	08088000	Young	1979	2007	4.6	5.8
		08082500	Baylor	1979	2007	0.16	2.0
1209	Navasota River	08110800	Robertson	1997	2007	12	47
		08110500	Leon	1980	2007	7.6	12
1211	Yegua Creek	08110000	Burleson	1969	1991	0.10*	0.33
1213	Little River	08106500	Milam	1979	2007	70	226
		08104500	Bell	1979	2007	68	169
1214	San Gabriel River	08106310	Milam	1981	1992	4.7	13
		08105700	Williamson	1981	2007	3.6	3.6
1215	Lampasas River	08104100	Bell	1970 1999	1989 2007	4.8	11
1217	Lampasas River	08103800	Lampasas	1979	2007	12	27
1219	Leon River	08102500	Bell	1980	2008	3.4	6.2
1221	Leon River	08100500	Coryell	1979	2007	4.7	3.2

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
		08100000	Hamilton	1973	2001	0.10*	1.1
1223	Leon River	08099100	Comanche	1961	1986	0.10*	0.28
1226	North Bosque River	08095200	Bosque	1977	2005	7.4	3.3
		08095000	Bosque	1979	2007	2.6	1.9
		08094800	Hamilton	1969	1999	0.45	1.5
1227	Nolan River	08092000	Hill	1963 1993 1998	1985 1996 1999	1.2	2.5
1229	Paluxy River	08091500	Somervell	1979	2007	1.6	1.3
1232	Clear Fork Brazos River	08085500	Shackelford	1993	2008	1.5	2.7
		08084000	Jones	1994	2008	0.10*	0.35
		08083230	Jones	2002	2008	0.10*	0.10*
		08083100	Fisher	1994	2008	0.10*	0.10*
1238	Salt Fork Brazos River	08082000	Stonewall	1980	2008	0.10*	0.31
1241	Double Mountain Fork Brazos River	08080500	Stonewall	1980	2008	0.10*	0.62
1242	Brazos River	08110200	Washington	1966	1983	526	1536
		08108700[i]	Brazos	1979	2007	489	1129
		08098290	Falls	1979	2007	167	459
		08096500	McLennan	1979	2007	52	128
1243	Salado Creek	08104310	Bell	1984	1996	16***	32
		08104290	Bell	1984	1996	2.5†	2.6
1244	Brushy Creek	08106300	Milam	1968	1980	3.4	6.2
1246	Middle Bosque River	08095300	McLennan	1960	1985	0.10*	0.46
1248	San Gabriel River	08104700, 08104900[j]	Williamson	1981	2007	3.5	7.6
	North Fork San Gabriel River	08104700	Williamson	1981	2007	1.1	1.9
1250	South Fork San Gabriel River	08104900	Williamson	1979	2007	0.25	0.67
1253	Navasota River	08110325	Limestone	1979	2007	0.10*	0.23
1255	North Bosque River	08093700	Erath	1960	1979	0.10*	0.10*
1257	Brazos River	08093100	Hill	1979	2007	26	84
1302	San Bernard River	08117500	Fort Bend	1979	2007	14	59
1402	Colorado River	08162500	Matagorda	1980	2008	206	471
		08162000	Wharton	1980	2008	419	950
		08161000	Colorado	1980	2008	378	1005
		08160400	Fayette	1988	2008	341	919
1409	Colorado River	08147000	San Saba	1980	2008	34	27
1410	Colorado River	08138000	Brown	1998	2007	0.10*	1.5
		08136700	Coleman	1990	2008	3.9	7.7
1412	Colorado River	08123850	Coke	1993	2008	0.10*	0.38

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
		08121000	Mitchell	1980	2008	0.10*	0.14
		08119500	Scurry	1960	1989	0.10*	0.13
1414	Pedernales River	08153500	Blanco	1980	2008	4.2	6.6
		08152900	Gillespie	1980 1998	1992 2008	2.9	5.3
1415	Llano River	08151500	Llano	1980	2008	55	85
		08150700	Mason	1974 1998	1992 2007	82	149
		08150000	Kimble	1974 1998	1992 2007	80	124
	South Llano River	08149400	Edwards	1959	2008	13***	22
	North Llano River	08148500	Kimble	1960 2002	1977 2007	2.7	4.2
1416	San Saba River	08146000	San Saba	1975 1998	1993 2008	21	29
		08144600	McCulloch	1980 1998	1993 2008	1.3	2.0
		08144500	Menard	1975 1998	1993 2007	9.7	18
1417	Pecan Bayou	08143600	Mills	1979	2007	1.6	2.4
1420	Pecan Bayou	08140700	Brown	1968	1978	0.10*	0.10*
1421	Concho River	08136500	Concho	1980	2008	0.10*	0.61
		08136000	Tom Green	1980	2008	0.10	0.24
	North Concho River	08135000	Tom Green	1960	1990	0.12	0.32
1424	Middle Concho River	08128400	Irion	1975 2001	1995 2008	0.10*	0.55
	South Concho River	08128000	Tom Green	1930 2001	1995 2008	2.4***	6.9
1426	Colorado River	08126380	Runnels	1979	2007	0.89	1.8
		08124000	Coke	1980	2008	0.41	0.26
1427	Onion Creek	08159000	Travis	1979	2007	0.10*	0.79
		08158827	Travis	2003 2005	2003 2008	0.10*	0.24
		08158800	Hays	1980 1992	1983 1995	0.10*	0.10*
		08158700	Hays	1980	2008	0.19	0.61
1428	Colorado River	08158000	Travis	1980	2008	105	300
1430	Barton Springs	08155500	Travis	1978	2007	11**	49
	Barton Creek	08155400	Travis	1999	2007	0.10*	0.32
		08155300	Travis	1979	2007	0.10*	0.19
		08155240	Travis	1989	2007	0.13	0.54
		08155200	Travis	1978 1989	1982 2007	0.10*	0.37
1432	Pecan Bayou	08143500	Brown	1960	1983	0.10*	0.43
1434	Colorado River	08159500	Bastrop	1998	2008	355	969

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
		08159200	Bastrop	1980	2008	305	787
1502	Tres Palacios River	08162600	Matagorda	1979	2007	7.3	16
1602	Lavaca River	08164000	Jackson	1979	2007	16	1.4
		08163500	Lavaca	1964	1992	0.74	1.6
1605	Navidad River	08164390	Jackson	1997	2007	4.3	1.2
		08164300	Lavaca	1979	2007	1.5	1.6
1802	Guadalupe River	08188800	Calhoun	2001	2007	930	1690
1803	Guadalupe River	08176500	Victoria	1979	2007	525	850
		08175800	De Witt	1979	2007	525	804
		08173900	Gonzales	1997	2007	489	902
1806	Guadalupe River	08167500	Comal	1980	2008	74	115
		08167000	Kendall	1980	2008	55	100
		08166200	Kerr	1987	2007	47	84
		08166140	Kerr	1978 1999	1985 2007	52	78
		08165500	Kerr	1979	2007	30	47
1807	Coleto Creek	08177500	Victoria	1980	2007	2.2	2.2
		08176900	Victoria	1980	2007	1.2	0.90
1808	San Marcos River	08172000	Caldwell	1939	2007	81***	185
1809	Blanco River	08171300	Hays	1980	2008	6.0	3.6
1810	Plum Creek	08173000	Caldwell	1971 2002	1993 2007	2.3	7.2
		08172400	Caldwell	1979	2007	0.10*	0.23
1811	Comal River	08169000	Comal	1928	2008	64**	226
		08168710	Comal	1928	2008	13**	241
1812	Guadalupe River	08168500	Comal	1980	2008	112	178
		08167800	Comal	1980	2008	96	137
1813	Blanco River	08171000	Hays	1928	2008	9.4***	31
1814	San Marcos River	08170000	Hays	1957	2008	55**	155
1816	Johnson Creek	08166000	Kerr	1974 1999	1993 2007	11	20
1817	North Fork Guadalupe River	08165300	Kerr	1967	2007	13***	24
1901	San Antonio River	08188500	Goliad	1979	2007	205	403
1902	Cibolo Creek	08186000	Karnes	1979	2007	15	28
1903	Medina River	08181500	Bexar	1979	2007	78	137
		08180800	Bexar	1973 1998	1995 2003	42	78
		08180700	Bexar	1981 1997	1995 2007	34	61
		08180640	Medina	1987	2000	29	42
		08180500	Medina	1960 2001	1973 2007	20	31

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
1905	Medina River	08178880	Bandera	1983	2008	8.2***	12
1906	Leon Creek	08181480	Bexar	1985	2007	2.5	5.7
1908	Cibolo Creek	08183900	Kendall	1965	1995	1.1	1.8
		08183850	Kendall	1997	2006	0.15	0.41
1910	Salado Creek	08178800	Bexar	1980	2008	3.9	5.4
		08178700	Bexar	1978	2006	0.10*	0.10
1911	San Antonio River	08183500	Karnes	1980	2008	144	321
		08181800	Bexar	1980	2008	136	299
		08178565	Bexar	1987	2007	13	36
		08178050	Bexar	1993	2007	8.7	20
1912	Medio Creek	08180750	Bexar	1987	1995	4.0	5.8
1913	Cibolo Creek	08185000	Bexar	1980	2008	0.10*	0.10*
2002	Mission River	08189500	Refugio	1979	2007	4.7	1.2
2004	Aransas River	08189700	Bee	1979	2007	1.5	2.3
2102	Nueces River	08211500	San Patricio	1990	2007	0.10*	1.1
		08211200	San Patricio	2000	2007	66	137
		08211000	San Patricio	2000	2007	53	121
2104	Nueces River	08194600	Live Oak	1965	1977	0.10*	0.37
		08194500	McMullen	1979	2007	0.10*	0.29
2105	Nueces River	08194000	La Salle	1979	2007	0.10*	0.32
		08193000	Dimmit	1979	2007	0.10*	0.12
2106	Nueces River	08210000	Live Oak	1984	2007	35	36
		08206910	Live Oak	1992	2008	29	35
2107	Atascosa River	08208000	Live Oak	1979	2007	0.44	1.0
		08207500	Atascosa	2003	2008	2.0	2.4
2108	San Miguel Creek	08206700	McMullen	1979	2007	0.10*	0.16
2109	Leona River	08204005	Uvalde	2003	2008	9.7***	27
2110	Sabinal River	08198500	Uvalde	1980	2008	0.63	1.2
2111	Sabinal River	08198000	Uvalde	1980	2008	8.8	1.8
2112	Nueces River	08192000	Uvalde	1980	2008	15	25
		08190000	Uvalde	1980	2008	41	74
2113	Frio River	08195000	Uvalde	1924	2008	13***	31
2114	Hondo Creek	08200720[k]	Medina	1978 2007	2005 2008	0.10*	0.10*
		08200000	Medina	1980	2008	1.0	1.0
2115	Seco Creek	08202700	Medina	1980	2008	0.10*	0.10*
		08201500	Medina	1980	2008	0.71	0.56
2117	Frio River	08206600	McMullen	1979	2007	0.11	0.67
		08205500	Frio	1979	2007	0.10*	1.0
		08197500	Uvalde	1980	2008	0.10*	0.10*

Seg-ment	Stream/River	Gage	County	Period of Record Starts	Period of Record Ends	Crit. Low-Flow (ft^3/s)	Harmonic Mean Flow (ft^3/s)
2302	Rio Grande	08473700	Cameron	1980	2008	51	173
		08469200	Hidalgo	1980	2008	260	796
		08464700	Starr	1980	2008	346	1228
		08461300	Zapata	1980	2008	175	538
2304	Rio Grande	08459200	Webb	1998	2007	615	1320
		08459000	Webb	1980	2008	853	1771
		08458700	Maverick	1980	2008	970	1805
		08458000	Maverick	1980 1989	1988 2008	929	1741
		08455700	Maverick	1980	2008	119	359
		08451800	Val Verde	1980	2008	732	1373
		08450900	Val Verde	1980	2008	660	1207
2306	Rio Grande	08377200	Val Verde	1995	2008	224	468
		08375000	Brewster	1995	2008	26	97
		08374200	Presidio	1995	2008	37	115
2307	Rio Grande	08371500	Presidio	1980	2008	13	23
		08371200	Presidio	1980	2008	12	24
		08370500	Hudspeth	1980	2008	31	66
2309	Devils River	08449400	Val Verde	1960	2008	37**	209
2310	Pecos River	08447410	Val Verde	1980	2008	83	148
2311	Pecos River	08446500	Pecos	1980	2008	6.9	18
		08412500	Reeves	1980	2008	5.9	13
2313	San Felipe Creek	08453000	Val Verde	1931	2008	8.1**	50
2314	Rio Grande	08365000	El Paso	1980	2008	2.1	6.9
		08364000	El Paso	2003	2008	13	35

* Calculated flow is less than 0.10 ft^3/s.

** Critical low-flow value is the 0.1% probability value derived from a lognormal distribution for the given period of record at the USGS gage.

*** Critical low-flow value is the 5th percentile of the data for the given period of record at the USGS gage.

† 7Q2 is estimated as the 10th percentile value of the available flow data.

a Data from U.S. Army Corp of Engineers – gated releases from Lake Wright Patman.

b 1968-1989 data from discontinued USGS gage 07344500.

c 1978-1989 data from discontinued USGS gage 08040500.

d Data from U.S. Army Corp of Engineers – gated releases from Richland-Chambers Reservoir.

e Data from U.S. Army Corp of Engineers – gated releases from Ray Roberts Lake.

f 1978-1995 data from discontinued USGS gage 08068520.

g 1965-1992 data from discontinued USGS gage 08077000.

[h] 1978-1989 data from discontinued USGS gage 08088600.

[i] 1978-1996 data from discontinued USGS gage 08109000.

[j] Daily average flows from each gage were added together, then the 7Q2 and harmonic mean flows were determined using the combined flows.

[k] 1978-2005 data from discontinued USGS gage 08200700.

Appendix D. Segment-Specific Values for Total Suspended Solids, pH, Total Hardness, Total Dissolved Solids, Chloride, and Sulfate.

Tables D-1 – D-25 Segment-Specific Values for Total Suspended Solids, pH, Total Hardness, Total Dissolved Solids, Chloride, and Sulfate.

Notes on tables:

1) Total suspended solids (TSS), pH, and total hardness are 15th percentile values.
2) Total dissolved solids (TDS), chloride, and sulfate are 50th percentile values.
3) Unless otherwise noted, only data from the segment itself has been used in the calculation. If less than 30 data values are available for a particular parameter for the segment, data from tributaries, other segments, the basin, or other basins may be used. These cases are footnoted for each table. The two cases that arise most often are footnoted throughout the tables as follows:
   [a] Basin-specific value
   [b] Calculated as (0.65)×(50th percentile conductivity for segment)

Table D-1 Segment-Specific Values for Basin 1, Canadian River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0101	6.0	7.6	233 [a]	2640	830	376
0102	2.0	8.2	223	1260	360	289
0103	13	7.9	246	2535	740	389
0104	2.0	7.8	233 [a]	676	242	62
0105	28	8.1	209 [a]	816	60	51

Table D-2 Segment-Specific Values for Basin 2, Red River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0201	27	7.1	175 [c]	610	147	117
0202	19	7.3	175 [c]	784	197	150
0203	3.0	7.9	175 [c]	1070	345	228
0204	31	7.8	552 [a]	2880	1080	605
0205	29	7.8	937	4510	1800	1095
0206	11	7.6	1100 [d]	12900	6290	2355
0207	16	7.6	1925	15900	15000	3000
0208	10	6.9	44 [e]	72 [b]	5.0	14
0209	4.0	7.1	44 [e]	101	7.0	14
0210	3.0	7.9	44 [e]	462 [b]	143	41
0211	16	7.3	44 [e]	364	70	12
0212	4.9	8.0	44 [e]	494 [b]	127	13
0213	5.0	8.1	44 [e]	289 [b]	49	14
0214	19	7.6	780 [f]	2951	1200	573
0215	5.0	7.7	780 [f]	3042 [b]	1103	714
0216	5.0	7.6	770	3088 [b]	1130	744

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0217	3.0	7.8	780 [f]	2940	1100	751
0218	6.0	7.7	1100	8060	4365	2195
0219	23	7.6	168 [g]	1002 [b]	390	118
0220	5.0	7.6	1120 [h]	18200	9255	2630
0221	8.0	7.5	1120 [h]	2616 [b]	735	1070
0222	4.0	7.7	1300	2760	270	1380
0223	2.0	7.9	168 [g]	416	46	88
0224	5.0	7.6	330 [i]	1650	439	481
0225	12	6.5	44 [e]	96 [b]	15	6.0
0226	9.0	7.5	2300	16250 [b]	9500	2800
0227	7.9 [j]	7.5 [j]	1120 [h]	2398 [b, j]	640 [j]	1020 [j]
0228	2.0	8.1	168 [g]	416	11	94
0229	5.0	7.6	330 [i]	1280	290	292
0230	8.0	7.5	1120 [h]	7600	3510	1690

[c] Data from Segments 0201, 0202, and 0203
[d] Data from Segments 0205 and 0207
[e] Data from Segments 0208, 0209, 0210, 0211, 0212, and 0213
[f] Data from Segments 0214, 0215, 0216, and 0217
[g] Data from Segments 0207 (tributary lake only), 0210, 0212, 0213, 0219, 0223, and 0228
[h] Data from Segments 0218, 0220, 0221, 0227, and 0230
[i] Data from Segments 0224 and 0229
[j] Data from Segments 0221 and 0227

Table D-3 Segment-Specific Values for Basin 3, Sulphur River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0301	10	6.9	54 [a]	150	11	18
0302	8.6	7.2	54 [a]	137	10	17
0303	22	7.1	54 [a]	219	15	34
0304	2.5	6.5	54 [a]	262	60	32
0305	5.6	7.5	54 [a]	490	30	150
0306	24	7.5	54 [a]	326	29	54
0307	9.0	7.5	54 [a]	143	5.7	12

Table D-4 Segment-Specific Values for Basin 4, Cypress Creek

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0401	3.0	6.0	19	84	13	12
0402	3.0	6.1	22	86	13	16
0403	2.5	6.5	25	99	14	23
0404	6.0	6.5	42	220	32	42
0405	3.0	6.6	29	86	15	16
0406	4.5	6.0	19 [(a)]	82	9.0	6.0
0407	5.0	5.9	12	72	15	5.0
0408	2.0	7.1	24 [(a)]	91	15	22
0409	5.0	6.2	19 [(a)]	116	16	14
0410	3.8	5.9	19 [(a)]	80	6	6

Table D-5 Segment-Specific Values for Basin 5, Sabine River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0501	6.0	6.7	28	618 [(b)]	179	44
0502	13	6.5	24	107	15	15
0503	5.0	6.7	29	117	16	16
0504	1.5	6.7	28	126	17	16
0505	16	6.7	42	237	39	26
0506	18	6.8	49	201	32	27
0507	5.0	7.6	64	130	5.0	11
0508	11	6.4	42	378	86	28
0509	5.0	6.9	32 [(a)]	123	21	22
0510	2.0	6.3	28	90	15	15
0511	8.0	6.2	31	704	185	26
0512	1.5	7.0	40	128	15	17
0513	5.0	6.1	12	31 [(b)]	5.0	3.0
0514	3.3	6.4	24	120	19	15
0515	12	6.7	45	230	40	32

Table D-6 Segment-Specific Values for Basin 6, Neches River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0601	8.0	6.6	38 [(a)]	2240	600	101
0602	17	6.5	27	112	18	19
0603	8.0	6.5	27 [(a)]	115	17	19
0604	10	6.5	36	92	24	20
0605	4.0	6.8	27 [(a)]	143	25	24
0606	5.0	6.4	42 [(c)]	232	34	36
0607	10	6.5	26	168	22	8.0
0608	6.0	6.0	14	83	14	5.0
0609	2.0	6.4	22	91 [(b)]	15	18
0610	2.0	6.9	27 [(a)]	90	16	20
0611	8.0	6.4	38 [(c)]	134	19	22
0612	9.3	6.5	20 [(a)]	100	10	16
0613	2.0	6.8	27 [(a)]	71	11	8.8
0614	1.0	7.1	27 [(a)]	61	7.0	6.0
0615	8.0	6.6	27 [(a)]	193	30	35

[(c)] Data from tributaries included.

Table D-7 Segment-Specific Values for Basin 7, Neches-Trinity Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0701	12	6.7	56	246	54	32
0702	14	6.8	288 [(c)]	10872	4700	690
0703	11	6.6	288 [(c)]	9000	4780	650
0704	12	6.7	74	249	56	33

[(c)] Data from Segments 0702 (including tributaries), 0703, 2411, and 2412

Table D-8 Segment-Specific Values for Basin 8, Trinity River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0801	18	7.3	84	224	36	33
0802	9.0	7.4	94	205	26	35
0803	7.3	7.4	94	240	29	43
0804	41	7.2	122	338	42	60
0805	23	7.2	148	408	52	77

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0806	10	7.5	136	287	35	38
0807	6.9	7.9	96 [a]	231	34	26
0808	5.0	7.5	98 [a]	260 [b]	36	23
0809	5.0	7.9	96 [a]	249	34	26
0810	16	7.5	98 [a]	425	53	39
0811	2.0	7.9	96 [a]	212	28	20
0812	28	7.2	98 [a]	490	59	36
0813	1.5	6.8	96 [a]	73	11	9.0
0814	18	7.5	120 [c]	349	23	70
0815	6.1	7.9	96 [a]	202 [b]	14	35
0816	4.7	7.8	96 [a]	179 [b]	8.0	17
0817	6.1	7.9	110	208 [b]	11	31
0818	5.4	7.5	96 [a]	121	14	24
0819	16	7.3	119	372	45	47
0820	5.0	7.8	98	190	15	26
0821	5.0	7.8	96 [a]	216	8.0	23
0822	13	7.5	116	259	24	41
0823	6.0	7.8	106	208	19	30
0824	7.0	7.6	77	422	49	49
0825	5.0	7.5	118 [d]	231	25	35
0826	5.0	7.9	118	208	24	30
0827	8.7	7.5	96 [a]	188 [b]	13	31
0828	6.0	7.9	100	187	18	28
0829	8.0	7.5	98 [a]	289	22	33
0830	6.0	7.9	96 [a]	205	22	27
0831	5.0	7.5	160	408	42	45
0832	5.0	8.0	96 [a]	283 [b]	41	31
0833	6.7	7.5	98 [a]	561	92	67
0834	2.0	7.7	96 [a]	182 [b]	27	12
0835	10 [e]	7.3 [e]	120 [c]	232 [e]	28 [e]	40 [e]
0836	2.0	7.7	96 [a]	170	11	33
0837	10 [e]	7.3 [e]	120 [c]	232 [e]	28 [e]	40 [e]
0838	4.0	7.9	153	342	21	102
0839	9.0	7.6	98 [a]	188 [b]	20	22

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0840	4.0	7.7	95	179	18	16
0841	16	7.3	160	467	74	68

(c) Data from Segments 0814 (including tributaries), 0835, and 0837
(d) Data from Segments 0825 and 0826
(e) Data from Segments 0835 and 0837

Table D-9 Segment-Specific Values for Basin 9, Trinity-San Jacinto Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
0901	18	7.4	930 (c)	8400	2875	261
0902	3.0	7.1	40 (d)	373	83	17

(c) Data from Segment 2426
(d) Data from Basin 10

Table D-10 Segment-Specific Values for Basin 10, San Jacinto River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1001	8.0	7.5	44	940	2765	246
1002	10	7.0	46	186	25	9.0
1003	7.0	6.6	37	144	32	5.0
1004	11	6.9	65	187	38	10
1005	11	7.5	620	10800	6190	838
1006	10	7.2	412	2920	2090	215
1007	8.0	7.1	108	1100	482	94
1008	10	6.8	48	241	47	10
1009	13	7.0	44	388	57	19
1010	5.0	6.6	28	99	15	5.0
1011	3.0	6.4	21	88	17	4.0
1012	3.0	7.3	65	131	17	6.0
1013	14	7.2	78(a)	381	60	24
1014	17	7.1	40(a)	368	64	23
1015	10	6.6	40(a)	168 (b)	43	9.7
1016	12	7.5	40(a)	456	82	38
1017	10	7.6	40(a)	463	86	33

Table D-11 Segment-Specific Values for Basin 11, San Jacinto-Brazos Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1101	15	7.5	134	1720	460	92
1102	15	7.4	126	568	125	38
1103	9.6	7.3	125	3142	1550	234
1104	12	7.3	116 [(a)]	493	99	58
1105	15	7.3	118 [(a)]	3149	2065	289
1107	19	7.6	118 [(a)]	10650	5327	705
1108	11	7.4	116 [(a)]	474	116	46
1109	15	7.5	118 [(a)]	7405	2590	411
1110	15	7.3	116 [(a)]	346	71	30
1111	9.0	7.9	3697	27700	14161	2020
1113	18	7.4	118 [(a)]	1913	902	120

Table D-12 Segment-Specific Values for Basin 12, Brazos River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1201	10	7.7	232 [(c)]	5150	3220	412
1202	36	7.6	160	438	88	60
1203	3.0	7.9	230 [(d)]	888	371	180
1204	4.3	7.8	230 [(d)]	1294	485	234
1205	4.0	7.9	230 [(d)]	1418	893	311
1206	7.0	7.8	230 [(d)]	1724	692	348
1207	2.0	8.1	230 [(d)]	1870	893	371
1208	17	7.7	473 [(e)]	4267	2000	900
1209	17	7.1	68 [(f)]	235	44	42
1210	19	7.6	68 [(f)]	182	10	14
1211	22	7.3	160 [(a)]	275	53	64
1212	7.0	7.6	120 [(a)]	256	46	59
1213	23	7.7	171 [(g)]	332	42	36
1214	17	7.5	170 [(h)]	392	25	30
1215	2.0	7.7	171 [(g)]	284	39	19
1216	2.0	8.1	171 [(g)]	257	55	22
1217	2.0	7.9	171 [(g)]	372	70	24
1218	4.0	7.2	171 [(g)]	390	53	46
1219	6.8	7.2	171 [(g)]	340	38	33

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1220	2.0	8.0	120 [a]	223	31	27
1221	11	7.6	160 [a]	396	70	48
1222	7.0	7.9	120 [a]	410	100	54
1223	4.0	7.6	160 [a]	639	232	75
1224	4.0	7.9	120 [a]	296	73	46
1225	5.0	7.9	124	217	16	25
1226	3.0	7.7	160 [a]	282	23	26
1227	4.4	7.4	160 [a]	386	42	52
1228	8.0	7.9	120 [a]	202 [b]	13	16
1229	2.0	7.9	160 [a]	336	24	45
1230	5.0	8.0	230 [d]	298 [b]	39	37
1231	5.0	8.0	230 [d]	416 [b]	123	24
1232	16	7.6	584	1800	520	778
1233	3.0	7.9	218	715 [b]	244	61
1234	2.0	7.9	120 [a]	263 [b]	29	36
1235	10	7.9	120 [a]	716 [b]	162	182
1236	5.0	8.0	203	458 [b]	94	78
1237	5.0	7.9	120 [a]	699 [b]	186	125
1238	8.7	7.5	1525 [i]	37367	16000	2505
1239	4 [j]	8.1 [j]	160 [a]	606 [j]	111 [j]	48 [j]
1240	4.0	8.1	120 [a]	606	111	47
1241	9.9	7.7	473 [e]	4325	1400	1340
1242	11	7.7	221 [k]	693	179	103
1243	0.5	7.3	160 [a]	296	12	16
1244	2.0	7.6	160 [a]	369	53	38
1245	12	7.4	140	352	70	46
1246	3.0	7.7	160 [a]	327	16	52
1247	8.0	7.9	120 [a]	229	20	24
1248	3.0	7.7	170 [h]	291	18	20
1249	2.0	7.9	120 [a]	202	12	16
1250	0.5	7.7	170 [h]	270	17	21
1251	1.0	7.8	170 [h]	270	13	21
1252	4.0	7.4	68 [f]	132	20	16
1253	10	7.4	68 [f]	208	20	14

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1254	5.0	7.9	120 [a]	228	12	54
1255	3.5	7.6	160 [a]	501	111	44
1256	5.0	7.7	177	574	219	91
1257	3.7	7.6	251 [l]	780	312	144

[c] Data from Segments 1201 and 1401
[d] Data from Segments 1203, 1204, 1205, 1206, 1207, 1230, and 1231
[e] Data from Segments 1208 and 1241
[f] Data from Segments 1209, 1210, 1252, and 1253
[g] Data from Segments 1213, 1215, 1216, 1217, 1218, 1219, and tributaries to these segments
[h] Data from Segments 1214, 1248, 1250, 1251, and tributaries to Segments 1247 and 1249
[i] Data from Segment 1238 and its tributaries
[j] Data from Segments 1239 and 1240
[k] Data from Segment 1242 and from stations 12039, 12040, 12041, and 14226 in Segment 1256
[l] Data from Segment 1257 and from station 12042 in Segment 1256

Table D-13 Segment-Specific Values for Basin 13, Brazos-Colorado Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1301	13	7.3	135 [a]	2300	2745	215
1302	19	7.0	96 [a]	267	48	16
1304	13	7.4	135 [a]	1080	190	62
1305	13	7.3	96 [a]	329	41	12

Table D-14 Segment-Specific Values for Basin 14, Colorado River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1401	12	7.7	232 [c]	7584	473	110
1402	12	7.8	200	336	51	41
1403	1.0	7.7	180 [d]	298	55	36
1404	1.0	8.0	180 [d]	300	57	36
1405	2.0	7.8	180 [d]	332	66	40
1406	3.0	7.9	180 [d]	332	67	41
1407	2.0	7.8	180 [d]	418	100	67
1408	2.0	8.1	180 [d]	422	100	64
1409	15	7.8	237 [e]	434	84	56
1410	14	7.7	320 [f]	788 [g]	260 [g]	177 [g]
1411	5.0	7.9	318 [h]	2473	740	465
1412	16	7.6	310	4600	1635	961
1413	7.0	7.8	188 [a]	367 [b]	47	63
1414	5.0	8.0	188	362	52	32

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1415	2.0	7.9	163 [i]	222	21	13
1416	8.0	7.8	163 [i]	307	24	17
1417	13	7.8	190 [a]	524 [b]	109	68
1418	5.0	7.9	188 [a]	296	71	38
1419	2.8	8.0	188 [a]	317	72	47
1420	9.4	7.6	190 [a]	462	91	81
1421	12	7.7	317	1080	447	243
1422	10	8.0	312	896	290	103
1423	5.0	8.0	188 [a]	434	102	47
1424	2.5	7.6	240	362	48	15
1425	5.0	8.0	217 [j]	474 [b]	120	54
1426	14	7.8	315 [k]	2190 [g]	776 [g]	720 [g]
1427	1.0	7.4	163 [i]	300	24	37
1428	3.0	7.4	190 [l]	334	55	41
1429	1.2	7.4	188 [a]	315	49	37
1430	0.5	7.2	194	306	23	30
1431	5.0	7.3	190 [a]	652	186	88
1432	5.0	7.6	190 [a]	464	96	68
1433	3.0	8.1	321 [m]	1165	371	287
1434	5.0	7.8	190 [l]	340	56	44

[c] Data from Segments 1201 and 1401
[d] Data from Segments 1403, 1404, 1405, 1406, 1407, and 1408
[e] Data from Segments 1409, 1410, and 1417
[f] Data from Segments 1410, 1426, and 1433
[g] Data from 1995 to present to reflect changes in the watershed
[h] Data from Segments 1411 and 1412
[i] Data from Segments 1415, 1416, and 1427
[j] Data from Segment 1425 and its tributaries
[k] Data from Segments 1411, 1412, and 1426
[l] Data from Segments 1428 and 1434
[m] Data from Segments 1421, 1426, and 1433

Table D-15 Segment-Specific Values for Basin 15, Colorado-Lavaca Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1501	15	7.3	85 [c]	706	384	65
1502	16	7.3	95 [c]	495	114	22

[c] Data from Basins 15 and 16

Table D-16 Segment-Specific Values for Basin 16, Lavaca River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1601	10	7.8	85 [a]	1108 [b]	123	29
1602	6.0	7.7	177	441	68	23
1603	8.0	7.9	82	454 [b]	69	16
1604	7.4	7.4	57	148 [b]	19	7.4
1605	5.3	7.6	141	480	72	15

Table D-17 Segment-Specific Values for Basin 17, Lavaca-Guadalupe Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1701	27	7.8	85 [c]	3700	974	164

[c] Data from Basin 16

Table D-18 Segment-Specific Values for Basin 18, Guadalupe River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1801	44	7.6	167 [a]	434	70	52
1802	40	7.7	212	460 [b]	63	52
1803	12	7.7	206	325	33	30
1804	4.8	7.7	213	297	18	24
1805	2.0	8.0	161	217	15	19
1806	3.0	7.7	204	290	18	16
1807	3.9	7.7	100	456	78	22
1808	8.0	7.7	225	332	25	28
1809	2.0	7.6	189 [c]	247	13	23
1810	12	7.6	215	673	135	85
1811	1.0	7.4	254	311	17	24
1812	2.0	7.7	184	248	14	19
1813	0.5	7.7	189	266	12	26
1814	2.0	7.5	265	388 [b]	19	24
1815	0.5	7.1	228	299	13	16
1816	2.8	7.7	185 [d]	292 [b]	23	12
1817	0.5	7.4	185 [d]	259 [b]	10	5.0
1818	0.5	7.6	185 [d]	266 [b]	10	5.0

[c] Data from Segment 1813
[d] Data from Segments 1816, 1817, and 1818

Table D-19 Segment-Specific Values for Basin 19, San Antonio River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
1901	30	7.7	312	616	100	97
1902	8.8	7.6	257	606	100	149
1903	6.0	7.4	240	372	41	60
1904	2.7	7.9	204 [(a)]	262	13	45
1905	2.0	7.6	240	339	13	76
1906	5.0	7.3	253	465	63	68
1907	0.5	7.4	204 [(a)]	402 [(b)]	21	43
1908	1.0	7.4	204 [(a)]	302	18	27
1909	1.2	7.3	204 [(a)]	258	14	44
1910	2.2	7.2	204	374	45	53
1911	5.0	7.4	202	477	54	54
1912	12	7.9	204 [(a)]	420	68	66
1913	5.0	7.2	256	500	60	45

Table D-20 Segment-Specific Values for Basin 20, San Antonio-Nueces Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2001	14	7.6	241 [(a)]	1780	1080	82
2002	10	7.5	243	1060	530	40
2003	12	7.6	241 [(a)]	810	193	40
2004	8.1	7.4	240 [(a)]	889	279	54

Table D-21 Segment-Specific Values for Basin 21, Nueces River

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2101	23	7.9	160 [(a)]	12150	2250	350
2102	10	7.8	164	431	132	49
2103	6.0	7.8	149	568	111	53
2104	8.0	7.6	137	452	105	42
2105	5.0	7.6	160 [(a)]	316	49	40
2106	15	7.6	158	498	128	75
2107	13	7.5	130	1080	242	225
2108	11	7.4	201	840	218	277
2109	10	7.5	226 [(c)]	508	73	128
2110	2.0	7.2	226 [(c)]	560	100	40

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2111	0.5	7.6	226 [c]	276	12	27
2112	0.5	7.6	190	242	16	15
2113	0.5	7.7	160 [a]	238	11	14
2114	0.5	7.7	160 [a]	252	12	34
2115	0.5	7.7	160 [a]	248	12	41
2116	4.0	7.8	167	494	146	73
2117	7.0	7.5	185	935	259	167

[c] Data from Segments 2109, 2110, and 2111

Table D-22 Segment-Specific Values for Basin 22, Nueces-Rio Grande Coastal

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2201	12	7.7	675 [a]	7950	3778	1150
2202	72	7.4	713	2780	860	770
2203	36	7.9	675 [a]	14200	10605	984
2204	15	7.3	653 [a]	13900 [c]	3300 [c]	598 [c]

[c] Data from 1995 to present to reflect changes in the watershed

Table D-23 Segment-Specific Values for Basin 23, Rio Grande

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2301	15	7.7	255	880	210	283
2302	5.9	7.6	240	712	146	247
2303	5.0	7.9	230 [a]	561	114	221
2304	5.0	7.7	237	650	117	212
2305	2.0	7.9	230 [a]	650	115	215
2306	47	7.4	251	1125	142	403
2307	39	7.5	229	1453	411	460
2308	20	7.7	224	775	126	223
2309	1.0	7.7	230 [a]	224	14	9.0
2310	4.0	7.7	510	2236	853	494
2311	6.0	7.6	2203	9840	4030	2381
2312	6.0	7.8	1973 [c]	5455	1954	1550
2313	4.0	7.5	230 [a]	285	18	20
2314	24	7.8	240	718	110	224

[c] Data from Segment 2312 and from station 13265 in Segment 2311

Table D-24 Segment-Specific Values for Basin 24, Bays and Estuaries

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2411	11	6.8	950 [a]	12800	7150	1010
2412	8.3	6.8	950 [a]	6790	3598	496
2421	11	7.8	787	13400	7842	1060
2422	8.0	7.8	148	7785	3290	460
2423	13	7.8	950 [a]	12800	7170	960
2424	13	7.8	3112	26099	13100	1789
2425	16	7.9	700	12846	6000	778
2426	16	7.6	930	12459	5970	814
2427	12	7.6	730	11915	5675	810
2428	16	7.9	1037	12870	6400	838
2429	9.0	7.5	644	10501	5625	815
2430	9.0	7.6	603	9670	4979	712
2431	15	7.7	1727 [c]	19412	8350	1171
2432	13	7.7	3163 [d]	21600	9759	1378
2433	10	7.8	3163 [d]	24862[b]	13200	1860
2434	14	7.9	3163 [d]	27100	14240	1940
2435	27	7.8	3163 [d]	25415[b]	13825	1880
2436	11	7.7	1002	13960	6545	900
2437	11	7.9	2867	24250	12200	1670
2438	10	7.7	1466 [e]	14000	6980	1025
2439	12	7.9	1606	19300	10500	1430
2441	25	7.8	1185 [f]	23600	11150	1465
2442	20	7.7	1185 [f]	20215[b]	11800	1295
2451	11	7.9	1185 [f]	26000	13400	1850
2452	12	7.8	1185 [f]	22150	11500	1600
2453	11	7.9	980	19200	9860	1340
2454	12	7.9	1185 [f]	22700	11780	1630
2455	11	8.0	1185 [f]	24450	12025	1597
2456	28	7.9	950 [a]	4260	2518	393
2461	10	7.9	950 [a]	26200	14100	1950
2462	16	8.0	950 [a]	10450	6970	960
2463	17	7.9	950 [a]	19800	10200	1365
2471	9.0	7.9	950 [a]	28600	14500	2000
2472	15	7.9	950 [a]	15500	7500	1012

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2473	16	7.8	950 [a]	19725	10000	1400
2481	10	7.9	5011 [g]	34850	17100	2400
2482	17	7.8	5011 [g]	30900	15800	2150
2483	13	7.9	5011 [g]	29650	15873	2220
2484	10	7.9	5011 [g]	33800	16800	2380
2485	33	7.7	5011 [g]	30850	17400	2400
2491	12	8.0	5011 [g]	36925	18700	2666
2492	17	7.9	5011 [g]	40050	21100	3095
2493	13	7.9	5011 [g]	37350	19250	2650
2494	10	7.9	5011 [g]	35950	18335	2565

[c] Data from Segments 2431 and 2439
[d] Data from Segments 2424, 2432, 2433, 2434, and 2435
[e] Data from Segment 2438 and from stations 13303 and 13304 in Segment 2421
[f] Data from Segments 2441, 2442, 2451, 2452, 2453, 2454, and 2455
[g] Data from Segments 2481, 2482, 2483, 2484, 2485, 2491, 2492, 2493, and 2494

Table D-25 Segment-Specific Values for Basin 25, Gulf of Mexico

Segment Number	TSS (mg/L)	pH (s.u.)	Total Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
2501	12	7.0	4613	28700	15500	2170

Appendix E. Minimum Analytical Levels and Suggested Analytical Methods.

Table E-1. Minimum Analytical Levels (MALs) and Suggested Methods for Permit Application Screening

Notes on table:

1) MALs, screening levels, and suggested methods in this table may be used for effluent screening.

2) This table includes pollutants in § 307.6 of the Standards, all 126 priority pollutants, and those pollutants listed in 40 CFR Part 122, Appendix D, Table 5.

3) Suggested analytical methods have traditionally been EPA-approved analytical methods either in the 40 CFR Part 136, as amended, or in EPA-published documents pertaining to wastewater matrices, or methods developed and published by the TCEQ or other government agencies for wastewater. Applicants and permittees may use any analytical method approved in 40 CFR Part 136 that is sufficiently sensitive to demonstrate compliance with permit application screening requirements.

Pollutant	**CASRN [1]**	**MAL (µg/L)**	**Screening Level [2] (µg/L)**	**Suggested Method**
Acenaphthene	83-32-9	10		625
Acenaphthylene	208-96-8	10		625
Acetaldehyde	75-07-0	50		1667
Acrolein	107-02-8	50		624
Acrylonitrile	107-13-1	50		1624B[3]
Aldrin	309-00-2	0.01		608
Allyl alcohol	107-18-6	50		1624[3]
Allyl chloride	107-05-1	10		1624[3]
Aluminum, total	7429-90-5	2.5		200.8 [4]
Amyl acetate	628-63-7	5		1666 [3]
Aniline	62-53-3	10		625 [11]
Anthracene	120-12-7	10		625
Antimony, total	7440-36-0	5		200.8 [4]
Arsenic, total	7440-38-2	0.5		200.8 [4]
Asbestos	1332-21-4	Not Specified [12]		100.1 and 100.2 [13]
Barium, total	7440-39-3	3		200.8 [4]
Benzene	71-43-2	10		624
Benzidine	92-87-5	50		625
Benzo(*a*)anthracene	56-55-3	5		625
Benzo(*a*)pyrene	50-32-8	5		625
Benzo(*b*)fluoranthene	205-99-2	10		625

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
Benzo(*g*,*h*,*i*)perylene	191-24-2	20		625
Benzo(*k*)fluoranthene	207-08-9	5		625
Benzonitrile	100-47-0	1 mg/L		ASTM D3371
Benzyl chloride	100-44-7	Not Specified [12]		TBD [5]
Beryllium, total	7440-41-7	0.5		200.8 [4]
Bis(2-chloroethoxy)methane	111-91-1	10		625
Bis(2-chloroethyl)ether	111-44-4	10		625
Bis(2-chloroisopropyl)ether	108-60-1	10		625
Bis(chloromethyl)ether	542-88-1	—[5]		—[5]
Bis(2-ethylhexyl)phthalate [Di(2-ethylhexyl)phthalate]	117-81-7	10		625
Boron, total	7440-42-8	20	100	200.7
Bromide	—	400		300.0, Rev. 2.1 300.1, Rev. 1.0
Bromodichloromethane [Dichlorobromomethane]	75-27-4	10		624
Bromoform	75-25-2	10		624
4-Bromophenyl phenyl ether	101-55-3	10		625
Butyl acetate	540-88-5	5		1666 [3]
n-Butylamine	109-73-9	Not Specified [11]		TBD [12]
sec-Butylamine	13952-84-6	Not Specified [11]		TBD [12]
tert-Butylamine	75-64-9	Not Specified [11]		TBD [12]
Butylbenzyl phthalate	85-68-7	10		625
Cadmium, total	7440-43-9	1		200.8 [4]
Captan	133-06-2	0.4[14]		SM6630B
Carbaryl	63-25-2	5		632
Carbazole	86-74-8	20		1625 [3]
Carbofuran	1563-66-2	3		632
Carbon disulfide	75-15-0	10		1624 [3]
Carbon tetrachloride	56-23-5	2		624
Chlordane	57-74-9	0.2		608
Chlorine	7782-50-5	33		4500-Cl E or G
Chlorobenzene	108-90-7	10		624
Chlorodibromomethane	124-48-1	10		624

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
Chloroethane	75-00-3	50		624
2-chloroethylvinyl ether	110-75-8	10		624
Chloroform	67-66-3	10		624
2-Chloronaphthalene	91-58-7	10		625
2-Chlorophenol	95-57-8	10		625
4-Chlorophenyl phenyl ether	7005-72-3	10		625
Chlorpyrifos	2921-88-2	0.05		1657
Chromium, total	7440-47-3	3		200.8 [4]
Chromium, hexavalent	18540-29-9	3		218.6, rev. 3.3
Chromium, trivalent	16065-83-1	—[7]		—[7]
Chrysene	218-01-9	5		625
Cobalt, total	7440-48-4	0.3	1500	200.8 [4]
Copper, total	7440-50-8	2		200.8 [4]
Coumaphos	56-72-4	0.025		1657
Cresols (all isomers)	1319-77-3	10		625 [11]
m-Cresol	108-39-4	10		625 [11]
o-Cresol	95-48-7	10		625 [11]
p-Cresol [4-Methylphenol]	106-44-5	10		625 [11]
Crotonaldehyde	4170-30-3	10		1624[3]
Cyanide, total	57-12-5	10		335.4 or 4500-CN D or 4500-CN E
Cyanide, available	57-12-5	10		4500-CN G
		2		OIA-1677
Cyclohexane	110-82-7	5		1666 [3]
4,4'-DDD	72-54-8	0.1		608
4,4'-DDE	72-55-9	0.1		608
4,4'-DDT	50-29-3	0.02		608
2,4-D [17]	94-75-7	0.7		615 or SM6640B
Danitol [Fenpropathrin]	39515-41-8	—[8]		—[8]

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
n-Decane	124-18-5	30		625 [11]
Demeton	8065-48-3	0.20		1657 [15, 16]
Diazinon	333-41-5	0.5		1657
		0.1		614
Dibenzo(*a*,*h*)anthracene	53-70-3	5		625
1,2-Dibromoethane	106-93-4	10		1624 [3, 11]
Dicamba	1918-00-9	0.110		1658 [15]
Dichlobenil	1194-65-6	Not Specified [12]		TBD [12]
Dichlone	117-80-6	Not Specified [12]		1656 [13]
m-Dichlorobenzene [1,3-Dichlorobenzene]	541-73-1	10		624
o-Dichlorobenzene [1,2-Dichlorobenzene]	95-50-1	10		624
p-Dichlorobenzene [1,4-Dichlorobenzene]	106-46-7	10		624
3,3'-Dichlorobenzidine	91-94-1	5		625
1,1-Dichloroethane	75-34-3	10		624
1,2-Dichloroethane	107-06-2	10		624
1,1-Dichloroethene [1,1-Dichloroethylene]	75-35-4	10		624
Dichloromethane [Methylene choride]	75-09-2	20		624
2,4-Dichlorophenol	120-83-2	10		625
1,2-Dichloropropane	78-87-5	10		624
1,3-Dichloropropene	542-75-6	10		624
2,2-Dichloropropionic acid [Dalapon]	75-99-0	2		615
Dichlorvos	62-73-7	0.004		1657
Dicofol [Kelthane]	115-32-2	1		ASTM D5812-96(02)
Dieldrin	60-57-1	0.02		608
Diethyl amine	109-89-7	50 mg/L		1671
Diethyl phthalate	84-66-2	10		625
Dimethyl amine	124-40-3	50 mg/L		1671
2,4-Dimethylphenol	105-67-9	10		625
Dimethyl phthalate	131-11-3	10		625
Di-*n*-butyl phthalate	84-74-2	10		625
Dinitrobenzene	25154-54-5	10		1625 [3]

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
2,4-Dinitrophenol	51-28-5	50		625
2,4-Dinitrotoluene	121-14-2	10		625
2,6-Dinitrotoluene	606-20-2	10		625
Di-*n*-octyl phthalate	117-84-0	10		625
Dioxins/Furans [TCDD Equivalents]		(ppq)		1613B
2,3,7,8-TCDD	1746-01-6	10		
1,2,3,7,8-PeCDD	40321-76-4	50		
2,3,7,8-HxCDDs				
1,2,3,4,7,8-HxCDD	39227-28-6	50		
1,2,3,6,7,8-HxCDD	57653-85-7	50		
1,2,3,7,8,9-HxCDD	19408-74-3	50		
1,2,3,4,6,7,8-HpCDD	35822-46-9	50		
OCDD	3268-87-9	100		
2,3,7,8-TCDF	51207-31-9	10		
1,2,3,7,8-PeCDF	57117-41-6	50		
2,3,4,7,8-PeCDF	57117-31-4	50		
2,3,7,8-HxCDFs				
1,2,3,4,7,8-HxCDF	70648-26-9	50		
1,2,3,6,7,8-HxCDF	57117-44-9	50		
1,2,3,7,8,9-HxCDF	72918-21-9	50		
2,3,4,6,7,8-HxCDF	60851-34-5	50		
2,3,4,7,8-HpCDFs	38998-75-3			
1,2,3,4,6,7,8-HpCDF	67562-39-4	50		
1,2,3,4,7,8,9-HpCDF	55673-89-7	50		
OCDF	39001-02-0	100		
1,2-Diphenylhydrazine (as Azobenzene)	122-66-7	20		1625 [3]
Diquat	2764-72-9	1.5		549, 549.1
Disulfoton	298-04-4	0.032		1657
Diuron	330-54-1	0.090		632
Endosulfan I (*alpha*)	959-98-8	0.01		608
Endosulfan II (*beta*)	33213-65-9	0.02		608
Endosulfan sulfate	1031-07-8	0.1		608
Endrin	72-20-8	0.02		608
Endrin aldehyde	7421-93-4	0.1		608
Epichlorohydrin	106-89-8	1 mg/L		ASTM D-3695 [15]
Ethion	563-12-2	0.02		1657
Ethylbenzene	100-41-4	10		624
Ethylene diamine	107-15-3	Not Specified [12]		TBD [12]
Ethylene dibromide	106-93-4	10		1624 [3]
Formaldehyde	50-00-0	50		1667
Fluoranthene	206-44-0	10		625
Fluorene	86-73-7	10		625

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
Fluoride	16984-48-8	500		300.0, 300.1
Furfural	98-01-1	50 mg/L		1667
Guthion [Azinphos Methyl]	86-50-0	0.1		1657
Heptachlor	76-44-8	0.01		608
Heptachlor epoxide	1024-57-3	0.01		608
Hexachlorobenzene	118-74-1	5		625
Hexachlorobutadiene	87-68-3	10		625
alpha-Hexachlorocyclohexane	319-84-6	0.05		608
beta-Hexachlorocyclohexane	319-85-7	0.05		608
gamma-Hexachlorocyclohexane [Lindane]	58-89-9	0.05		608
delta-Hexachlorocyclohexane	319-86-8	0.05		608
Hexachlorocyclopentadiene	77-47-4	10		625 or 1625B [3, 17]
Hexachloroethane	67-72-1	20		625
Hexachlorophene	70-30-4	10		604.1
Indeno(1,2,3-*cd*)pyrene	193-39-5	5		625
Iron, total	7439-89-6	7	300	200.7
Isophorone	78-59-1	10		625
Isopropanolamine dodecylbenzenesulfonate	42504-46-1	Not Specified [12]		TBD [12]
Kepone	143-50-0	0.3		1656
Lead, total	7439-92-1	0.5		200.8 [4]
Malathion [17]	121-75-5	0.1		1657 or SM6630C
Magnesium, total	7439-95-4	20		200.7
Manganese, total	7439-96-5	0.5	50	200.8 [4]
Mercaptodimethur [Methiocarb]	2032-65-7	0.06		632 [15]
Mercury, total[9, 10]	7439-97-6	0.005		245.7, Rev. 2.0
		0.0005		1631E
Methoxychlor [18]	72-43-5	2.0		617 or SM6630B and C
Methyl bromide [Bromomethane]	74-83-9	50		624
Methyl chloride [Chloromethane]	74-87-3	50		624

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
Methyl ethyl ketone	78-93-3	50		624
Methyl mercaptan	74-93-1	Not Specified [12]		TBD [12]
Methyl methacrylate	80-62-6	10		1624
Methyl parathion [17]	298-00-0	0.05		1657 or SM6630C
Mevinphos	7786-34-7	0.2		1657
Mexacarbate	315-18-4	1.5		632
Mirex	2385-85-5	0.02		SM6630B and C [17]
Molybdenum, total	7439-98-7	1	500	200.8 [3]
Monoethyl amine	75-04-7	Not Specified [12]		TBD [12]
Monomethylamine	74-89-5	50 mg/L		1667
Naled	300-76-5	0.05		1657
Napthalene	91-20-3	10		625
Napthenic acid	1338-24-5	Not Specified [12]		TBD [12]
Nickel, total	7440-02-0	2		200.8 [4]
Nitrate-nitrogen	14797-55-8	100		300.0, Rev. 2.1 300.1, Rev. 1.0
Nitrobenzene	98-95-3	10		625
2-Nitrophenol	88-75-5	20		625
4-Nitrophenol	100-02-7	50		625
N-Nitrosodiethylamine	55-18-5	20		625
N-Nitrosodimethylamine	62-75-9	50		625 or 1625B [3]
N-Nitroso-di-*n*-butylamine	924-16-3	20		625
N-Nitroso-di-*n*-propylamine	621-64-7	20		625 or 1625B [3]
N-Nitrosodiphenylamine	86-30-6	20		625 or 1625B [3]
Nitrotoluene	1321-12-6	Not Specified [12]		TBD [12]
Nonylphenol	104-40-5	333		1625
para-Nonylphenol	84852-15-3	333		1625
Nonylphenol	25154-52-3	333		1625
n-Octadecane	593-45-3	30		625 [11]
Parathion (ethyl) [17]	56-38-2	0.1		1657 or SM6630C
Pentachlorobenzene	608-93-5	20		625
Pentachlorophenol	87-86-5	5		625

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
Phenanthrene	85-01-8	10		625
Phenol, total	108-95-2	10		625
p-Phenolsulfonate	127-82-2	Not Specified [12]		TBD [12]
Phosgene	75-44-5	— [8, 12]		Degrades in water[8]
Polychlorinated biphenyls (PCBs)	1336-36-3			
PCB-77	32598-13-3	0.0005		1668B [19]
PCB-81	70362-50-4	0.0005		1668B [19]
PCB-126	57465-28-8	0.0005		1668B [19]
PCB-169	32774-16-6	0.0005		1668B [19]
PCB-1016	12674-11-2	0.2		608
PCB-1221	11104-28-2	0.2		608
PCB-1232	11141-16-5	0.2		608
PCB-1242	53469-21-9	0.2		608
PCB-1248	12672-29-6	0.2		608
PCB-1254	11097-69-1	0.2		608
PCB-1260	11096-82-5	0.2		608
Propargite	2312-35-8	0.02		GCMS
Propylene oxide	75-56-9	25		624 Heated Purge
Pyrene	129-00-0	10		625
Pyrethrin I	121-21-1	3.1		1660
Pyrethrin II	121-29-9	3.3		1660
Pyridine	110-86-1	20		625 [11]
Quinoline	91-22-5	1 mg/L		ASTM D-4763
Resorcinol	108-46-3	100		1625 [3]
Selenium, total	7782-49-2	5		200.8 [4]
Silver, total	7440-22-4	0.5		200.8 [4]
Strontium	7440-24-6	1.0		200.7
Strychnine	57-24-9	40		1625 [3]
Styrene	100-42-5	10		1625 [3]
1,2,4,5-Tetrachlorobenzene	95-94-3	20		1625 [3]
1,1,2,2-Tetrachloroethane	79-34-5	10		624
Tetrachloroethene [Tetrachloroethylene]	127-18-4	10		624
Thallium, total	7440-28-0	0.5		200.8 [4]
Tin, total	7440-31-5	5		200.7, 200.9 [4]
Titanium, total	7440-32-6	30	40	283.2
Toluene	108-88-3	10		624

Pollutant	CASRN [1]	MAL (µg/L)	Screening Level [2] (µg/L)	Suggested Method
Toxaphene	8001-35-2	0.3		608
2,4,5-TP [Silvex]	93-72-1	0.3		SM6640B
1,2-Trans-dichloroethene 1,2-Trans-dichloroethylene	156-60-5	10		624
Tributyltin [TBT]	688-73-3	0.01		TNRCC 1001
1,2,4-Trichlorobenzene	120-82-1	10		625
1,1,1-Trichloroethane	71-55-6	10		624
1,1,2-Trichloroethane	79-00-5	10		624
Trichloroethene [Trichloroethylene]	79-01-6	10		624
Trichlorofon	52-68-6	0.45		1657
2,4,5-Trichlorophenol	95-95-4	50		1625 [3]
2,4,6-Trichlorophenol	88-06-2	10		625
Triethanolmine dodecylbenzenesulfonate	27323-41-7	Not Specified [12]		TBD [12]
Triethylamine	121-44-8	50 mg/L		1667
TTHM (Total Trihalomethanes) Bromodichloromethane Dibromochloromethane Tribromomethane [Bromoform] Trichloromethane [Chloroform]	 75-27-4 124-48-1 75-25-2 67-66-3	 10 10 10 10		624
Trimethylamine	75-50-3	Not Specified [12]		1666 [13]
Uranium, total	7440-61-1	0.5		200.8 [4]
Vanadium, total	7440-62-2	5		200.8 [4]
Vinyl acetate	108-05-4	50		1624 [3]
Vinyl chloride	75-01-4	10		624
Xylenes, total	1330-20-7	10		1624C [3]
Xylenol	1300-71-6	30		625
Zinc, total	7440-66-6	5.0		200.8 [4]
Zirconium	7440-67-7	100		1620

[1] Chemical Abstracts Service Registry Number.

[2] Screening levels are noted for toxic pollutants that (1) do not have numerical criteria in the Standards and (2) are of potential concern only at concentrations substantially higher than the MAL.

[3] EPA Methods 624 and 625 may be utilized in lieu of Methods 1624 and 1625, respectively, as provided in the protocol for Transfer of an Analyte Between Methods as described in *Analytical Method Guidance for the Pharmaceutical Manufacturing Point Source Category, U. S. Environmental Protection Agency, EPA 821-B-00-003, August 1999.* See Appendix G.

[4] EPA Methods 200.8 and 200.9 are approved for use in the NPDES program (40 CFR Part 136, revised March 12, 2007).

[5] 40 CFR Part 136, Table IC refers to the *Methods for Benzene: Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater*, U.S. Environmental Protection Agency, September 1978. However, no analytical method number is specified in 40 CFR Part 136.

[6] Hydrolyzes in water. Will not require applicant to analyze at this time.

[7] Trivalent chromium (Cr) determined by subtracting hexavalent Cr from total Cr.

[8] EPA procedure not approved. Will not require applicant to analyze at this time.

[9] Either method listed for mercury may be used.

[10] Although EPA Methods 245.1 Revision 3.0 and 245.2 are included as approved analytical methods for mercury in the 40 CFR Part 136 (*Federal Register/ Vol. 72, No. 47/ Monday, March 12, 2007/ Rules and Regulations, page 11220*), the Director of the EPA Office of Wastewater Management published a policy memo, dated August 23, 2007, clarifying and explaining that based on the existing regulatory requirements for NPDES permitting, only the most sensitive analytical methods for mercury, such as EPA Methods 1631E and 245.7, are appropriate in most instances for use in deciding whether to set a permit limit for mercury and for sampling and analysis of mercury pursuant to monitoring requirements within a permit.

[11] Pollutant analyzed by the EPA as published in the *Centralized Waste Treatment Final Development Document*, Chapter 7, and *Federal Register* Vol. 65, No. 247, Friday, December 22, 2000, pp. 81295-81300, using Method 625.

[12] The TCEQ has requested the EPA to provide MALs and/or suggested methods.

[13] Method is draft and has not yet been approved by EPA.

[14] The MAL is 3.3 times the MDL and lowest calibration point for Captan of 0.1 µg/L as given in Method 1656.

[15] *Methods for Benzene: Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water And Wastewater.* U.S. Environmental Protection Agency, September 1978,

[16] *Selected Analytical Methods Approved and Cited by the USEPA.* Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater*, 1981.

[17] EPA Methods 605, 607, and 612 may also be used.

[18] Except as provided in 40 CFR Part 136.5, pesticide manufacturers must determine the discharge parameter values required under the Clean Water Act by one of the methods described in Table 1G of 40 CFR Part 136.3(a). *See* 40 CFR Part 455.50.

[19] Method 1668B is not currently listed as an approved method at 40 CFR Part 136.

Table E-2. Analytical Methods and MALs for the Determination of Pollutants Regulated by § 307.6 of the Standards

Notes on table:

1) Suggested analytical methods have traditionally been EPA-approved analytical methods either in the 40 CFR Part 136, as amended, or in EPA-published documents pertaining to wastewater matrices, or methods developed and published by the TCEQ or other government agencies for wastewater. Applicants and permittees may use any analytical method approved in 40 CFR Part 136 that is sufficiently sensitive to demonstrate compliance with their numeric permit limits (mass and concentration).

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Acrylonitrile	1624B	50	50	The MAL is based on the MDL published in 40 CFR Part 136, Method 1624B. The MAL is equal to the minimum level at which the analytical system shall give acceptable calibration points documented in 40 CFR Part 136, Method 1624B.
Aldrin	608	0.01	0.004	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is 2.5 times the MDL documented in 40 CFR Part 136, Method 608.
Aluminum, total	200.8	2.5	1.0	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is 2.5 times the MDL based on EPA Method 200.8.[1]
Anthracene	625	10	—[4]	The MAL is based on the MQL developed by EPA Region 6, July 1992.
Antimony, total	200.8	5	0.4	The MAL is 12.5 times the MDL based on EPA Method 200.8.[1]
Arsenic, total	200.8	0.5	0.4	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is published in EPA Method 200.8.[1]
Barium, total	200.8	3	0.8	The MAL is approximately 3.8 times the MDL based on EPA Method 200.8.[1]

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Benzene	624	10	4.4	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Benzidine	625	50	44	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 625.
Benzo(*a*)anthracene	625	5	—[11]	The MAL is based on the CERCLA National Contract Laboratory Program's CRQL referred to by EPA Region 6 MQL guidance dated February 8, 2008.
Benzo(*a*)pyrene	625	5	2.5	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 625.
Bis(2-chloroethyl)ether	625	10	5.7	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Bis(chloromethyl)ether	—[4]	—[4]	—[4]	Analytical method undetermined.
Bis(2-ethylhexyl)phthalate [Di(2-ethylhexyl)phthalate]	625	10	2.5	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Bromodichloromethane [Dichlorobromomethane]	624	10	2.2	The MAL is based on the MQL developed by EPA Region6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Cadmium, total	200.8	1	0.5	The MAL is two times the MDL based on EPA Method 200.8.[1]
Carbaryl	632	5.0	0.02	The MAL is based on laboratory consensus taken October 1992. The MDL is given by EPA Method 632.[6]

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Carbon tetrachloride	624	2	—[11]	The MAL is four times the CERCLA National Contract Laboratory Program's CRQL of 0.5 µg/L referred to by EPA Region 6 MQL guidance dated February 8, 2008.
Chlordane	608	0.2	0.014	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
Chlorine	4500-Cl E 4500-Cl G	33	10	The MAL is based on the MQL developed by EPA Region 6, February 8, 2008. The MDL is documented in SM 4500-Cl E and 4500-Cl G.
Chlorobenzene	624	10	6.0	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Chlorodibromomethane	624	10	3.1	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Chloroform	624	10	1.6	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Chlorpyrifos	1657	0.05	0.004	The MAL is 12.5 times the MDL given by EPA, Method 1657.[6]
Chromium, total	200.8	3	0.9	The MAL is 3.3 times the MDL based on EPA Method 200.8.[1]
Chromium, hexavalent	218.6, Rev. 3.3	3.0	0.3	The MAL is ten times the MDL given by EPA Method 218.6, Revision 3.3.[3]

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Chromium, trivalent	See documen-tation note.	—	—	Trivalent chromium is determined by subtracting the concentration of hexavalent chromium (dissolved) from the dissolved total chromium concentration.
Chrysene	625	5	2.5	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 625.
Copper, total	200.8	2	0.5	The MAL is 3.3 times the MDL from Method 200.8 rounded
m-cresol	625	10	3	The MDL is documented in 40 CFR Part 136, Method 625.[2, 15]
o-cresol	625	10	4.7	The MDL is documented in 40 CFR Part 136, Method 625.[2, 15]
p-Cresol [4-Methylphenol]	625	10	7.8	The MDL is documented in 40 CFR Part 136, Method 625.[2, 15]
Cyanide, total	335.4, 4500-CN D, 4500-CN E,	10	—[4]	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008.
Cyanide, available [16]	4500-CN G	10	—[5]	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008.There is no MDL documented in Standard Methods (20th Edition).[5]
	OIA-1677	2	0.5	The MAL and MDL are documented in EPA Method OIA-1677 dated August 1999.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
4,4'-DDD	608	0.1	0.011	The MAL is approximately 9.1 times the detection limit documented in 40 CFR Part 136, Method 608. The MAL is based on the MQL developed by EPA Region 6, July 1992.
4,4'-DDE	608	0.1	0.004	The MAL is based on the MQL Developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 608.
4,4'-DDT	608	0.02	0.012	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
2,4-D	615 or SM6640B	0.7	0.07	The MAL is ten times the detection limit given by SM6640B.[5]
Danitol [Fenpropathrin]	No published EPA method available	—[4]	—[4]	No published EPA method available.
Demeton	1657 [12, 13]	0.20	0.020	The MAL is ten times the detection limit given by EPA Method 1657.[6]
Diazinon	1657	0.5	0.038	The MAL is approximately 13.2 times the detection limit given by EPA Method 1657.[6]
	614	0.1	0.01	The MAL is 10 times the detection limit given by EPA Method 614.[6]
Dibenzo(*a*,*h*)anthracene	625	5	—[4]	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008.
1,2-Dibromoethane	1624	10	—[4]	The MAL is based on the baseline value documented in Attachment 15-1, page 5-17 of the EPA *Development Document for Effluent Limitations Guidelines and Standards for the Centralized Waste Treatment Industry - Final*, August 2000.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
m-Dichlorobenzene [1,3-Dichlorobenzene]	624	10	1.9	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
o-Dichlorobenzene [1,2-Dichlorobenzene]	624	10	1.9	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
p-Dichlorobenzene [1,4-Dichlorobenzene]	624	10	4.4	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
3,3'-Dichlorobenzidine	625	5	—[11]	The MAL is based on the CERCLA National Contract Laboratory Program's CRQL referred to by EPA Region 6 MQL guidance dated February 8, 2008.
1,2-Dichloroethane	624	10	2.8	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
1,1-Dichloroethene [1,1-Dichloroethylene]	624	10	2.8	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Dichloromethane [Methylene choride]	624	20	2.8	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
1,2-Dichloropropane	624	10	6.0	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
1,3-Dichloropropene	624	10	5.0	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624 for cis-1,3-Dichloropropene.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Dicofol [Kelthane]	ASTM D5812-96(02)	1	—[4]	The MAL is 3.3 times the lowest calibration point for Dicofol of 0.3 µg/L given in Method 1656.
Dieldrin	608	0.02	0.002	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
2,4-Dimethylphenol	625	10	2.7	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Di-*n*-butyl phthalate	625	10	—[4]	The MAL is based on the MQL developed by EPA Region 6, July 1992.
Dioxins/Furans (TCDD Equivalents) 2,3,7,8-TCDD 1,2,3,7,8-PeCDD **2,3,7,8-HxCDDs** 1,2,3,4,7,8-HxCDD 1,2,3,6,7,8-HxCDD 1,2,3,7,8,9-HxCDD 1,2,3,4,6,7,8-HpCDD OCDD 2,3,7,8-TCDF 1,2,3,7,8-PeCDF[10] 2,3,4,7,8-PeCDF **2,3,7,8-HxCDFs** 1,2,3,4,7,8-HxCDF 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF **2,3,4,7,8-HpCDFs** 1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF OCDF	1613B	(ppq) 10 50 50 50 50 50 100 10 50 50 50 50 50 50 50 50 100	(ppq) See documentation note	The MAL is based on the Minimum Level (ML) published in 40 CFR Part 136, Method 1613B. The ML for each analyte is defined as the level at which the entire analytical system must give a recognizable signal and acceptable calibration point. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
Diuron	632	0.09	0.009	The MAL is ten times the detection limit given by EPA Method 632.[6]

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Endosulfan I (*alpha*)	608	0.01	—[11]	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
Endosulfan II (*beta*)	608	0.02	0.004	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
Endosulfan sulfate	608	0.1	0.066	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 608.
Endrin	608	0.02	0.006	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
Ethylbenzene	624	10	7.2	The MAL is based on the MQL developed by EPA Region 6 July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Fluoride	300.0 or 300.1	500	50	The MAL is ten times the lowest concentration of the applicable working range given by EPA Method 300.0.
Guthion [Azinphos Methyl]	1657	0.1	0.009	The MAL is 11.1 times the detection limit given by EPA Method 1657.[6]
Heptachlor	608	0.01	0.003	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is 3.3 times the detection limit documented in 40 CFR Part 136, Method 608.
Heptachlor epoxide	608	0.01	—[11]	The MAL is based on the CERCLA National Contract Laboratory Program's CRQL referred to by EPA Region 6 MQL guidance dated February 8, 2008.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Hexachlorobenzene	625	5	1.9	The MAL is based on the CERCLA National Contract Laboratory Program's CRQL referred to by EPA Region 6 MQL guidance dated February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 625.
Hexachlorobutadiene	625	10	0.9	The MAL is 11.1 times the detection limit documented in 40 CFR Part 136, Method 625 and corresponds to the MQL developed by EPA Region 6, July 1992.
Alpha-Hexachlorocyclohexane	608	0.05	0.003	The MAL is 16.7 times the detection limit documented in 40 CFR Part 136, Method 608. The MAL is based on the MQL developed by EPA Region 6, July 1992.
Beta-Hexachlorocyclohexane	608	0.05	0.006	The MAL is 8.3 times the detection limit documented in 40 CFR Part 136, Method 608. The MAL is based on the MQL developed by EPA Region 6, July 1992.
Gamma-Hexachlorocyclohexane [Lindane]	608	0.05	0.004	The MAL is 12.5 times the detection limit documented in 40 CFR Part 136, Method 608. The MAL is based on the MQL developed by EPA Region 6, July 1992.
Hexachlorocyclopentadiene	625 or 1625B [14]	10	—[4]	The MAL is based on the MQL developed by EPA Region 6, July 1992.
Hexachloroethane	625	20	1.6	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Hexachlorophene	604.1	10	1.2	The MAL is 8.3 times the detection limit given in EPA Method 604.1.[6]

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Lead, total	200.8	0.5	0.05	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is published in EPA Method 200.8.[1]
Malathion	1657 or SM6630C	0.1	0.011	The MAL is 9.1 times the detection limit given in EPA Method 1657.[6]
Mercury[7, 8, 9]	245.7, Rev. 2.0	0.005	0.0018	The MAL is based on the MQL published in the EPA national policy memorandum dated August 23, 2007 and in the Method 245.7 published in February 2005.
Mercury[7, 8, 9]	1631E	0.0005	0.0002	The MAL is based on the MQL published in the EPA national policy memorandum dated August 23, 2007 and in the Method 1631E published in August 2002.
Methoxychlor	617 or SM6630B and C	2	0.176	The MAL is 11.4 times the detection limit given in EPA Method 617.[6]
Methyl ethyl ketone	624	50	50	The MAL is the minimum level at which the analytical system shall give acceptable calibration points documented in 40 CFR 136, Method 1624. MAL is five times the CRQL for water analysis using Method 624 from the EPA Region 6, Target Compound List acquired January 14, 1993.
Mirex	SM6630B and C	0.02	0.004	The MAL is 3.75 times the MDL and lowest calibration point for Mirex of 0.004 µg/L as given in Method 1656.
Nickel, total	200.8	2	0.5	The MAL is less than or equal to 3.3 times the MDL for EPA Method 200.8 [1] rounded.
Nitrate-nitrogen	300.1	100	10	The MAL is ten times the lowest concentration of the applicable range given by EPA Method 300.1, Rev. 1.0.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Nitrobenzene	625	10	1.9	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.
N-Nitrosodiethylamine	625	20	5	The suggested method, MAL and MDL are based on laboratory consensus taken October 1992.
N-Nitroso-di-*n*-butylamine	625	20	5	The suggested method, MAL and MDL are based on laboratory consensus taken October 1992.
para-Nonylphenol (CASRN 84852-15-3)	1625	333	111	The MAL is three times the MDL published in Method 1625.
Nonylphenol (CASRN 25154-52-3)	1625	333	111	The MAL is three times the MDL published in Method 1625.
Parathion (ethyl)	1657 or SM6630C	0.1	0.010	The MAL is ten times the detection limit given in EPA Method 1657.[6]
Pentachlorobenzene	625	20	5	The suggested method, MAL and MDL are based on laboratory consensus taken October 1992.
Pentachlorophenol	625	5	3.6	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008.
Phenanthrene	625	10	5.4	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Polychlorinated biphenyls (PCBs)				
PCB-77	1668B	0.0005	0.000169	The MALs are based on estimated minimum levels as published in Method 1668B.
PCB-81	1668B	0.0005	0.000177	
PCB-126	1668B	0.0005	0.000136	
PCB-169	1668B	0.0005	0.000161	
PCB-1016	608	0.2	ND[4]	The MALs are based on the MQLs approved by EPA Region 6 on February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
PCB-1221	608	0.2	ND[4]	
PCB-1232	608	0.2	ND[4]	
PCB-1242	608	0.2	0.065	
PCB-1248	608	0.2	ND[4]	
PCB-1254	608	0.2	ND[4]	
PCB-1260	608	0.2	ND[4]	

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Pyridine	625 [2]	20	10	The MAL is two times the MDL published in the *List of Lists: A Catalog of Analytes and Methods*, U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Industrial Technology Division, September 1990.
Selenium, total	200.8	5	2.1	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is published in EPA Method 200.8.[1]
Silver, total	200.8	1	0.1	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is five times the MDL in EPA Method 200.8.[1]
1,2,4,5-Tetrachlorobenzene	1625	20	10	The MAL is 2 times the MDL published in the *List of Lists: A Catalog of Analytes and Methods*, U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Industrial Technology Division, September 1990.
1,1,2,2-Tetrachloroethane	624	10	6.9	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Tetrachloroethene [Tetrachloroethylene]	624	10	4.1	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Thallium, total	200.8	1	0.3	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is approximately 1.7 times the MDL in EPA Method 200.8.[1]

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Toluene	624	10	6.0	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Toxaphene	608	1	0.24	The MAL is based on the MQL approved by EPA Region 6 in February 8, 2008. The MDL is documented in 40 CFR Part 136, Method 608.
2,4,5-TP [Silvex]	SM6640B	0.3	0.03	The MAL is ten times the detection limit given by SM6640B.[5]
Tributyltin [TBT]	TNRCC 1001	0.01	3.2×10^{-3}	The method is entitled "Measurement of Butyltin Species in Water by n-Pentyl Derivatization with Gas Chromatography/Flame Photometric Detection (GC/FPD) and Gas Chromatography/Mass Spectrometry (GC/MS)." The MAL is equal to EPA tributyltin advisory level.
1,1,1-Trichloroethane	624	10	3.8	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
1,1,2-Trichloroethane	624	10	5.0	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
Trichloroethene [Trichloroethylene]	624	10	1.9	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
2,4,5-Trichlorophenol	1625	50	10	The MAL is five times the minimum level at which the analytical system shall give acceptable calibration points documented in 40 CFR Part 136, Method 1625.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
TTHM (Total Trihalomethanes) Bromodichloromethane Dibromochloromethane Tribromomethane [Bromoform] Trichloromethane [Chloroform]	624	 10 10 10 10	 2.2 3.1 4.7 1.6	The MAL is based on the CRQL for water analysis using Method 624 from the EPA Region 6, Target Compound List acquired January 14, 1993. Method detection limits are documented in 40 CFR Part 136, Method 624.
Vinyl chloride	624	10	—[4]	The MAL is based on the MQL developed by EPA Region 6, July 1992. The MDL is given as "nd" in 40 CFR Part 136, Method 624.
Zinc, total	200.8	5	1.8	The MAL is approximately 2.8 times the MDL based on EPA Method 200.8.[1]

[1] Method 200.8 is approved for use in the NPDES program [40 CFR Part 136, revised March 12, 2007]. *Method 200.8. Determination of Trace Elements in Waters and Wastes by Inductively Coupled-Plasma - Mass Spectrometry*, U.S. Environmental Protection Agency, EPA 600-R-94-111, May 1994. Method 200.8 contains accuracy and precision data generated using determination of trace elements in waters and wastes by inductively coupled plasma-mass spectrometry techniques for the following metals: aluminum, arsenic, barium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc.

[2] Pollutant analyzed by the EPA as published in the *Centralized Waste Treatment Final Development Document*, Chapter 7, and *Federal Register* Vol. 65, No. 247, Friday, December 22, 2000, pp. 81295-81300, using Method 625.

[3] *Methods for the Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-Cl), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.

[4] Not determined or not published by the EPA.

[5] *Standard Methods Online*, American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. URL: http://www.standardmethods.org/applications/Login/index.cfm?test=no&forwardto=

[6] *EPA Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater*, U.S. Environmental Protection Agency, EPA-821-R-93-010-A & B, August 1993.

[7] Either method listed for mercury may be used.

[8] *Method 1631, Revision E. Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry*, U.S. Environmental Protection Agency, Office of Water, EPA 821-R-02-019, August 2002.

[9] Although EPA Methods 245.1 Revision 3.0 and 245.2 are included as approved analytical methods for mercury in the 40 CFR Part 136 (*Federal Register/ Vol. 72, No. 47/ Monday, March 12, 2007/ Rules and Regulations, page 11220*), the Director of the EPA Office of Wastewater Management published a policy memo, dated August 23, 2007, clarifying and explaining that based on the existing regulatory requirements for NPDES permitting, only the most sensitive analytical methods for mercury, such as EPA Methods 1631E and 245.7, are appropriate in most instances for use in deciding whether to set a permit limit for mercury and for sampling and analysis of mercury pursuant to monitoring requirements within a permit.

[10] The ML is not published in 40 CFR Part 136, Method 1613B.

[11] The MDL is published in 40 CFR Part 136.

[12] *Methods for Benzene: Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water And Wastewater.* U.S. Environmental Protection Agency, September 1978,

[13] *Selected Analytical Methods Approved and Cited by the USEPA.* Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater*, 1981.

[14] EPA Methods 605, 607, and 612 may also be used.

[15] *Product and Product Group Discharges Subject to Effluent Limitations and Standards for the Organic Chemicals, Plastics, and Synthetic Fibers Point Source Category – 40 CFR Part 414*, U.S. Environmental Protection Agency, Office of Water. April 2005.

[16] The EPA has published Method OIA-1677 for the analysis of available cyanide as a method that tends to overcome matrix interferences present with other methods and includes a lower MAL. Permit writers may determine the appropriate method for permittees on a case-by-case basis in situations where a lower MAL is needed for permit compliance or for eliminating interferences and matrix problems.

Appendix F. Nutrient Screening Parameters for Certain Reservoirs.

Table F-1: Total Phosphorus and Chlorophyll *a* Means for Certain Reservoirs

Notes on table:

1) Segment numbers in parentheses refer to the segment in whose watershed the lake is located.

2) Data used to calculate the TP, chlorophyll *a*, and secchi depth means were collected at the SWQM monitoring site(s) listed in the Site ID column for each reservoir.

3) The mean values for TP, chlorophyll *a*, and secchi depth are arithmetic means. The means are calculated from the same data sets used to calculate TP and transparency screening levels and chlorophyll *a* criteria in the Standards.

Seg-ment No.	Lake/Reservoir Name	Site ID	TP Mean (mg/L)	Chlorophyll *a* Mean (µg/L)	Secchi Mean (m)
(0100)	Palo Duro Reservoir	10005	0.171	12.95	0.40
0102	Lake Meredith	10036	0.022	3.10	1.98
0208	Lake Crook	10137	0.165	4.77	0.23
0209	Pat Mayse Lake	10138	0.029	7.64	1.34
0210	Farmers Creek Reservoir (also known as Lake Nocona)	10139	0.026	4.06	1.18
0212	Lake Arrowhead	10142	0.130	6.99	0.69
0213	Lake Kickapoo	10143	0.066	3.81	0.35
0215	Diversion Lake	10157	0.026	6.21	0.96
0217	Lake Kemp	10159	0.023	5.78	1.33
0223	Greenbelt Lake	10173	0.022	3.14	2.03
0228	Mackenzie Reservoir	10188	0.021	3.74	1.37
0229	Lake Tanglewood	10192	1.022	24.75	0.70
0302	Wright Patman Lake	10213	0.087	12.46	0.64
0403	Lake O' the Pines	10296	0.027	9.31	1.17
0405	Lake Cypress Springs	10312	0.027	11.21	1.28
0507	Lake Tawakoni	10434	0.045	23.95	1.00
0509	Murvaul Lake	10444	0.057	37.46	0.61
0510	Lake Cherokee	10445	0.019	5.69	1.41
0512	Lake Fork Reservoir	10458	0.036	9.78	1.59
0603	B. A. Steinhagen Lake	10582	0.068	8.04	0.43
0605	Lake Palestine	16159	0.027	17.37	0.90
0610	Sam Rayburn Reservoir	14906	0.028	4.52	1.97
0613	Lake Tyler	10637	0.026	8.27	1.16
0613	Lake Tyler East	10638	0.027	7.00	1.16
0614	Lake Jacksonville	10639	0.026	4.05	1.63

Seg-ment No.	Lake/Reservoir Name	Site ID	TP Mean (mg/L)	Chlorophyll *a* Mean (µg/L)	Secchi Mean (m)
0803	Lake Livingston	10899	0.136	15.15	0.79
0807	Lake Worth	10942	0.073	23.51	0.79
0809	Eagle Mountain Reservoir	10944 10945	0.062	17.25	0.92
0811	Bridgeport Reservoir	10970	0.045	3.73	1.23
0813	Houston County Lake	10973	0.026	7.35	1.43
0815	Bardwell Reservoir	10979	0.043	15.05	0.64
0816	Lake Waxahachie	10980	0.027	11.84	0.78
0817	Navarro Mills Lake	10981	0.062	9.74	0.45
0818	Cedar Creek Reservoir	10982 16749	0.067	21.88	0.86
0823	Lewisville Lake	11027	0.046	11.67	0.76
0826	Grapevine Lake	11035 16113	0.063	7.21	1.01
0827	White Rock Lake	11038	0.086	20.89	0.51
0828	Lake Arlington	11040 13904	0.033	15.99	0.86
0830	Benbrook Lake	11046 15151	0.057	18.01	0.84
0832	Lake Weatherford	11061	0.045	8.31	0.70
0834	Lake Amon G. Carter	11063	0.030	3.91	1.45
0836	Richland-Chambers Reservoir	15168	0.031	10.58	1.27
1002	Lake Houston	11204	0.165	7.18	0.34
1012	Lake Conroe	11342	0.042	16.05	0.94
1203	Whitney Lake	11851	0.027	11.21	1.49
1205	Lake Granbury	11860	0.054	15.53	1.14
1207	Possum Kingdom Lake	11865	0.041	6.84	2.64
(1208)	Millers Creek Reservoir	11679	0.062	10.34	0.31
1212	Somerville Lake	11881	0.082	35.16	0.68
1216	Stillhouse Hollow Lake	11894	0.029	1.71	3.22
1220	Belton Lake	11921	0.028	4.11	2.05
1222	Proctor Lake	11935	0.079	18.48	0.60
1224	Leon Reservoir	11939	0.023	6.17	1.22
1225	Waco Lake	11942	0.068	16.11	0.88
1228	Lake Pat Cleburne	11974	0.059	11.93	0.56
1230	Lake Palo Pinto	11977	0.050	3.81	0.69
1231	Lake Graham	11979	0.039	4.37	0.73

Seg-ment No.	Lake/Reservoir Name	Site ID	TP Mean (mg/L)	Chlorophyll *a* Mean (µg/L)	Secchi Mean (m)
1233	Hubbard Creek Reservoir	12002	0.030	3.68	1.34
1234	Lake Cisco	12005	0.017	3.07	1.58
1235	Lake Stamford	12006	0.056	11.02	0.47
1236	Fort Phantom Hill Reservoir	12010	0.044	6.12	0.59
1237	Lake Sweetwater	12021	0.033	8.49	0.88
1240	White River Lake	12027	0.046	8.02	0.54
(1241)	Buffalo Springs Lake	11529	0.081	38.20	0.65
1247	Granger Lake	12095	0.044	7.43	0.47
1249	Lake Georgetown	12111	0.032	2.61	2.15
1252	Lake Limestone	12123	0.065	13.08	0.83
1254	Aquilla Reservoir	12127	0.037	8.73	0.69
1403	Lake Austin	12294	0.023	2.45	2.12
1404	Lake Travis	12302	0.021	2.46	3.68
1405	Marble Falls Lake	12319	0.023	6.87	1.44
1406	Lake Lyndon B. Johnson	12324	0.022	6.72	1.44
1407	Inks Lake	12336	0.026	9.66	1.62
1408	Lake Buchanan	12344	0.022	6.41	1.97
1411	E. V. Spence Reservoir	12359	0.022	8.97	1.27
(1412)	Lake Colorado City	12167	0.039	10.11	0.77
(1416)	Brady Reservoir	12179	0.030	17.02	0.69
1418	Lake Brownwood	12395	0.019	3.49	1.24
1419	Lake Coleman	12398	0.018	4.02	1.29
1422	Lake Nasworthy	12418	0.045	11.12	0.52
1423	Twin Buttes Reservoir	12422	0.066	8.81	0.87
1425	O.C. Fisher Lake	12429	0.112	23.60	0.36
(1426)	Oak Creek Reservoir	12180	0.025	4.62	0.78
1429	Lady Bird Lake (formerly Town Lake)	12476	0.031	4.51	1.94
1433	O. H. Ivie Reservoir	12511	0.024	4.14	2.11
1805	Canyon Lake	12598	0.025	2.64	2.72
1904	Medina Lake	12826	0.011	1.86	2.84
2103	Lake Corpus Christi	12967	0.148	10.08	0.49
2116	Choke Canyon Reservoir	13019	0.044	7.77	1.16
2303	International Falcon Reservoir	13189	0.047	9.56	0.79
2305	International Amistad Reservoir	13211	0.015	1.44	3.55

Seg-ment No.	Lake/Reservoir Name	Site ID	TP Mean (mg/L)	Chlorophyll *a* Mean (µg/L)	Secchi Mean (m)
2312	Red Bluff Reservoir	13267	0.030	14.81	0.85
(2454)	Cox Creek Lake	12514	0.268	8.10	0.16

Table F-2: Size Characteristics and Retention Times for Certain Reservoirs

Notes on table:

1) Segment numbers in parentheses refer to the segment in whose watershed the lake is located.

2) Surface areas are at normal pool elevation as defined in Appendix C of the Standards. Surface areas were obtained from the Texas Water Development Board unless noted otherwise.

3) Volumes are at normal pool elevation as defined in Appendix C of the Standards. Volumes include the dead pool and were obtained from the Texas Water Development Board (TWDB) unless noted otherwise.

4) The volumetric survey year is the year in which the actual survey was performed (not the report year).

5) Retention times are calculated as noted in the source documentation but may be recalculated as reservoir capacities or flows are updated or as the TCEQ becomes aware of significant water transfers in or out of these reservoirs.

Segment No.	Lake/Reservoir Name	Surface Area (acres)	Volume (acre-ft.)	Volumetric Survey Year	Retention Time (yrs)	Retention Time Source*
(0100)	Palo Duro Reservoir	2,397	61,239	1986	—	—
0102	Lake Meredith	16,411	817,970	1995	15.1	Ground
0208	Lake Crook	1,060	9,210	2003	0.22	Ground
0209	Pat Mayse Lake	5,940	118,100	2008	1.3	Ground
0210	Farmers Creek Reservoir (also known as Lake Nocona)	1,362	21,749	2001	3.0	Ground
0212	Lake Arrowhead	14,969	235,997	2001	4.7	TCEQ
0213	Lake Kickapoo	6,028	85,825	2001	2.2	TCEQ
0215	Diversion Lake	3,133	33,420	1958	0.36	TCEQ
0217	Lake Kemp	15,357	245,434	2006	3.0	Ground
0223	Greenbelt Lake	2,025	60,400	—	6.4	Ground
0228	Mackenzie Reservoir	896	46,454	1973	38.1	Ground
0229	Lake Tanglewood	258 [(a)]	—	—	—	—
0302	Wright Patman Lake	24,438	167,300	1997	0.06	Ground
0403	Lake O' the Pines	16,919	241,081	1998	0.56	Ground
0405	Lake Cypress Springs	3,461	67,690	2007	1.7	Ground
0507	Lake Tawakoni	37,879	888,140	1997	2.5	Ground
0509	Murvaul Lake	3,529	38,284	1998	0.85	Ground
0510	Lake Cherokee	3,467	43,737	2003	0.68	Ground
0512	Lake Fork Reservoir	27,264	636,133	2001	3.9	Ground
0603	B. A. Steinhagen Lake	10,687	66,972	2003	0.03	Ground
0605	Lake Palestine	22,656	373,202	2003	1.2	Ground
0610	Sam Rayburn Reservoir	112,590	2,876,033	2004	1.8	Ground

Segment No.	Lake/Reservoir Name	Surface Area (acres)	Volume (acre-ft.)	Volumetric Survey Year	Retention Time (yrs)	Retention Time Source*
0613	Lake Tyler	2,341 [(b)]	43,500 [(c)]	2003	—	—
0613	Lake Tyler East	2,396 [(b)]	36,698 [(d)]	2003	0.84	Ground
0614	Lake Jacksonville	1,165	25,732	2006	1.8	Ground
0803	Lake Livingston	83,277	1,741,867	1991	0.35	Ground
0807	Lake Worth	3,458	33,495	2001	—	—
0809	Eagle Mountain Reservoir	8,702	182,505	2008	0.95	Ground
0811	Bridgeport Reservoir	11,954	366,236	2000	3.1	Ground
0813	Houston County Lake	1,330	17,665	1999	1.3	Ground
0815	Bardwell Reservoir	3,138	46,472	1999	1.0	Ground
0816	Lake Waxahachie	656	11,386	2000	—	—
0817	Navarro Mills Lake	4,736	49,827	2008	0.64	Ground
0818	Cedar Creek Reservoir	32,873	644,785	2005	1.7	Ground
0823	Lewisville Lake	29,170	571,926	2007	0.99	Ground
0826	Grapevine Lake	6,893	164,703	2002	1.5	Ground
0827	White Rock Lake	1,088	9,004	1993	—	—
0828	Lake Arlington	1,926	40,188	2007	2.4	Ground
0830	Benbrook Lake	3,635	85,648	1998	1.7	Ground
0832	Lake Weatherford	1,112	17,812	2008	1.3	TCEQ
0834	Lake Amon G. Carter	1,540	20,050	—	—	—
0836	Richland-Chambers Reservoir	41,356	1,136,600	2007	1.8	TCEQ
1002	Lake Houston	11,854	133,990	1994	0.11	Ground
1012	Lake Conroe	20,118	416,228	1996	2.7	Ground
1203	Whitney Lake	23,220	554,203	2005	0.61	Ground
1205	Lake Granbury	7,945	129,011	2003	0.21	Ground
1207	Possum Kingdom Lake	16,716	540,340	2005	1.1	Ground
(1208)	Millers Creek Reservoir	2,268	29,171	1993	—	—
1212	Somerville Lake	11,555	147,104	2003	0.65	TCEQ
1216	Stillhouse Hollow Lake	6,484	227,825	2005	1.5	Ground
1220	Belton Lake	12,135	435,225	2003	1.3	Ground
1222	Proctor Lake	4,537	55,457	2002	0.86	Ground
1224	Leon Reservoir	1,590	27,290	—	1.2	Ground
1225	Waco Lake	7,913	199,405	1995	0.73	Ground
1228	Lake Pat Cleburne	1,558	25,730	2008	—	—
1230	Lake Palo Pinto	2,498	27,650	2007	0.98	Ground

Segment No.	Lake/Reservoir Name	Surface Area (acres)	Volume (acre-ft.)	Volumetric Survey Year	Retention Time (yrs)	Retention Time Source*
1231	Lake Graham	2,444	45,302	1998	1.9	Ground
1233	Hubbard Creek Reservoir	14,922	324,983	1997	4.1	Ground
1234	Lake Cisco	10,450	26,000	—	—	—
1235	Lake Stamford	5,124	51,573	1999	—	—
1236	Fort Phantom Hill Reservoir	4,213	70,036	1993	—	—
1237	Lake Sweetwater	630	11,900	—	3.8	Ground
1240	White River Lake	2,020	44,300	1993	16.3	Ground
(1241)	Buffalo Springs Lake	200	4,200	—	—	—
1247	Granger Lake	4,064	52,525	2002	0.42	Ground
1249	Lake Georgetown	1,287	36,904	2005	0.76	Ground
1252	Lake Limestone	12,553	208,017	2002	0.93	Ground
1254	Aquilla Reservoir	3,066	44,566	2008	1.3	Ground
1403	Lake Austin	1,599	21,804	1999	0.02	Ground
1404	Lake Travis	19,199	1,134,863	2008	1.1	Ground
1405	Marble Falls Lake	608	7,486	2007	0.01	Ground
1406	Lake Lyndon B. Johnson	6,273	133,090	2007	0.14	Ground
1407	Inks Lake	788	14,074	2007	0.02	Ground
1408	Lake Buchanan	22,019	875,610	2006	1.2	Ground
1411	E. V. Spence Reservoir	14,640	517,272	1999	33.3	Ground
(1412)	Lake Colorado City	1,612	31,805	—	1.3	Ground
(1416)	Brady Reservoir	2,020	30,430	—	2.3	Ground
1418	Lake Brownwood	6,587	131,429	1997	1.2	Ground
1419	Lake Coleman	1,811	38,094	2006	2.1	Ground
1422	Lake Nasworthy	1,380	10,108	1993	1.2	Ground
1423	Twin Buttes Reservoir	9,080	186,200	—	18.7	Ground
1425	O. C. Fisher Lake	5,440	115,743	—	6.2	Ground
(1426)	Oak Creek Reservoir	2,375	39,360	—	2.1	Ground
1429	Lady Bird Lake (formerly Town Lake)	468	6,409	1999	0.01	Ground
1433	O. H. Ivie Reservoir	19,149	554,340	—	11.9	Ground
1805	Canyon Lake	8,308	378,852	2000	1.3	Ground
1904	Medina Lake	6,066	254,823	1995	1.6	Ground
2103	Lake Corpus Christi	18,256	257,260	2002	0.53	Ground
2116	Choke Canyon Reservoir	25,989	695,271	1993	3.7	Ground
2303	International Falcon	85,195	2,646,817	—	1.2	Ground

Segment No.	Lake/Reservoir Name	Surface Area (acres)	Volume (acre-ft.)	Volumetric Survey Year	Retention Time (yrs)	Retention Time Source*
	Reservoir					
2305	International Amistad Reservoir	65,597	3,275,532	1994	2.1	Ground
2312	Red Bluff Reservoir	11,193	289,670	—	2.8	Ground
(2454)	Cox Creek Lake	541	5,034	—	—	—

(a) Dimensions obtained from http://findlakes.com

(b) Surface area proportions derived from http://www.tpwd.state.tx.us and then adjusted to the surface area at normal pool elevation

(c) Capacity from http://www.cityoftyler.org

(d) Calculated as the difference between the TWDB total capacity for both lakes (80,198 acre-ft) and the City of Tyler's capacity for Lake Tyler (http://www.cityoftyler.org).

* Ground: Ground, T. A. 1992. Relationships of Watershed Climate and Geochemical Processes to Trophic Characteristics in Texas Reservoirs. Master of Science thesis. Retention time was calculated using the mean annual discharge from the nearest downstream USGS gage and the mean annual reservoir volume as published by USGS.

TCEQ: Calculated using capacity at conservation pool from TWDB and annual average flow calculated either from the nearest downstream USGS gage or from US Army Corps of Engineers gated flow data.

Appendix G. Transfer of Analytes.

Applicants and Permittees may transfer an analyte from one EPA-approved method to another EPA-approved method as described below. The section below is an excerpt from pages 6-2 and 6-3 of the EPA document *Analytical Method Guidance for the Pharmaceutical Manufacturing Point Source Category*, EPA 821-B-99-003 (August 1999). Use of this guidance is not intended to be limited to pharmaceutical manufacturing and may be undertaken by any applicant or permittee for any analyte as long as applicable NELAC accreditation for the analyte is obtained.

Transfer of an Analyte Between Methods

Some laboratories asked whether a target analyte from one EPA-approved method could be transferred to another EPA-approved method, thereby reducing the number of methods required for monitoring. During development of the Pharmaceuticals Industry final rule, EPA did not evaluate the effect of transferring analytes between methods. On March 28, 1997, when EPA proposed the Streamlining Initiative (now referred to as the performance-based measurement system or "PBMS"), the Agency included a procedure to allow the addition of an analyte to an existing method. This procedure centered on meeting the quality control (QC) acceptance criteria for performance tests for the analyte.

Using PBMS as the basis for transfer of an analyte from one method to another, EPA recommends allowance of a transfer, provided the following conditions are met:

1) The QC tests in the method from which the analyte is transferred must be run as an integral part of the method to which the analyte is transferred,
2) The QC acceptance criteria in the method from which the analyte is transferred must be met when the QC tests are run as an integral part of the method to which the analyte is transferred, and
3) The MDL obtained for the analyte in the method to which the analyte is transferred must be equal to or less than MDL in the method from which the analyte is transferred or less than one third the regulatory compliance limit specified in the permit, whichever is greater.

QC tests in the 600- and 1600-series EPA methods include calibration, calibration verification, initial and ongoing precision and recovery, analysis of blanks, and matrix spike/matrix spike duplicates. EPA recommends that these QC tests be performed and the QC acceptance criteria be met, as follows:

1) When the analyte is transferred to a method, the added analyte must be included in the initial calibration and ongoing calibration checks, and the QC acceptance criteria in the method from which the analyte is transferred must be met for both initial calibration and calibration verification.

2) All initial and ongoing performance tests in the method from which the analyte is transferred must be performed as an integral part of the method to which the analyte is transferred, and the QC acceptance criteria in the method from which the analyte is transferred must be met. The initial and ongoing tests must include a blank with the initial demonstration of performance and with each sample batch.

3) The quality control check or matrix spike/matrix spike duplicate test (whichever is applicable) in the method from which the analyte is transferred must be performed as an integral part of the method to which the analyte is transferred, and the QC acceptance criteria in the method from which the analyte is transferred must be met.

4) An MDL study must be performed for the analyte as an integral part of the method to which the analyte is transferred, and the MDL obtained must be equal to or less than either a) the MDL in the method from which the analyte is transferred or b) one-third the regulatory compliance limit specified in the permit, whichever is greater.

Notes:

1. A possible conflict could arise if the methods are chromatographic (i.e., GC or GC/MS). Some EPA chromatographic methods contain QC tests and QC acceptance criteria for absolute and/or relative retention time. When transferring an analyte between methods, it is unlikely that the two methods would require use of the same chromatographic column and it is therefore unlikely that the retention time criteria in the method from which the analyte is transferred could be met in the method to which the analyte is transferred. To resolve this issue, the absolute and/or relative retention time requirements are waived for the transferred analyte only. If there are absolute and/or relative retention time requirements for the target analytes in the method to which the analyte is transferred, those requirements must continue to be met.

2. Some methods do not contain an MDL, but contain a minimum level of quantitation (ML) for each analyte. MLs were created by multiplying the MDL by 3.18 and rounding. Therefore, for the purpose of establishing that the MDL for a transferred analyte is less than or equal to the MDL in the method from which the analyte is transferred, divide the ML by 3.18 to establish the MDL.

   Examples:

   Example 1: The final rule requires that certain volatile analytes be determined by EPA Method 524.2. These analytes may be added to EPA Method 1666 or any other approved method provided the three conditions specified above are met.

   Example 2: The final rule requires that tert-butyl alcohol, diethylamine, dimethyl sulfoxide, isobutyraldehyde, methyl cellosolve, methyl formate, and triethyl amine be analyzed by EPA Method 1666 or 1671. These analytes may be added to EPA Method 624, 625, or any other approved method provided that the three conditions specified above are met.