

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

**AGENDA ITEM REQUEST**


for Proposed Revisions to Regulatory Guidance


**AGENDA REQUESTED:** January 13, 2010

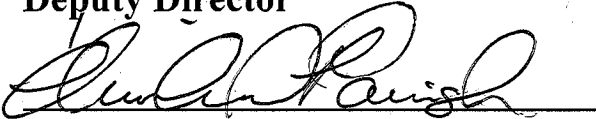
**DATE OF REQUEST:** December 18, 2009

**NAME & NUMBER OF PERSON TO CONTACT REGARDING CHANGES TO THIS REQUEST, IF NEEDED:** David Galindo, 239-0951

**CAPTION:** Docket No. 2009-1060-MIS. Consideration for approval to publish and solicit public comment on proposed amended *Procedures to Implement the Texas Surface Water Quality Standards, RG-194*. This process conforms to the policies and procedures in the Water Quality Management Program Continuing Planning Process. (David Galindo, Robert Brush)

  
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Deputy Director

  
\_\_\_\_\_  
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Copy to CCC Secretary? NO X YES

# Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

**To:** Commissioners **Date:** December 18, 2009  
**Thru:** LaDonna Castañuela, Chief Clerk  
Mark R. Vickery, P.G., Executive Director  
**From:** L'Oreal W. Stepney, P.E., Deputy Director *lws 02/12/09*  
Office of Water  
**Docket No.:** 2009-1060-MIS  
**Subject:** Commission Approval for Proposed Rule Guidance  
*Procedures to Implement the Texas Surface Water Quality Standards (RG-194)*

## Background and Reasons for the revision:

Revisions are proposed to the *Procedures to Implement the Texas Surface Water Quality Standards* (hereafter referred to as the IP). The proposed revisions are the result of a review of the IP in conjunction with the revisions to 30 Texas Administrative Code Chapter 307, the Texas Surface Water Quality Standards. The IP was last revised in 2002, approved by the TCEQ in August 2002, and approved by the United States Environmental Protection Agency (EPA) in November 2002.

The revisions to the IP are proposed to address new provisions in the Texas Surface Water Quality Standards, to incorporate new information and data on individual water bodies, and to respond to public comments.

## Scope of the proposed revision:

The proposed revisions to the IP include numerous substantive changes and clarifications in all sections of the guidance document. The proposed revisions address new provisions in the Texas Surface Water Quality Standards, incorporate new information and data on individual water bodies, and respond to public comments.

### A) Summary of the revisions

Specific proposed changes to the IP include:

- addition of information on implementing revised bacteria criteria in wastewater permits;
- addition of screening procedures and data to address wastewater discharge impacts on nutrients and aquatic vegetation;
- revised low-flow calculations for rivers and streams that are dominated by spring flow;
- addition of reasonable potential determination for whole effluent toxicity limits (lethal and sublethal);
- addition of dechlorination for new permits or permit amendments to increase flow with flows of 0.5 million gallons per day (MGD) – 1.0 MGD; permit renewals of 1.0 MGD or greater will continue to dechlorinate;

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- addition of procedures to address aluminum in storm water discharges;
- addition of procedure to convert fish tissue-based criteria to water column criteria;
- updated minimum analytical levels (MALs) and language to address MALs that are much lower than typical permit limits;
- addition of general information on recreational use attainability analyses;
- updated segment information and data used for screening wastewater permits; and
- addition of critical low-flows and harmonic mean flows for classified segments (moved from the rule).

**B) Scope required by federal regulations or state statutes:**

Revisions to the IP are proposed to address new provisions in the Texas Surface Water Quality Standards, to incorporate new information and data on individual water bodies, and to respond to public comments.

**C) Additional staff recommendation that are not required by federal state or state stature:**

Revisions to the IP are proposed to address new provisions in the Texas Surface Water Quality Standards, to incorporate new information and data on individual water bodies, and to respond to public comments.

**Regulatory authority:**

Memorandum of Agreement between the TNRCC and the EPA concerning the Texas Pollutant Discharge Elimination System (TPDES) program; Water Quality Management Program Continuing Planning Process (August 1999)

**Effect on the:**

**A) Regulated Community:**

The IP can directly affect permitted wastewater discharges in Texas. This includes cities, counties, state agencies, water districts, utility districts, investor-owned utilities, river authorities, mobile home parks, recreational vehicle parks, hotels, motels, industries, campgrounds, or any other business with an industrial or domestic wastewater treatment facility.

State, municipal, agricultural, and industrial effluent limits may have to change based on new or revised implementation of the rules. This may involve changes or new treatment methods or techniques which can range from best management practices to renovating, expanding, or building new treatment facilities. These permit holders may need to seek permit amendments to adjust treatment criteria to newly approved guidance. Small businesses that discharge wastewater will also be required to conform with the proposed guidance.

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**B) Public:**

The IP affects all citizens of the State. The public benefit anticipated from approval and use of the proposed revisions includes increased protection of public drinking water supplies and aquatic life resources, an improved regulatory process for permitted wastewater discharges, and potentially improved quality of the surface water resources of the State. However, proposed revisions to site-specific information which are less stringent than the existing values may be of interest and concern to some members of the public.

**C) Agency Programs:**

The IP explains how limits in wastewater discharge permits are established to ensure that water quality standards are met. Wastewater permitting in the Water Quality Division would be affected by these proposed revisions.

No additional costs are anticipated for the TCEQ to implement the revisions to the IP as the impacts will be primarily operational and procedural. These effects will be higher during the first two years after TCEQ approval and EPA approval of the IP.

The review of wastewater permit applications will need to incorporate numerous changes and additions to screening procedures and segment-specific data and information.

**Stakeholder Meetings:**

Approximately 7 stakeholder meetings were held at the TCEQ complex in Austin on the following dates: March 7, 2007, May 16, 2007, June 26, 2007, September 6, 2007, May 5, 2008, January 6, 2009, and April 27, 2009 (on nutrient criteria and implementation). Revisions to both the water quality standards and the IP were topics at these meetings.

Other outreach efforts have included presentations at:

Water Quality Advisory Group Quarterly Meetings  
TCEQ Environmental Trade Fair and Conference  
Numerous meetings of specific stakeholder groups

Written notice of the stakeholder meetings were sent to the Surface Water Quality Standards Advisory Workgroup, which is a balanced group of regulated entities, public, environmental, consumer, governmental offices, and professional organization representatives. An open invitation was also published on the TCEQ Texas Surface Water Quality Standards home page with a link under "Future Revisions to the Texas Surface Water Quality Standards."

Other interested parties or individuals who requested notification of stakeholder meetings were provided an open invitation to the meetings via written notice.

On average, approximately 100 people attended each meeting.

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**Potential controversial concerns and legislative interest:**

- Nutrient screening and implementation – Several workgroup members expressed the following concerns regarding the proposed new screening procedures for nutrients: proposed total phosphorus limits (based on permitted flow) will be a disproportionate burden for small facilities; proposed nutrient impact evaluation distances are inconsistent for various screening methodologies; ratio of chlorophyll *a* to total phosphorus not a good screening parameter; cumulative impacts need to be evaluated.
- Whole effluent toxicity testing – Workgroup members have not seen revised language, which is much less specific than what they have reviewed previously.
- Dechlorination for minor domestic facilities – EPA Region 6 disagrees with the exclusion from dechlorination of permit renewals with flows from 0.5 MGD to 1.0 MGD.
- Minimum analytical levels (MALs) – Numerous workgroup members expressed serious concerns about MALs that were set well below typical permit limits for various pollutants. Although language has been added to the draft IP to address these concerns, stakeholders have not yet seen the new language.

**Will this revision affect any current policies or require development of new policies?**

The IP establishes procedures used to screen wastewater discharges and establish permit limits to protect water quality. For individual water bodies, the IP includes ambient water quality information used to perform pollutant screenings.

**What are the consequences if this revision does not go forward? Are there alternative to this revision?**

The IP establishes procedures used to evaluate the need to include water quality based effluent limits in wastewater discharge permits. If these revisions are not approved, wastewater permits would not be evaluated entirely consistent with the revised water quality standards. EPA would likely begin objecting to individual permits and preventing their issuance.

**Key points in proposed guidance document schedule:**

<b>Anticipated proposal date:</b>	1/13/10
<b>Anticipated <i>Texas Register</i> publication date:</b>	1/29/10
<b>Public hearing date:</b>	3/11/10
<b>Public comment period:</b>	1/19/10 – 3/17/10
<b>Anticipated adoption date:</b>	7/14/10

**Agency contacts:**

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Bob Brush, Staff Attorney, 239-5600  
Patricia Duron, Texas Register Coordinator, 239-6087

Commissioners  
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December 18, 2009

Re: Docket No. 2009-1060-MIS

cc: Chief Clerk, 5 copies  
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Susana M. Hildebrand, P.E.  
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Patricia Duron, Texas Register Coordinator

**Proposed Revisions to Procedures to Implement  
the Texas Surface Water Quality Standards, RG-194 (IP)  
January 13, 2010**

**Nutrient Screening**

- Added evaluations and models to assess attainment with proposed numerical chlorophyll *a* criteria in reservoirs; evaluates effect of single discharge on entire reservoir.
- Added screening procedures to assess attainment with narrative nutrient criteria.
  - Nutrient screening for local effects in reservoirs (with or without numeric nutrient criteria); evaluates effect of single discharge on coves, backwaters, transition zones of reservoir.
  - Nutrient screening for streams and rivers; evaluates effect of single discharge on stream or river.
- Added tables of reservoir-specific parameters to use in screening procedures.

Numeric Criteria Screening

- If main pool effects screening shows >10% change in mean total phosphorus (TP) **AND** the % change in chlorophyll *a* assimilative capacity is:
  - >20% → TP limit
  - 10 – 20% → TP reporting only
  - <10% → no TP limit or reporting
- Permits with final permitted flow volumes ≤0.25 MGD not screened for main pool effects.
- TP decay rate revised from 0.08 to 0.14 in response to stakeholder input.
- Screenings determine need for a nutrient limit but do not specify the limitation. Typical TP limits based on permitted flow are provided as general guidelines.
- As discharge size increases, or distance to reservoir decreases, the likelihood of a TP limit increases. Statistically, of the 308 discharge permits in the segments with proposed numeric nutrient criteria, 58 (19%) would need a TP limit if they were to come in new or with an amendment to increase flow.
- Industrial permits and domestic renewals will be reviewed on a case-by-case basis. Change made in response to stakeholder and EPA comments. Municipalities and water districts will be impacted the most and expressed concern that industrial discharges were not included in initial draft.
- Evaluation may be revised to be consistent with final rule revisions.

### Narrative Criteria Screening

- Performed to evaluate local effects in reservoirs and in streams/rivers against narrative standard.
- Screening factors (qualitative and/or quantitative) are assigned low, moderate, or high levels of concern with respect to eutrophication.
- Results of screening are assessed using a weight of evidence approach.

### **Whole Effluent Toxicity (WET)**

- **Reasonable Potential (RP) Determination:** Performed upon permit renewal or amendment using previous five year WET history.
  - If RP is determined, then permit will be issued with a WET limit effective following a 1 year investigative period and a 3 year compliance period.
  - RP determined for lethality when there are more than 2 failures in the past 3 yrs.
  - Final determination made considering factors outlined in the IPs based on BPJ.
  - EPA wants the TSD RP approach [one failure (or none) = RP] with flexibility on the back end of the final RP determination, where BPJ can remove test results.
  - Staff wanted the procedure to be defined, with explicit up-front flexibility for predictability.
  - Given the variability of WET tests and false-positive rate, staff concerned with one previous failure resulting in a WET limit, since multiple failures are needed to trigger the TRE.
  - Raised questions about the validity of the statistically derived TSD approach.
- **Sublethal WET Limits:**
  - EPA wants WET limits to apply for sublethal effects rather than just for lethal effects.
  - Previous drafts presented to stakeholders have included sublethal WET limits; however, this language has been removed from the current draft.
- **WET Testing Frequencies:**
  - Permittees demonstrating RP will receive WET limits and will not be eligible for the testing frequency reduction.
  - All permittees without existing WET limits for “other reasons” will now be eligible for the testing frequency reduction. Other reasons include discharge volume, existing water-quality based limit, or pretreatment program.
- **Removal of WET Limits:**
  - Automatically during the compliance period based on no additional demonstrations of significant toxicity; or
  - By major amendment after the limit has become effective and with no demonstrations of toxicity in the previous three years.



- **Enforcement of WET Limits:**
  - Initial failure results in increased testing frequency but without NOV issuance. A Notice of Enforcement (NOE) will be made if another failure occurs during the period of increased testing.

## **Toxic Pollutants**

- Require more domestic discharges to dechlorinate (new and expanding discharges with 0.5 or more million gallons per day, rather than the existing 1.0 MGD or greater).
  - EPA commented that renewals should also be subject to dechlorination requirement. They may also want us to use a lower flow cutoff.
  - No changes made in response to EPA comment.
- Added procedure for converting fish-tissue criteria to water column criteria.
  - For mercury, PCBs, dioxins/furans.
  - No opposition from stakeholders.
- Revised list of approved test methods and updated minimum analytical levels (MALs) to be consistent with EPA published methods. Many MALs became more stringent, and stakeholders commented that in many cases the more stringent MALs were well below permit limits, and other methods/MALs would be adequate and less expensive.
  - Added clarification of MAL requirements based on stakeholder comments.
  - Additional stakeholder comments possible, but not expected.

## **Recreational Uses and Bacteria**

- Added section on recreational uses and criteria, consistent with Standards revisions.
- Added section on implementing revised bacteria criteria in wastewater permits.
  - Consistent with Standards revisions.
  - Rulemaking underway for bacteria limits in domestic discharge permits.
- Added a section on recreational use-attainability analyses.

## **Other Changes of Note**

- Established alternate method of calculating critical low-flow for streams and rivers that are dominated by springflow (consistent with rule revision).
- Updated process for use-attainability analyses.
- Extensively updated appendices and data tables that are used to evaluate discharge permits.

# Procedures to Implement the Texas Surface Water Quality Standards

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Prepared by  
Water Quality Division

RG-194  
December 2009



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# Abbreviations

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[moved from Appendix A]

Abbreviation	Full Name
ACR	acute-to-chronic ratio
<u>AU</u>	<u>assessment unit</u>
BAF	bioaccumulation factor
BAT	best available technology
BCF	bioconcentration factor
BMP	best management practice
BOD	biochemical oxygen demand
<u>BPJ</u>	<u>best professional judgement</u>
<u>CASRN</u>	<u>Chemical Abstracts Service Registry Number</u>
CBOD	carbonaceous biochemical oxygen demand
CFR	Code of Federal Regulations
<u>CIU</u>	<u>categorical industrial user</u>
CPP	Continuing Planning Process
<del>CRDL</del>	<del>contract required detection limit</del>
<del>CRP</del>	<del>Clean Rivers Program</del>
CRQL	contract required quantitation level
<del>CS</del>	<del>chemical specific</del>
<del>CSTR</del>	<del>Continuously Stirred Tank Reactor</del>
CV	coefficient of variation
CWA	Clean Water Act
DO	dissolved oxygen
EPA	Environmental Protection Agency
FR	Federal Register
<u>GIS</u>	<u>geographic information system</u>
<u>HM</u>	<u>harmonic mean flow</u>
HUC	hydrological unit code
<u>IBWC</u>	<u>International Boundary and Water Commission</u>
<u>IU</u>	<u>industrial user</u>
LTA	long-term average
MAL	minimum analytical level
MCL	maximum contaminant level
MDL	method detection limit

<b>Abbreviation</b>	<b>Full Name</b>
MGD	million gallons per day
<u>ML</u>	<u>minimum level</u>
MOA	<del>m</del> Memorandum of <del>a</del> Agreement
MQL	minimum quantitation level
MS4	municipal separate storm sewer system
MSDS	material safety data sheet
MZ	mixing zone
<u>NCR</u>	<u>noncontact recreation</u>
NH <sub>3</sub> -N	ammonia-nitrogen
<u>NOE</u>	<u>Notice of Enforcement</u>
NOEC	<del>N</del> o <del>O</del> bservable <del>E</del> ffects <del>C</del> oncentration
<del>NOV</del>	<del>Notice of Violation</del>
NPDES	National Pollutant Discharge Elimination System
<u>1Q2</u>	<u>one-day, two-year low-flow</u>
ONRW	outstanding national resource water
<u>PCR</u>	<u>primary contact recreation</u>
<del>PEP</del>	<del>public education program</del>
<u>PMSD</u>	<u>percent minimum significant difference</u>
<del>POTW</del>	<del>publicly owned treatment works</del>
<u>QSAR</u>	<u>quantitative structure-activity relationship</u>
<u>RP</u>	<u>reasonable potential</u>
RWA	receiving water assessment
<u>SCR</u>	<u>secondary contact recreation</u>
7Q2	seven-day, two-year low-flow
<u>SIU</u>	<u>significant industrial user</u>
<u>SM</u>	<u>Standard Methods</u>
SMAV	species mean acute value
<del>SMCL</del>	<del>secondary maximum contaminant level</del>
SOD	sediment oxygen demand
<u>SPIF</u>	<u>supplemental permit information form</u>
<u>SWMP</u>	<u>storm water management plan</u>
SWP3	storm water pollution prevention plan
SWQM	Surface Water Quality Monitoring
<u>SWQMIS</u>	<u>Surface Water Quality Monitoring Information System</u>
TAC	Texas Administrative Code
<u>TBD</u>	<u>to be determined</u>

<b>Abbreviation</b>	<b>Full Name</b>
<u>TCEQ</u>	<u>Texas Commission on Environmental Quality</u>
TDS	total dissolved solids
TEAC	Texas Environmental Advisory Council
TEF	toxicity equivalency factor
TEQ	toxicity equivalence
TIE	toxicity identification evaluation
TMDL	total maximum daily load
<u>TN</u>	<u>total nitrogen</u>
TNRCC	Texas Natural Resource Conservation Commission
<u>TP</u>	<u>total phosphorus</u>
TPDES	Texas Pollut <del>ion</del> Discharge Elimination System
<u>TPWD</u>	<u>Texas Parks and Wildlife Department</u>
TRE	toxicity reduction evaluation
TSS	total suspended solids
<del>TSWQS</del>	<del>Texas Surface Water Quality Standards</del>
<u>TWDB</u>	<u>Texas Water Development Board</u>
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
<del>WQBEL</del>	<del>water quality based effluent limit</del>
WQMP	Water Quality Management Plan
ZID	zone of initial dilution

# Preface

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On September 1, 2002, a change took effect in the name of our agency: the Texas Natural Resource Conservation Commission (TNRCC) became the Texas Commission on Environmental Quality (TCEQ). The text of this document had been completed well before the changeover date, but final approval to print the publication and post the final version on the Internet was not received until January 2003. So, the previous name of the agency, as it appears in the text of this document, should be understood to refer to the TCEQ.

Although our Web address will also change to reflect our new name, it will take some time for each page on our site to be moved. In the meantime, be sure to follow this procedure for finding pages mentioned in this publication:

1. Enter the URL exactly as shown in the text—for example, **[www.tnrcc.state.tx.us/permitting/waterperm/wqstand/](http://www.tnrcc.state.tx.us/permitting/waterperm/wqstand/)**
2. If the page has not yet been moved, it will appear directly. Continue to use this URL for the time being.
3. If the page has already been moved, you should first see a “redirect page,” which will tell you the new URL for this information. Update your bookmarks accordingly and continue to use the new URL.
4. If you get a “file not found” message, go to our home page (**[www.tceq.state.tx.us](http://www.tceq.state.tx.us)**) and use the Site Search or Subject Index at the upper right of the page to look for topics that are relevant to the information you need.



# Introduction

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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.<sup>1</sup>

The TCEQ applies these ~~Texas Surface Water Quality Standards (TSWQS)~~ 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 ~~water quality 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; ~~it should~~ and not be interpreted as a replacement to the rules.

***Document approval process.*** This document was ~~approved~~ adopted by the TCEQ on ~~August 23, 2002~~ [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 ~~November 22, 2002~~ [new date], EPA ~~conditionally approved this document with the exception of two specific permitting issues. These items have been footnoted in the text. In addition, the approval letter indicated that some portions of this document may be included in EPA's consultation with the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act on the new and revised provisions of the Standards.~~

For more information concerning revisions to the Standards and to this document, visit the Texas Surface Water Quality Standards page (~~[www.tnec.state.tx.us/permitting/waterperm/wqstand/](http://www.tnec.state.tx.us/permitting/waterperm/wqstand/)~~)

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<sup>1</sup> On ~~July 26, 2000~~ [new date], the TCEQ adopted the most recent revision to Chapter 307, Texas Surface Water Quality Standards (TSWQS).



([www.tceq.state.tx.us/nav/eq/eq\\_swqs.html](http://www.tceq.state.tx.us/nav/eq/eq_swqs.html)) and follow the link “Revisions to the Texas Surface Water Quality Standards and Implementation Procedures.” “Future Revisions of the Texas Surface Water Quality Standards.”

***The ~~a~~Application review process.*** The TCEQ believes that a consistent approach to application review is important. A permit applicant may provide information throughout the technical review period 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 and revision through the public hearing process. Case-by-case permitting decisions are 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.

***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](http://www.tceq.state.tx.us/implementation/water/planning/CPPMain.html)). ~~Surface and Ground Water Quality page ([www.tnrec.state.tx.us/water/quality/](http://www.tnrec.state.tx.us/water/quality/))~~ and follow the link “Standards and Planning” and then “Continuing Planning Process.”

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

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.

***Same agency, new name.*** On September 1, 2002, a change took effect in the name of our agency: the Texas Natural Resource Conservation Commission (TNRCC) became the Texas Commission on Environmental Quality (TCEQ). The text of this document had been completed well before the changeover date, but final approval to print the publication and post the final version on the Internet was not received until some time afterwards. So, the previous name of the agency, as it appears in the text of this document, should be understood to refer to the TCEQ.

# Determining Water Quality Uses and Criteria

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## Designated and Presumed Uses

### ~~Classified Waters~~

~~The designated uses and associated criteria for classified segments in 30 TAC §307.10 Appendix A are normally used to evaluate permit applications. Seven day, two year low flows (7Q2s) for each segment are published in 30 TAC §307.10 Appendix B. However, a site-specific 7Q2 unique to a discharge location within a segment may be used to calculate discharge limits if appropriate.~~

### 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 with specific uses and criteria in Appendix A or D of 30 TAC §307.10 of the Standards TSWQS. Certain unclassified water bodies are listed in Appendix D of the Standards. These are water bodies for which 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 section 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 section 307.4(j) of the Standards. A general contact recreation use is presumed for all

unclassified waters. [Comment: part of this paragraph was moved here from the end of the section.]

## **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	<u>Minimal</u>
DISSOLVED OXYGEN CRITERIA (mg/L)	Freshwater mean/minimum	6.0/4.0	5.0/3.0	4.0/3.0	3.0/2.0	<u>2.0/1.5</u>
	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 section 307.7(b)(3)(A) of the Standards.

[Comment – this table was moved from Appendix C and reformatted in portrait orientation.]

## **Perennial Waters**

As stated in section 30 TAC §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 ~~(see Table 1 in Appendix C of this document)~~. ~~In accordance with results from statewide ecoregion studies, unclassified perennial streams in the eastern and southern portions of Texas (shown as~~

area “A” on Figure 1, page 6) are assigned dissolved oxygen criteria as described in 30 TAC §307.7(b)(3)(A)(ii) and in the section of this document entitled “Eastern and Southern Portions of the State” on page 10. 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-  
Where flow records are available, a stream with
- a seven-day, two-year low-flow (7Q2) flow less than 0.1 ft<sup>3</sup>/s (where  
flow records are available) is considered intermittent.

According to section 30 TAC §307.4(h)(4) of the Standards, intermittent,  
unclassified intermittent streams that are not specifically listed in  
Appendix A or D of 30 TAC §307.10 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 significant aquatic life uses created  
by perennial pools are presumed to have a limited aquatic life use and  
corresponding dissolved oxygen criterion (see Table 1 in Appendix C of  
this document). Higher uses will be maintained where they are attainable.  
At this time, determination of what constitutes a seasonal aquatic life use;  
a significant aquatic life use, and perennial pool designation is done on a  
case-by-case basis using available data and best professional judgement.  
The TCEQ will continue to develop improved procedures to address the  
issues of seasonal aquatic life use, significant aquatic life use, and  
perennial pools.

### ***Playa Lakes***

The applicability of the Standards and the concomitant appropriate aquatic  
life use designation for playa lakes is discussed in the Playa Lake Policy  
Statement that was signed by the TNRCC's agency's executive director on  
October 20, 1997 (see Appendix BA on page 212 of this document).  
In addition to aquatic life uses, unclassified waters can be assigned uses  
for contact 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. A general contact recreation use is

~~presumed for all unclassified waters.~~ [Comment – this paragraph was moved up into the first paragraph of this section.]

## **Assessment and Review of Uses**

### **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 75.)

Staff use 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. In some cases, 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. ~~Uses and associated criteria for classified waters are normally assumed as stated in 30 TAC §307.10 Appendices A and D.~~

**Table 2. Estimated Extent of Downstream DO Impact from Discharge**

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

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 section 307.4(l) of the Standards). ~~Implementing 30 TAC §307.4(h) (concerning~~

~~aquatic life uses and dissolved oxygen) and §307.4(l) (concerning assessment of unclassified waters) requires that appropriate uses be determined for unclassified waters that are affected by permit renewals, permit amendments, and new permit applications. Assignments of aquatic life use categories are based on characteristics shown in Table 1 on page 5. Please note the following: The assigned uses and associated criteria are used in water quality simulations to determine the effluent limits needed to protect the uses. The criteria for assessing aquatic life use categories are based on categorical characteristics in 30 TAC §307.7(b)(3)(A), which are summarized in Table 1 in Appendix C of this document.~~

- 
- ~~Site-specific modification of the aquatic life criteria in 30 TAC §307.7(b)(3)(A) (summarized in Table 1 of this document) 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 192).~~
  - ~~The attribute characteristics in 30 TAC §307.7(b)(3)(A) (summarized in Table 1 of this document) will be further clarified, modified, and “calibrated” as more region-specific data become available. [Comment: these two bullets were moved up from farther down in this section.]~~

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 evaluate 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 ~~s~~Standards for unclassified streams may be inappropriate, additional data may be obtained by the TCEQ or the applicant in the form of a “receiving water assessment (RWA).”<sup>2</sup> Guidelines for collecting the additional data and evaluating aquatic life uses for ~~receiving water assessments~~ RWAs are described in the most recent versions of the TNRCC Receiving Water Assessment Procedures Manual, GI-253, June 1999 TCEQ’s Surface Water Quality Monitoring Procedures, RG-415 and RG-416 or the most recent revision. These ~~is~~ documents ~~are~~ is available upon request from TCEQ’s Water Quality Standards Team; or, on the agency’s Web site ([www.tceq.state.tx.us](http://www.tceq.state.tx.us)); follow the link for “Publications.”  
Considerations for TCEQ staff consider hydrological conditions, appropriate assessment location, and applicability when determining the aquatic life uses categories include the following: for water bodies that

receive or may receive a permitted wastewater discharge.

- TCEQ staff determine aquatic life use determinations are estimated 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 seasonal hydrological conditions other than critical conditions. Permit limits for pertinent parameters are established as necessary to protect seasonal uses in both intermittent and perennial streams.

- TCEQ staff determine 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 primary assessments of physical, hydrological, chemical, and biological conditions emphasize the area upstream of and/or in an area unaffected by an existing discharge. Staff will also consider differences in stream morphometry downstream of the discharge are also taken into account in when determining appropriate aquatic life uses.

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

- Site-specific modification of the aquatic life criteria in 30 TAC §307.7(b)(3)(A) (summarized in Table 1 of this document) 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 133). [Comment: this bulleted item was moved to the second paragraph of this section.]

- The aquatic life attributes in 30 TAC §307.7(b)(3)(A) (summarized in Table 1 of this document) are used to assign aquatic life use categories. For freshwater streams, the aquatic life use attributes are evaluated primarily from the use of an index of biotic integrity as described in the *TNRCC Receiving Water Assessment Procedures Manual*, GI-253, June 1999 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 or the most recent revision. Other water body types are evaluated on a case-by-case basis.

- The attribute characteristics in 30 TAC §307.7(b)(3)(A) (summarized in Table 1 of this document) will be further clarified, modified, and “calibrated” as more region-specific data become available. [Comment: this bulleted item was moved into the second paragraph of this section.]

- The ~~instream~~ 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 ~~perennial~~ waters with sufficient information obtained under these procedures will be considered for ~~classification~~ 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 196).

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. [Comment: Figure 1 has been moved to the chapter “Modeling Dissolved Oxygen” and renumbered as Figure 3.]





# Evaluating Impacts on Water Quality

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## 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 3). **[Comment: this sentence was moved up from lower down on this page.]**

~~In order to determine impacts from baseline conditions,~~ 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 45.

The impact of discharges on endangered and threatened species is considered in accordance with the ~~m~~Memorandum of ~~a~~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 12.

Waste load evaluation (~~WLE~~) 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 75). **[Comment: this paragraph was moved down from farther up on this page.]**

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. **[Comment: the section “Eastern and Southern Portions of the State” has been moved to the chapter “Modeling Dissolved**

## Minimum and Seasonal Criteria for Dissolved Oxygen

Instantaneous minimum dissolved oxygen criteria (from Table 1 of this document—see page 5) 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 ~~low-flow~~ conditions in a particular month or season. For more detailed information, see the discussion on critical conditions used in modeling on page 77 of the “Modeling Dissolved Oxygen” chapter. ~~Procedures for establishing mixing zones for dissolved oxygen considerations are identical to the mixing zone procedures described in the chapter of this document entitled “Mixing Zones and Critical Conditions” (see page 61), in accordance with 30 TAC 307.8(b)(1).~~

## 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 ~~Memorandum of Agreement (MOA)~~ between the TCEQ and the EPA concerning the TPDES program, available on the agency’s Web site (www.tceq.state.tx.us)<sup>2</sup>
- the USFWS biological opinion (dated September 14, 1998) associated with assumption of the TPDES program by the State of Texas; ~~available on the agency's Web site (www.tceq.state.tx.us)~~
- 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

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<sup>2</sup> 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”

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.

## **Screening Process**

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

1. The first classified segment that the discharge ~~either directly or eventually~~ enters is determined.
2. The list of segments in ~~Table 3~~ Appendix B on page 214 (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, ~~which is mailed after the permit is drafted~~.
5. TCEQ staff perform 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 ~~of~~to adversely affecting 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. 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 ~~324 in Appendix C of this document~~ 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 34. Segments that Cross the Contributing and Recharge Zones of the Southern Section of the Edwards Aquifer**

**[Comment – moved from Appendix C.]**

Segment Number	Segment Name
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

Segment Number	Segment Name
1816	Johnson Creek
1817	North Fork Guadalupe River
1818	South Fork Guadalupe River
1903	Medina River Below Medina Diversion Lake
1904	Medina Lake
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**

<u>Use</u>	<u>Geometric Mean (colonies/100 ml)</u>	<u>Single Sample (colonies/100 ml)</u>
<u>PCR</u>	<u>206</u>	<u>399</u>
<u>SCR 1</u>	<u>630</u>	<u>=</u>
<u>SCR 2</u>	<u>1,030</u>	<u>=</u>
<u>NCR</u>	<u>2,060</u>	<u>=</u>

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

#### **Enterococci Criteria for Saltwater**

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<u>Use</u>	<u>Geometric Mean (colonies/100 ml)</u>	<u>Single Sample (colonies/100 ml)</u>
<u>PCR</u>	<u>35</u>	<u>104</u>
<u>SCR1</u>	<u>175</u>	<u>=</u>
<u>NCR</u>	<u>350</u>	<u>=</u>

Enterococci criteria have been established as follows for certain high saline inland water bodies in Appendix A of the Standards and in the unclassified water bodies that are within the watershed of those classified segments.

**Enterococci Criteria for High Saline Inland Water Bodies**

<u>Use</u>	<u>Geometric Mean (colonies/100 ml)</u>	<u>Single Sample (colonies/100 ml)</u>
<u>PCR</u>	<u>54</u>	<u>78</u>
<u>SCR 1</u>	<u>165</u>	<u>=</u>
<u>SCR 2</u>	<u>270</u>	<u>=</u>
<u>NCR</u>	<u>540</u>	<u>=</u>

Fecal coliform may still be used as an alternate bacterial indicator of recreational suitability in these same high saline inland water bodies during the two-year transition period to Enterococci to allow time for sufficient Enterococci data to be collected. Fecal coliform criteria apply as shown in the following table.

**Fecal Coliform Criteria for High Saline Inland Water Bodies During Transition Period**

<u>Use</u>	<u>Geometric Mean (colonies/100 ml)</u>	<u>Single Sample (colonies/100 ml)</u>
<u>PCR</u>	<u>200</u>	<u>400</u>
<u>SCR 1</u>	<u>1,000</u>	<u>=</u>
<u>SCR 2</u>	<u>2,000</u>	<u>=</u>

**Wastewater Permitting**

Wastewater discharge permits with effluent limits or monitoring requirements for bacteria are designed to protect for the applicable indicator bacteria as provided by the numeric criteria for **primary contact recreation** established in the Standards. Any rules that are approved in the future regarding bacteria limits in wastewater permits will supersede the provisions in this section. The applicable indicator bacteria is assigned based on the type of water body as follows:

**Freshwater**—*E. coli* is used as the indicator bacteria in effluent limits for wastewater discharges into freshwater.

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

**High Saline Inland Water Bodies**—Enterococci is used as the indicator bacteria in effluent limits for wastewater discharges into or within the watershed of any classified segment in Appendix A of the Standards where Enterococci is the designated recreational indicator.

## **Non-Human Sources of Bacteria**

In situations where sanitary surveys, bacteria source tracking, use-attainability analyses, or similar studies demonstrate that wildlife sources of bacteria are unavoidably high (such as 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.

## **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 (section 307.4)
- Antidegradation provisions of the Standards (section 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 45.) 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**

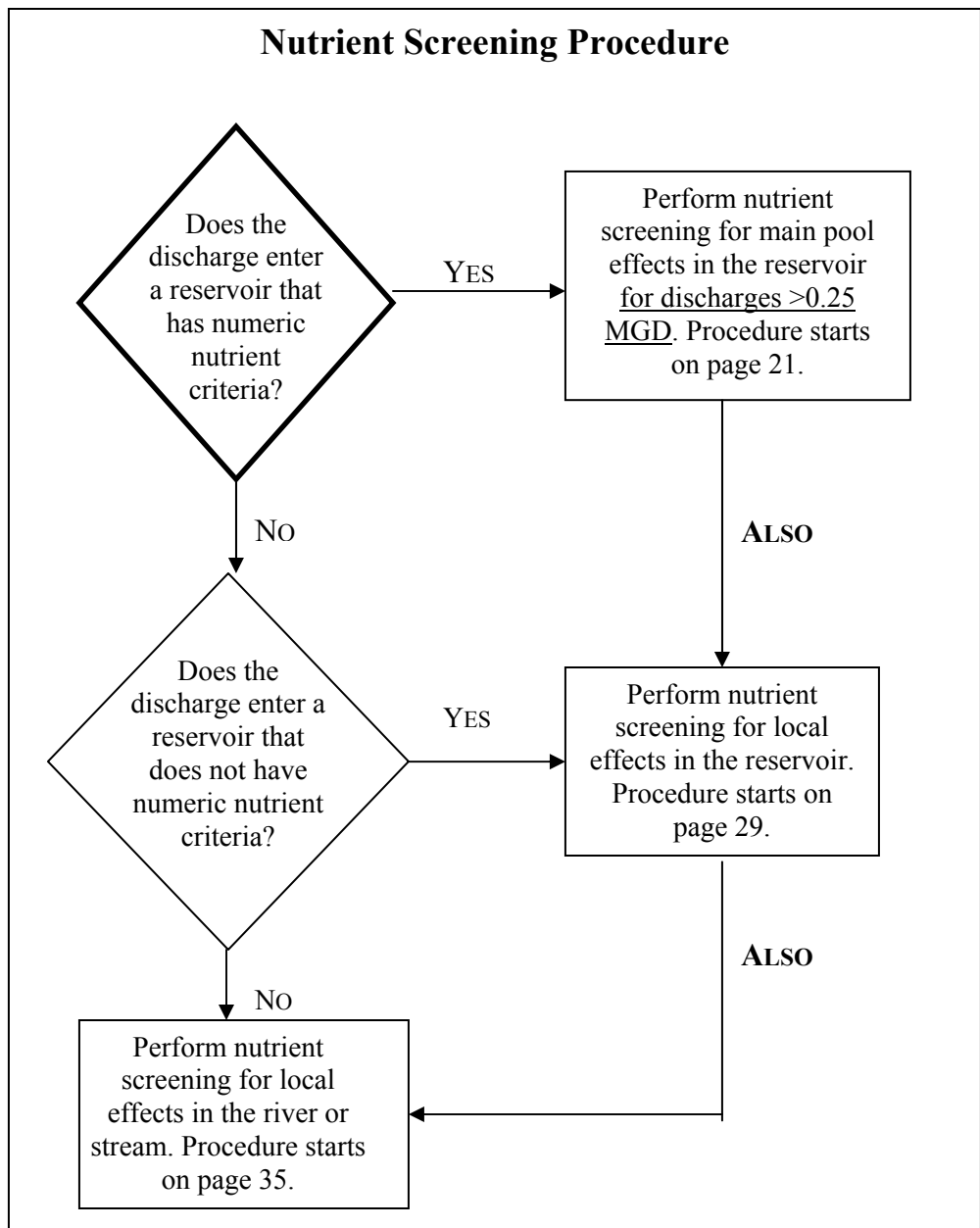
The following general procedure is also shown by flow chart in Figure 1 on page 19. Discharges >0.25 MGD into or near a reservoir that has been assigned numerical nutrient criteria in the Standards are first screened to evaluate main pool effects. Additional screening is performed regardless of flow 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 21.



**Figure 1. Flow chart showing the nutrient screening procedure.**

**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 29 and “Nutrient Screening in Streams and

Rivers” on page 35.

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.

### **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:

<b><u>Permitted Flow (MGD)</u></b>	<b><u>Typical TP Limit (mg/L)</u></b>
<u>&lt; 0.5</u>	<u>1.0</u>
<u>0.5 – 3.0</u>	<u>1.0 to 0.5</u>
<u>&gt; 3.0</u>	<u>0.5</u>

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 rule (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 47)
- 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 extraordinary 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. Supplemental screening levels for TP and for transparency in reservoirs have been similarly established (see Appendix F of the Standards).

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 reservoir:

<u>Permitted flow (MGD)</u>	<u>Distance from reservoir (stream miles)</u>
<u>&gt;0.25 – &lt; 1</u>	<u>≤ 5</u>
<u>1 – 3</u>	<u>≤ 10</u>
<u>&gt; 3</u>	<u>≤ 20*</u>

\* 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.<sup>3</sup>

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 25.

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

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

<sup>3</sup> 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.

- $k_p =$  TP decay rate at an assumed annual mean temperature of 20°C. 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·s)<sup>1/2</sup> and conversion factor of 86,400 s/day (s<sup>1/2</sup>/(m<sup>1/2</sup>·day))
- $Q_T =$  permitted discharge flow **plus** harmonic mean flow upstream of the discharge (m<sup>3</sup>/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 ( $\text{g}/\text{m}^2\cdot\text{yr}$ )  
 $TP_L$  = annual average loading of TP in the entire reservoir due to the discharge ( $\text{g}/\text{yr}$ ), 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 ( $\text{mg}/\text{L}$ )  
 $w'$  = TP areal loading rate ( $\text{g}/\text{m}^2\cdot\text{yr}$ ), calculated using Equation 4  
 $v_s$  = settling velocity ( $\text{m}/\text{yr}$ ). For TP, assume 13  $\text{m}/\text{yr}$   
 $z$  = mean depth (ft), see Appendix F, Table F-2 (divide volume by surface area to get mean depth)  
 $\tau$  = 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:** 
$$\% \text{ change} = \frac{100 \times TP_R}{TP_A}$$

where:  $\% \text{ change}$  = 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 ( $\text{mg}/\text{L}$ ), 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 percent 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!

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

(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.

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

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

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

(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.)

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

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

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

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

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

Chlorophyll *a* screening is necessary based on the TP screening. This example is continued with chlorophyll *a* calculations on page 30, local effects screening for Somerville Lake on page 35, and local effects screening for South Yegua Creek on page 42.

**Estimating Change in Chlorophyll *a***

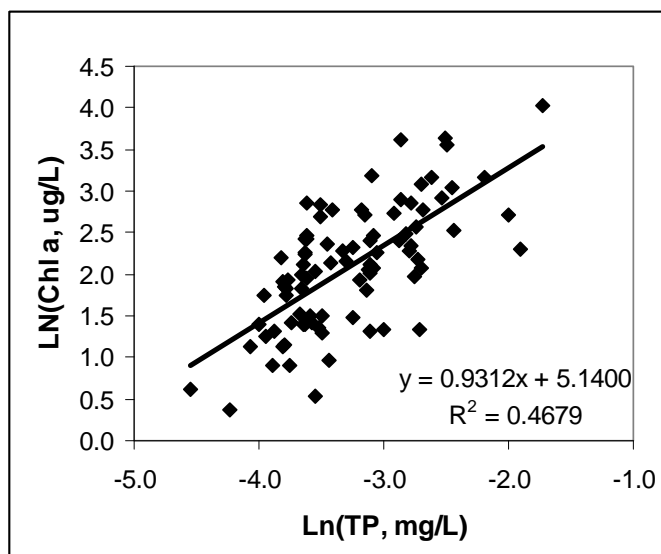
If the projected change in TP over the entire reservoir is greater than 10%,



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<sup>4</sup> for Texas reservoirs, as shown in Figure 2 and Equation 7 below:

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



**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.

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

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

The potential change in chlorophyll *a* in the entire reservoir is then

<sup>4</sup> 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.

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 ( $\mu\text{g/L}$ )  
 $Chl_{AR}$  = chlorophyll *a* ( $\mu\text{g/L}$ ) predicted in the reservoir due to the discharge at permitted flow, calculated using Equation 8a  
 $Chl_{AP}$  = chlorophyll *a* ( $\mu\text{g/L}$ ) 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:** 
$$\% \text{ change} = \frac{100 [Chl_R]}{Chl_C - Chl_A}$$

where:  $\% \text{ change}$  = 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 ( $\text{mg/L}$ ), 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 20) 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 25. 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.

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

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

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

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

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

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

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

**Final Assessment:** A limit on TP is unlikely to be recommended based on this screening. However, TP monitoring is likely to be recommended. This example is continued with local effects screening for Somerville Lake on page 35 and for South Yegua Creek on page 42.

## **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 35). Evaluations are conducted for the following permitted discharge sizes within the listed distance from the reservoir:

<b><u>Permitted flow (MGD)</u></b>	<b><u>Evaluation Distance (stream miles)</u></b>
<u>&lt; 0.25</u>	<u>≤ 5</u>
<u>0.25 to &lt; 1.0</u>	<u>≤ 10</u>
<u>≥ 1.0*</u>	<u>≤ 20</u>

\* 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 21).

### **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
- where explicitly required by watershed rules or other specific

regulatory requirements.

Smaller proposed discharges (such as those between 0.1 to 0.25 MGD) can also be of concern and 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. sensitivity to nutrient enrichment—chlorophyll *a* to TP ratio
- G. consistency with similar permits
- H. local dispersion and mixing
- I. impact on the main pool of the reservoir
- J. 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.

<b><u>Level of Concern</u></b>	<b><u>Permitted Flow (MGD)</u></b>
<u>Low</u>	<u>&lt; 0.25</u>
<u>Moderate</u>	<u>0.25 to &lt; 1.0</u>
<u>High</u>	<u>≥ 1.0</u>

#### **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.

<b><u>Size of Discharge (MGD)</u></b>	<b><u>Level of Concern (stream miles)</u></b>		
	<b><u>Low</u></b>	<b><u>Moderate</u></b>	<b><u>High</u></b>

<u>&lt; 0.25</u>	<u>&gt; 3</u>	<u>3 to &gt; 1</u>	<u>≤ 1</u>
<u>0.25 to &lt; 1.0</u>	<u>&gt; 7</u>	<u>7 to &gt; 3</u>	<u>≤ 3</u>
<u>≥ 1.0*</u>	<u>&gt; 15</u>	<u>15 to &gt; 7</u>	<u>≤ 7</u>

\* 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.

<b><u>Level of Concern</u></b>	<b><u>Discharge Environment</u></b>
<u>Low</u>	<u>Turbid from suspended particles or color (tannins)</u>
<u>Moderate</u>	<u>Some visible turbidity but without heavy murkiness</u>
<u>High</u>	<u>A “clear water” reservoir with high transparency</u>

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:

<b><u>Level of Concern</u></b>	<b><u>Secchi (m)*</u></b>
<u>Low</u>	<u>≤ 0.75</u>
<u>Moderate</u>	<u>0.76 to 1.27</u>
<u>High</u>	<u>≥ 1.28</u>

\* 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:

<b><u>Level of Concern</u></b>	<b><u>Observed Aquatic Vegetation</u></b>
<u>Low</u>	<u>Little attached, floating, or suspended aquatic vegetation</u>
<u>Moderate</u>	<u>Limited patches of attached, floating, or suspended vegetation</u>

<u>Level of Concern</u>	<u>Observed Aquatic Vegetation</u>
<u>High</u>	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.

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

**F. SENSITIVITY TO NUTRIENT ENRICHMENT – CHLOROPHYLL *a* TO TP RATIO**

The relative effect of TP on algal growth in a reservoir is estimated by the ratio of chlorophyll *a* to TP. Higher ratios indicate a potentially higher sensitivity to TP additions. Using long-term mean concentrations of chlorophyll *a* and TP (both in mg/L) in the main pool of the reservoir (see Table F-1 in App. F), the following ratio is calculated for Texas reservoirs<sup>5</sup>:

$$\frac{\text{Ratio} = -0.01 \ln[\text{Chl } a \text{ (mg/L)}]}{\text{TP (mg/L)}}$$

Levels of concern based on this ratio are as follows:

<u>Level of Concern</u>	<u>-0.01 ln Chl <i>a</i> (mg/L) :TP (mg/L)</u>
<u>Low</u>	<u>≤ 1</u>
<u>Moderate</u>	<u>1 to 1.5</u>
<u>High</u>	<u>≥ 1.5</u>

**G. 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.

<sup>5</sup> Glenn C. Clingenpeel. Trinity River Authority of Texas. Letter to the TCEQ dated January 21, 2009.

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

## **H. 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 ( $\Delta$ TP).

*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 into narrow, slow moving areas of a reservoir, whether riverine transition zones or wetlands, are of high concern.

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

*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 ( $\Delta$ TP) that will be added by the discharge at permitted flow. A steady-state, completely-mixed model is used to determine  $\Delta$ TP as described in the section entitled “Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria” on page 21.

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  $\Delta$ TP 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 21.

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

<u>Level of Concern</u>	<u>Predicted <math>\Delta</math>TP (mg/L)</u>
<u>Low</u>	<u>&lt; 0.05</u>
<u>Moderate</u>	<u>0.05 to &lt; 0.25</u>
<u>High</u>	<u><math>\geq</math> 0.25</u>

**I. 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
- 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  $\Delta$ TP in the main pool, as described in the section entitled “Nutrient Screening for Main Pool Effects in Reservoirs with Numerical Nutrient Criteria” on page 21. (Note that  $\Delta$ TP 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:

<u>Level of Concern</u>	<u>Predicted ΔTP (mg/L)</u>
<u>Low</u>	<u>&lt; 0.0001</u>
<u>Moderate</u>	<u>0.0001 to &lt; 0.001</u>
<u>High</u>	<u>≥ 0.001</u>

**J. 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.

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

**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

**Example of local effects screening for a reservoir:**

This example is a continuation of the scenario presented on page 25. 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. Sensitivity to nutrient enrichment – chlorophyll *a* to TP ratio:**

0.41 – low

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

**H. 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.

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

**J. 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.

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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.

## **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:

<b><u>Permitted flow (MGD)</u></b>	<b><u>Evaluation Distance (stream miles)</u></b>
<u>&lt; 0.25</u>	<u>&lt; 3</u>
<u>0.25 to &lt; 1.0</u>	<u>&lt; 7</u>
<u>≥ 1.0*</u>	<u>&lt; 15</u>

\* 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  $\geq$  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  $\geq$  0.25 MGD to streams with long, shallow, relatively clear perennial impoundments
- 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 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.

<u>Level of Concern</u>	<u>Permitted Flow (MGD)</u>
<u>Low</u>	<u>&lt; 0.25</u>
<u>Moderate</u>	<u>0.25 to &lt; 1.0</u>
<u>High</u>	<u>≥ 1.0</u>

### **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.

<u>Level of Concern</u>	<u>Percent Effluent</u>
<u>Low</u>	<u>&lt; 10</u>
<u>Moderate</u>	<u>10 to &lt; 25</u>
<u>High</u>	<u>≥ 25</u>

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.

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

### **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:

<u>Level of Concern</u>	<u>Depth Characteristics</u>
<u>Low</u>	<u>Relatively steep banks and deep channels across stream</u>
<u>Moderate</u>	<u>Gently sloping sides with some shallow areas</u>

<u>Level of Concern</u>	<u>Depth Characteristics</u>
<u>High</u>	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.

<u>Level of Concern</u>	<u>Discharge Environment</u>
<u>Low</u>	Turbid from suspended particles or color (tannins), bottom may not be visible
<u>Moderate</u>	Some visible turbidity but without heavy murkiness, bottom sometimes visible
<u>High</u>	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:

<u>Level of Concern</u>	<u>Observed Aquatic Vegetation</u>
<u>Low</u>	Little attached, floating, or suspended aquatic vegetation
<u>Moderate</u>	Limited patches of attached, floating, or suspended vegetation
<u>High</u>	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.

<u>Level of Concern</u>	<u>Canopy Cover and Shading During Warm Months</u>
<u>Low</u>	Extensive canopy cover shades most of stream surface
<u>Moderate</u>	Substantial canopy cover, but shading is only partial and not equivalent to "deep woods"
<u>High</u>	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.

<u>Level of Concern</u>	<u>Stream Type</u>
<u>Low</u>	<u>Intermittent</u>
<u>Moderate</u>	<u>Intermittent with perennial pools</u>
<u>High</u>	<u>Perennial</u>

### **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 29). The presence of smaller riverine impoundments and perennial pools can also increase the level of concern for eutrophication impacts.

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

### **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.

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

### **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.

<u>Level of Concern</u>	<u>Listed as a Concern for Nutrients or Aquatic Vegetation in Integrated Report?</u>
<u>Low</u>	<u>No concern for nutrients or aquatic vegetation in latest integrated report.</u>



<u>Level of Concern</u>	<u>Listed as a Concern for Nutrients or Aquatic Vegetation in Integrated Report?</u>
<u>Moderate</u>	<u>Concern for nutrients or aquatic vegetation in latest integrated report due to exceedance of the 85<sup>th</sup> percentile.</u>
<u>High</u>	<u>Concern for nutrients or aquatic vegetation in latest integrated report due to documented problem with one or both of these.</u>

### **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 and 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.

**Example of local effects screening for a river:**

This example is a continuation of the scenario presented on page 25. 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; however, access to the water is not easily attained - 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.

## 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](http://www.tceq.state.tx.us)); follow the link for “Rules.”

# Antidegradation

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## Policy

The antidegradation policy and framework for the antidegradation implementation procedures are specified in section 30 TAC §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 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 “~~Assessment and Review of Assigned Aquatic Life Uses~~” on page 6. Applicable uses, and the numerical and narrative criteria needed to support those uses, are established in the Standards 30 TAC §307. 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 ~~(TDS)~~
- 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 3, “Evaluating Impacts on Water Quality” on page 11, and “Toxic Pollutants” on page 128.

## Protecting Impaired Waters under Tier 1

The procedures in this section address proposed wastewater discharges to water bodies listed on the Clean Water Act Section 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~~the area 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
- 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 segments.

~~Permittees with existing discharges to water bodies on the 303(d) List will be required to monitor listed pollutants that are present in significant amounts in their effluent.<sup>6</sup>~~

## **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 75).

### ***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

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<sup>6</sup> This provision has not been approved by the EPA. According to the November 22, 2002 EPA letter approving this document, EPA will require permit limits if the listed pollutant is present in the effluent.

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 172). The current procedures preclude additional TDS loadings when they would cause further increases in ambient TDS concentrations that are already at or above standards. ~~ambient TDS concentrations in the area affected by the discharge are 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***

~~Effluent monitoring is required when relevant pollutants are present in the effluent, as determined by effluent screening for permit applications or other available information.<sup>7</sup>~~ 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.

~~If a listed pollutant is determined to be present in significant amounts in the~~

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<sup>7</sup> This provision has not been approved by the EPA. According to the November 22, 2002 EPA letter approving this document, EPA will require permit limits if the listed pollutant is present in the effluent.



~~effluent of an existing discharge, or if it is expected to be present in significant amounts in the effluent of a proposed discharge, then the permit will require effluent monitoring for that pollutant. The monitoring requirement applies even if no increase in loading of that pollutant is anticipated. For example, if a listed toxic pollutant is detected at or above the MAL, effluent monitoring for that toxic pollutant will be included in the permit.<sup>8</sup>~~

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 47. 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 188.

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 (POTWs) to listed water bodies where industrial users of the wastewater system contribute listed pollutants.

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<sup>8</sup> ~~This provision has not been approved by the EPA. According to the November 22, 2002 EPA letter approving this document, EPA will require permit limits if the listed pollutant is present in the effluent.~~

## **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.
- At some sites, water quality models might predict that an additional discharge of BOD from a highly treated effluent would have no adverse effect on instream dissolved oxygen. This additional load could be allowed if the model reasonably predicts that existing conditions of dissolved oxygen in the water body will not be adversely affected.

## **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 solidsTDS
- 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 ~~Surface~~-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 3, “Evaluating Impacts on Water Quality” on page 11, and “Toxic Pollutants” on page 128.

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 potential degradation but will receive further

evaluation.

### ***New Discharges***

~~Increases in loading~~ 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:

\_\_\_\_\_ current: 
$$\% \text{ change} = \frac{100[C_P - C_A]}{C_C}$$

\_\_\_\_\_ proposed: 
$$\% \text{ change} = \frac{100[C_P - C_A]}{C_C - C_A}$$

- where:     $\% \text{ change}$  = 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, ~~or~~ 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 17. 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 145 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” ~~or the effluent is disinfected~~
- 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-based effluent limit (WQBEL) 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 section 30 TAC §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 section 30 TAC §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 section 30 TAC §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	<u>Subchapter of 30 TAC 311</u>
0807	Lake Worth	<u>G</u>
0809	Eagle Mountain Reservoir	<u>G</u>
0811	Bridgeport Reservoir	<u>G</u>
0818	Cedar Creek Reservoir	<u>G</u>
0828	Lake Arlington	<u>G</u>
0830	Benbrook Lake	<u>G</u>
0836	Richland-Chambers Reservoir	<u>G</u>
1002	Lake Houston	<u>D</u>
1403	Lake Austin	<u>A</u>
1404	Lake Travis	<u>A</u>
1405	Marble Falls Lake	<u>F</u>
1406	Lake Lyndon B. Johnson	<u>F</u>
1407	Inks Lake	<u>B</u>
1408	Lake Buchanan	<u>B</u>
1427	Onion Creek	<u>E</u>
1428	Colorado River Below Town Lake/ <u>Lady Bird Lake</u>	<u>E</u>
<u>1434</u>	<u>Colorado River Above La Grange</u> <u>(portion above City of Smithville)</u>	<u>E</u>
2425	Clear Lake	<u>C</u>

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

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## 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 ~~permits~~ 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~~ ~~permits~~ (excepting ~~those~~ ~~discharges~~ that consist entirely of storm water runoff).

AThe 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”.

## 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 section 30 TAC §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 ~~maximum~~-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 ( $\geq$  400 feet across) are expressed in the permit as a ~~maximum~~-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 for acute and chronic numerical toxic criteria, as appropriate, using an effluent fraction that represents critical mixing conditions (see the section of this document entitled “Deriving Permit Limits for Aquatic Life Protection” on page 129). Theis 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 105).

### ***Intermittent Streams and Ditches***

For discharges into intermittent streams or ditches with no significant 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 stream within three miles, chronic toxic criteria apply at that perennial water body stream (see subsequent discussions below). For discharges into intermittent streams or ditches with limited, intermediate, high, or exceptional significant 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 dilution 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 67). In addition, acute toxic criteria apply at the edge of the ZID in the perennial water body using the effluent percentage dilution 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 dilutions:

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

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

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 129. For more information on how the 7Q2 is determined, see the section of this document entitled “Determining the 7Q2” on page 65.

### ***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 dilution, TCEQ uses the horizontal Jet Plume equation<sup>9</sup>:

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

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

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<sup>9</sup> 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.

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.

~~TCEQ staff may use d~~Data from appropriately performed effluent dispersion dye studies or effluent mixing models may be used to vary from the conservative initial dilution assumptions. ~~Effluent concentration limits for specific toxic materials are initially calculated 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. The estimated effluent concentration at the edge of the mixing zone is also used as the primary concentration for chronic whole effluent toxicity testing.~~

### ***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.

In the absence of site-specific data such as dispersion dye studies or nearby flow measurements, minimum effluent percentages ~~critical dilutions of 8% effluent~~ at the edge of the mixing zone and 30% ~~effluent~~ 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 ~~dilutions~~ 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 ~~30 TAC §307~~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 ~~or other bacteriological indicators~~
- 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 ~~CB~~ of this document ~~the Standards~~ lists 7Q2s for ~~classified~~designated stream segments (see page 222), but ~~the Standards~~ also allow the 7Q2 to be 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 USGS gage 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, ~~but are not limited to:~~ self-reporting data from upstream dischargers, Surface Water Quality Monitoring (SWQM) stations (including Clean Rivers Program targeted monitoring), or other data sources as available, ~~receiving water assessments (RWAs), intensive surveys, or Clean Rivers Program (CRP) targeted monitoring.~~ Estimates of the 7Q2 using this kind of data are generally based on the 10<sup>th</sup> percentile of the available flow data or on ~~comparisons ng flow measurements from the ungaged site~~ with a nearby USGS or IBWC gage.

In the absence of flow data, a drainage area ratio is used to estimate the 7Q2. ~~For this purpose, the 7Q2 is assumed to be directly proportional to drainage area.~~ 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<sup>10</sup>, the following equation is used to estimate the 7Q2:

current:

$$7Q2_d = \frac{7Q2_g}{DA_g} \times DA_d$$

proposed:

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

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

<sup>10</sup> 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.

a stream or river that is not dominated by springflow tends to be about a 10<sup>th</sup> percentile; the 7Q2 of a stream or river that is dominated by spring flow tends to be a 20<sup>th</sup> 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.
- for spring-fed streams that do not contain federally-listed endangered or threatened species (as listed in Appendix B of this document), the critical low-flow will be the 5<sup>th</sup> 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 dilution that occurs at the harmonic mean flow. The equation under “Perennial streams, ditches, and rivers” is used to calculate the human health effluent percentage dilution.

### ***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 percentagedilution that occurs at the harmonic mean flow. The following equation is used to calculate the human health effluent percentagedilution:

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

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 137. 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 71.

### **Lakes, and 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<sup>11</sup>:

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

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

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<sup>11</sup> 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.

zone is 4% for bays, estuaries, and wide tidal rivers.

~~At this distance, the assumed effluent dilution is 8% for discharges of less than or equal to 10 MGD. If it is necessary to assign a smaller human health mixing zone radius, this effluent percentage will increase. These effluent dilutions are based on the horizontal Jet Plume equation discussed in the section of this document entitled “Critical Conditions for Aquatic Life Protection” on page 40. 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.~~

~~The staff may use the results of Data from appropriately performed effluent dispersion dye studies or effluent mixing models may be used to vary from these conservative initial dilution assumptions.~~

~~***Bays, estuaries, and wide tidal rivers.*** 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. At this distance, the assumed effluent dilution is 4% for discharges of less than or equal to 10 MGD. If it is necessary to assign a smaller human health mixing zone radius, this effluent percentage will increase. These effluent dilutions are based on the horizontal Jet Plume equation discussed in the section of this document entitled “Critical Conditions for Aquatic Life Protection” on page 40.~~

~~TCEQ assigns an effluent percentage of 100% for discharges equal to or greater than 100 MGD. The staff may use the results of appropriately performed effluent dispersion dye studies or effluent mixing models to vary from these assumptions.~~

### ***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 dilution~~ of 4% ~~effluent~~ 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 dilution~~ 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 dilution~~. In these cases, the mixing zone radius is equal to the width of the river at the discharge point, and the effluent ~~percentage dilution~~ 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 ~~when instream flows are at or above the harmonic mean flow~~.

~~Many of the numerical water quality standards, as established in 30 TAC §307, do not apply when stream flow is less than the harmonic mean flow. The following criteria apply at and above the harmonic mean flow:~~

- ~~• Numerical toxic criteria to protect human health~~
- ~~• Numerical criteria for total dissolved solids, sulfate, and chloride.~~

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-B of this document ~~the Standards~~, but ~~the Standards also allow~~ the harmonic mean flow ~~to be~~ 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 ~~based effluent limits (WQBELs)~~ 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 on which 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 ~~any~~ flow data ~~at all~~, a drainage area ratio is used to estimate the harmonic mean flow. ~~For this purpose, the harmonic mean flow is assumed to be directly proportional to drainage area.~~ 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<sup>12</sup>, the following equation is used to estimate the harmonic mean flow:

current:

$$HM_d = \frac{HM_g}{DA_g} \times DA_d$$

proposed:

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

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~~ should be 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.

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<sup>12</sup> 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

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## General Information

Numerical criteria for dissolved oxygen correspond to specific aquatic life use categories as specified in Table 1 in ~~Appendix C~~ on page 5 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 ~~negatively affect~~ 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 ( $\text{NH}_3\text{-N}$ ), 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 ~~Appendix D~~ page 91). 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<sup>2</sup>-day.

These rates are expressed at a standard temperature of 20°C 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:

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

where:  $K_2$  = reaeration rate (day<sup>-1</sup>)  
 $V$  = 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 20°C, and the minimum value for this parameter is not allowed to go below the value calculated from the following equation:

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

where:  $K_{2\text{min}}$  = minimum allowable reaeration rate (day<sup>-1</sup>)  
 $D$  = 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 42 (see page 82) or Tables 4a-4e (see pages 88-91), as appropriate. If base flow information is not available to estimate the 7Q2, then a value of 0.1 ft<sup>3</sup>/s is usually assumed for perennial streams, and a value of 0.0 ft<sup>3</sup>/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 80. 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 84.

- 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 30.5°C unless critical low-flows reliably occur only at other temperatures. Alternative critical temperatures can be used if justifiable based on analysis of measured temperatures. ~~Ninetieth percentile monthly temperatures are considered appropriate for the development of seasonal permit limits.~~

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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).

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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 judgement. Near-field dilution models may be used to provide supplementary information.

#### ***Ponds***

Small impoundments such as ponds may be evaluated using a ~~Continuously Stirred Tank Reactor (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)
- 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 judgement. 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.

## **Eastern and Southern Portions of the State Critical Low-Flow Values for East and South Texas Streams**

[Comment – this section was moved from the chapter “Evaluating Impacts to Water Quality.”] As specified in section 30 TAC §307.7(b)(3)(A)(ii) of the Standards, streams with limited, intermediate, high, or exceptional significant aquatic life uses and those listed in Appendix A or D (of 30 TAC §307.10) 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 (see as presented in Table 42 on page 82 in Appendix C of this document). Flows in Table 4 apply in the months April through October.

The ~~criteria~~ critical low-flows in Table 42 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



Figure 34. Dissolved oxygen criteria Headwater flows for streams in area “A” may be adjusted based on Table 4 as stated in 30 TAC §307.7(b)(3)(A)(ii).  
 [This figure was moved here from the chapter “Determining Water Quality Uses and Criteria.”]



**Table 42. Critical Low-Flow Values for Dissolved Oxygen for East and South the Eastern and Southern Texas Ecoregions as Described in 307.7(b)(3)(A)(ii)**

Bedslope (m/km)	Critical Low-Flow (ft <sup>3</sup> /s)			
	DO <sup>a</sup> = 6.0 mg/L	5.0 mg/L	4.0 mg/L	3.0 mg/L
0.1	— <sup>b</sup>	18.3	3.0	0.5
0.2	— <sup>b</sup>	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.

—<sup>a</sup> Dissolved oxygen criteria in this table apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

—<sup>b</sup> 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<sup>3</sup>/s.

[Comment – this table was moved here from Appendix C.]

by U.S. Highway 57 from the community of Moore to the Rio Grande (area “A” in Figure 31 on page 81). The ~~headwater~~ flows shown in Table 42 may be used to evaluate summertime 24-hour dissolved oxygen criteria (see Table 1 ~~on page 5 of this document~~) 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 84.

### **Regression Equation Relating Dissolved Oxygen, Flow, and Bedslope**

The flow values in Table 42 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 ~~U.S. Geological Survey (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<sup>3</sup>/s)  
 $Bd$  = bedslope (m/km)  
 $k$  = 1.61 (constant for 50<sup>th</sup> 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 stream 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 ~~values~~ in Table 42 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 42 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 ~~values~~.
- Site-specific changes in critical low-flows ~~values~~ will have to be reviewed and approved by the TCEQ.
- EPA will review any site-specific, critical low-flows ~~values~~ 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 section 307.10, Appendix A, of the Standards
- Harrison Bayou (in Segment 0401) and Black Cypress Bayou (Creek) upstream of Segment 0410 as specified in section 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.<sup>13</sup> 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 88-91) 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<sup>3</sup>/s)  
 $WS =$  watershed size (km<sup>2</sup>)

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<sup>2</sup> to 1000 km<sup>2</sup>. For sites that have watershed sizes greater than 1000 km<sup>2</sup>, a watershed size of 1000 km<sup>2</sup> will be used. For sites that have watershed sizes less than 50 km<sup>2</sup>, a watershed size of 50 km<sup>2</sup> will be used. The headwater flows are calculated for DO concentrations of 0.5 mg/L greater

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<sup>13</sup> 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<sup>3</sup>/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 ~~-based effluent limits (WQBELs)~~ are necessary when ~~impacts from point source dischargers and/or nonpoint sources have caused violations of the water quality criteria for dissolved oxygen.~~ These 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 76).

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.**

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

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

<sup>a</sup> Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

<sup>b</sup> Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft<sup>3</sup>/s).

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

1140 ft<sup>3</sup>/s to meet 5 mg/L DO,

313 ft<sup>3</sup>/s to meet 4 mg/l DO,

35 ft<sup>3</sup>/s to meet 3 mg/L DO,

3.9 ft<sup>3</sup>/s to meet 2 mg/L DO, and

1.3 ft<sup>3</sup>/s to meet 1.5 mg/L DO.

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

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

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

<sup>a</sup> Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

<sup>b</sup> Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft<sup>3</sup>/s).

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

1140 ft<sup>3</sup>/s to meet 5 mg/L DO,

256 ft<sup>3</sup>/s to meet 4 mg/l DO,

29 ft<sup>3</sup>/s to meet 3 mg/L DO,

3.2 ft<sup>3</sup>/s to meet 2 mg/L DO, and

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

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

<sup>a</sup> Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

<sup>b</sup> Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft<sup>3</sup>/s).

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

1140 ft<sup>3</sup>/s to meet 5 mg/L DO,

539 ft<sup>3</sup>/s to meet 4 mg/l DO,

60 ft<sup>3</sup>/s to meet 3 mg/L DO,

6.7 ft<sup>3</sup>/s to meet 2 mg/L DO, and

2.2 ft<sup>3</sup>/s to meet 1.5 mg/L DO.



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

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

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

<sup>a</sup> Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

<sup>b</sup> Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft<sup>3</sup>/s).

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

1140 ft<sup>3</sup>/s to meet 5 mg/L DO,

707 ft<sup>3</sup>/s to meet 4 mg/l DO,

79 ft<sup>3</sup>/s to meet 3 mg/L DO,

8.8 ft<sup>3</sup>/s to meet 2 mg/L DO, and

2.9 ft<sup>3</sup>/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.**

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

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

<sup>a</sup> Dissolved oxygen criteria apply as 24-hour averages at all stream flows at or above the indicated stream flow for each category.

<sup>b</sup> Flows are beyond the observed data used in the regression equation. Use the highest flow observed (1140 ft<sup>3</sup>/s).

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

1140 ft<sup>3</sup>/s to meet 5 mg/L DO,

577 ft<sup>3</sup>/s to meet 4 mg/l DO,

64 ft<sup>3</sup>/s to meet 3 mg/L DO,

7.2 ft<sup>3</sup>/s to meet 2 mg/L DO, and

2.4 ft<sup>3</sup>/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:

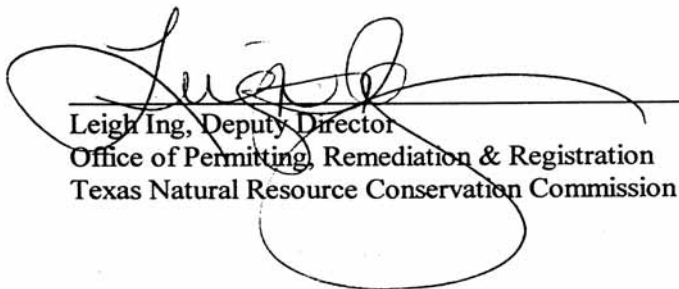
1. WLAs for facilities included in a WQMP update with discharge flows less than or equal to 0.2 million gallons per day (MGD), which are developed using uncalibrated QUAL-TX modeling, where appropriate, with the reaction rates outlined below in Number 2, will be considered technically acceptable without 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 20°C) when performing uncalibrated QUAL-TX modeling in freshwater streams:
  - a. CBOD decay rate:  $K_d = 0.10/\text{day}$ ; and  
CBOD settling rate:  $K_s = 0.0 \text{ m/day}$
  - b. Ammonia-Nitrogen oxidation rate:  $K_n = 0.30/\text{day}$
  - c. Sediment Oxygen Demand:  $\text{SOD} = 0.35 \text{ g/m}^2/\text{day}$
  - d. Reaeration Rate:  $K_2$  will be calculated from equations contained in “Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition)” 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;  $0.6/\text{depth(m)} \leq K_2 \leq 10/\text{day}$ .
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

  
\_\_\_\_\_  
Date

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

  
\_\_\_\_\_  
Date



# Whole Effluent Toxicity Testing (Biomonitoring)

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## Applicability

Whole effluent toxicity (WET) testing, also known as biomonitoring, is required in permits ~~for dischargers whose~~ where the potential exists for the effluent has a significant potential to exert to cause toxicity in the receiving water (30 TAC §section 307.6(e)(2)(A) of the Standards) and 40 CFR 122.44(d)(1)(v)). 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). The TCEQ requires WET testing for domestic wastewater facilities with a final permitted average flow of 1 million gallons per day (MGD) or greater, most major industrial facilities, and other facilities that have the potential to cause toxicity in the receiving water.

Drinking water facilities using reverse osmosis/desalination technologies are not subject to WET testing.

## *Domestic Dischargers*

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

- an average permitted 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)
- a final phase of their permit with a design flow of 1 MGD or greater
- any individual WWTP with an approved pretreatment program with significant industrial users discharging into ~~its~~their collection systems
- the potential to cause toxicity in the receiving water.

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

Complementing the WET testing requirements, the TCEQ requires all domestic dischargers with an average permitted flow equal to or greater than 1 MGD to dechlorinate their chlorinated effluent or to employ another form of disinfection. TCEQ does not require effluent dechlorination for facilities discharging directly to the Rio Grande. [Revised language moved to "Toxic Pollutants" chapter on page 128.]

## ***Industrial Dischargers***

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

- classification as an EPA-classified major industrial dischargers with continuous flow outfalls
- a continuous discharge of process treated wastewater
- other industrial dischargers with continuous flow outfalls a discharge with the potential for causing to exert toxicity in the receiving water.

Although the TCEQ generally does not require WET testing of ~~once-through cooling water outfalls~~ or of EPA-classified minor industrial dischargers, the TCEQ may will normally 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 exerteause toxicity in the receiving water
- the permit requires effluent limits based on aquatic life water-quality criteria-based effluent limits (WQBELs) to protect aquatic life because the effluent analysis exceeded the screening criteria
- ~~the permittee commingles other potentially toxic waste streams with the once-through cooling water~~
- ~~the cooling water source and the receiving water are different water bodies.~~

## ***Chapter Outline***

The rest of this chapter covers the following topics:

- **types of WET tests** (chronic and 48-hour acute—page 97; 24-hour acute—page 114)
- **test acceptability criteria** (chronic and 48-hour acute—page 99; 24-hour acute—page 116)
- **statistical interpretation of test results** (chronic and 48-hour acute only—page 100)
- **test frequencies** (chronic and 48-hour acute—page 101; 24-hour acute—page 116)
- **dilution series, dilution water, and type of WET tests**—page 105
- **reasonable potential determination** (chronic and 48-hour acute only—page 108)
- **toxicity reduction evaluations** (chronic and 48-hour acute—page

110; 24-hour acute—page 118)

- **toxicity control measures** (chronic and 48-hour acute—page 112; 24-hour acute—page 119)
- **toxicity caused by some specific pollutants**—dissolved salts (page 120), ammonia (page 125), and Diazinon (page 126).

## 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 section 30 TAC §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 or below 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~~ may 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*~~ *Mysidopsis 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*~~ *Mysidopsis 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 120 and “Site-Specific Standards for Total Toxicity” on page 208).

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. The permittee will have to repeat any toxicity test, including the control and all effluent dilutions, that fails to meet any one of the following criteria.

### ***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 ~~at any dilution~~, 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~~40% males in a single concentration or < ~~20~~40% 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 ~~at any dilution~~, 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.

~~Also note that tests should be ended within a period of two hours before the appropriate test end time to two hours afterward.~~

### **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.<sup>14</sup>

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<sup>14</sup> Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing (40 CFR Part 136), EPA 821-B-00-004, July 2000.

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.<sup>15</sup>

## **Test Frequencies**

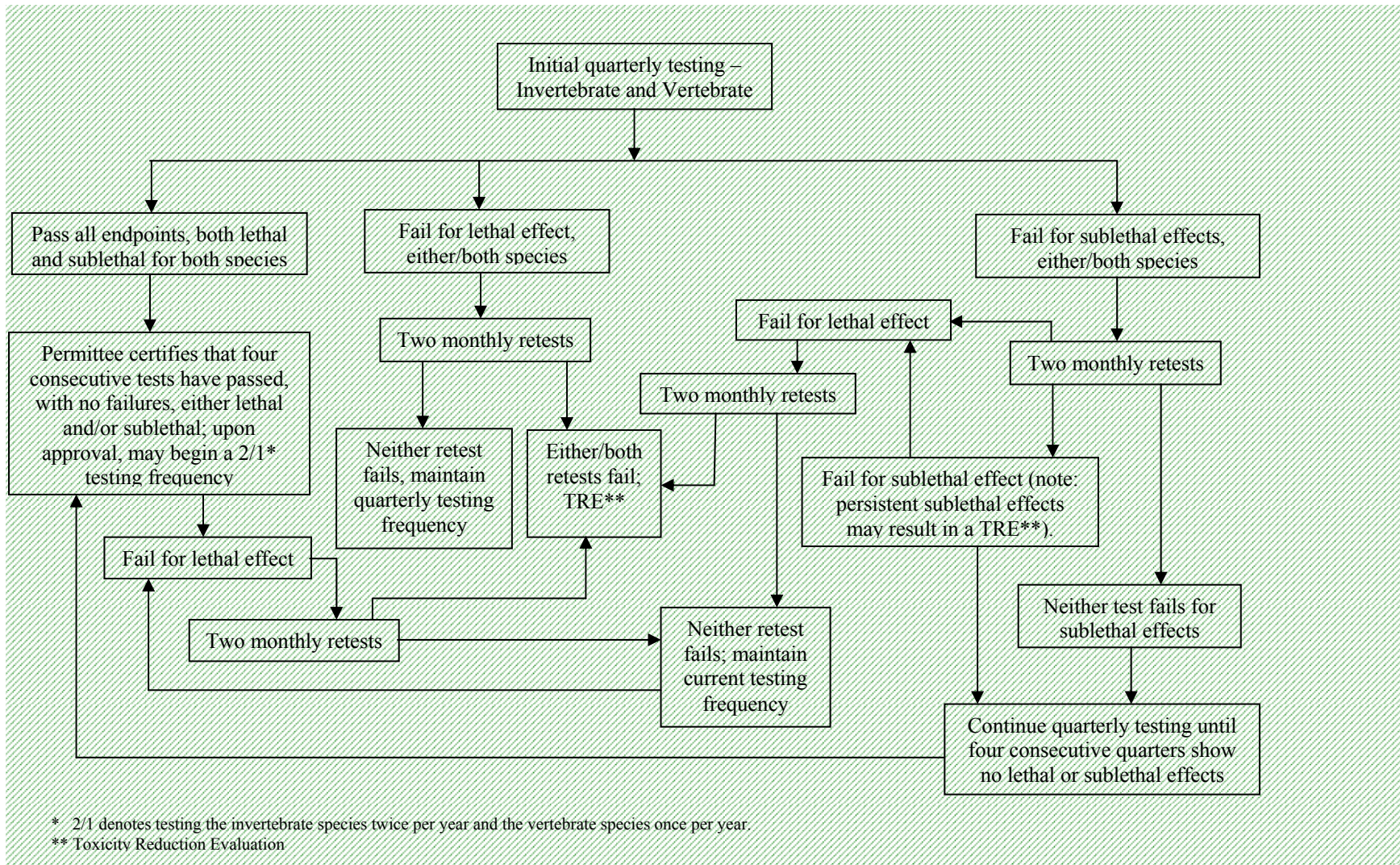
### **General**

~~Figure 4 on page 103 illustrates the chronic and 48-hour acute WET-testing frequencies for domestic and industrial wastewater treatment facilities subject to biomonitoring with WET requirements. Except in unusual circumstances, WET testing is typically performed quarterly for both the vertebrate and the invertebrate test species for the first year of the permit term is in effect. EPA requires quarterly testing for at least one year is needed to adequately assess the variability and toxic potential of effluents. Below this minimum frequency, the chance of missing toxic events increases. Permits issued after adoption of EPA's Post Third Round Policy (10/01/1992) contained minimal test frequencies; these were based on intensive WET monitoring data acquired before 1992 that demonstrated an absence of toxicity. This information is now outdated because effluent additives, processes, and treatments may have changed over the long and short term. Periodic reassessment of an effluent's variability and toxic potential is needed to ensure an adequate level of protection for the receiving water.~~

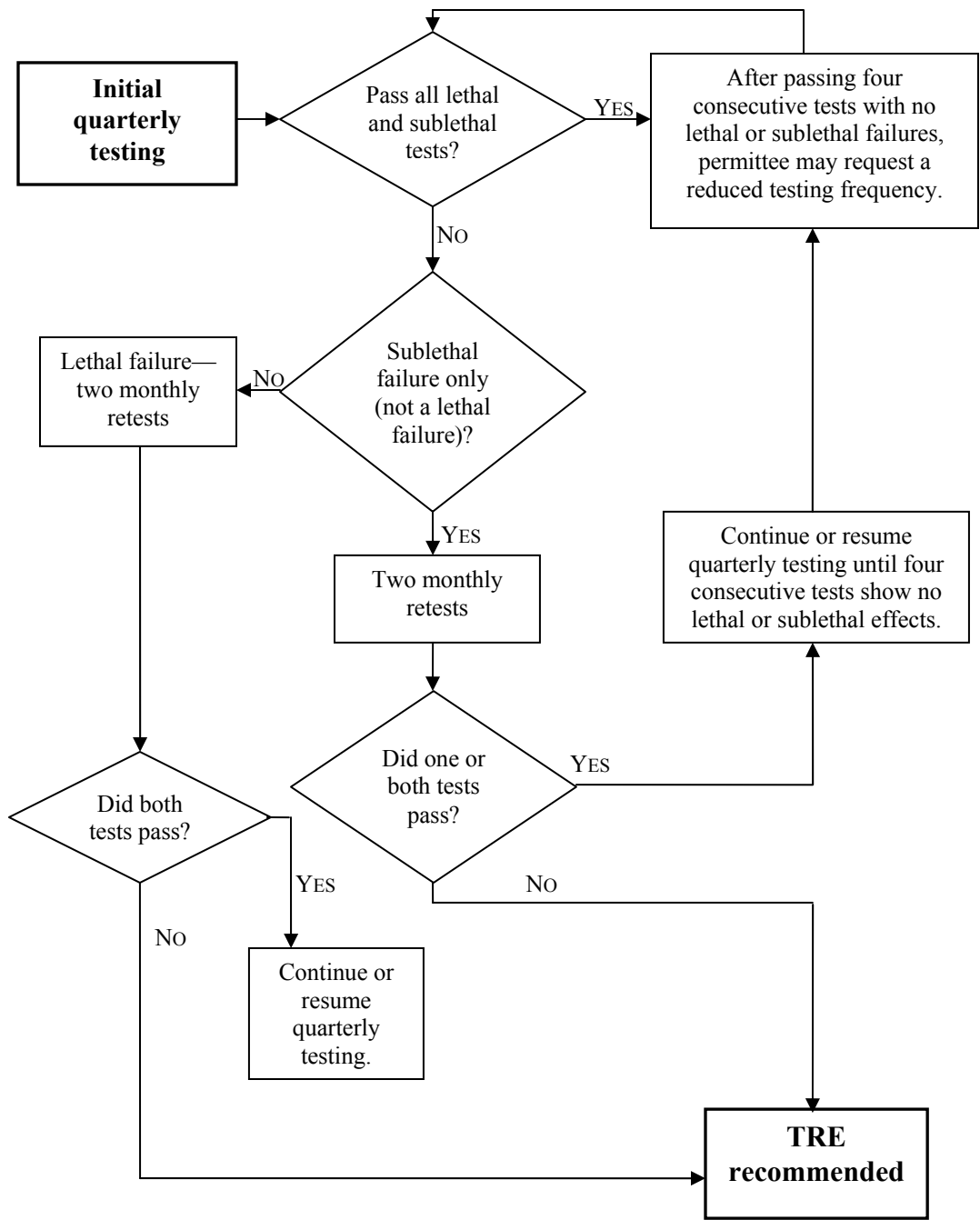
~~If no control of toxicity is demonstrated by the absence of significant effects are demonstrated in the first year of in the last four consecutive quarterly testing\_s for both the invertebrate and the vertebrate test species, the TCEQ may, at the written request of the permittee may request ; reduce the a testing frequency reduction to not less than once per six months for the invertebrate and not less than once per year for the vertebrate for the remainder of the permit term. This is the minimum test frequency that will be assigned. Permittees with established WET limits or who are already monitoring at a quarterly frequency for other reasons are not eligible to apply for a reduction in monitoring frequency. Different frequencies may be specified on a case-by-case basis. Due dates for test results are specified in the permit.~~

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<sup>15</sup> 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.



**Figure 8. Chronic and 48-Hour WET Testing Frequencies**



**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.

***Additional considerations.*** Dischargers will perform quarterly testing when there is insufficient data to determine reasonable potential to cause toxicity. The TCEQ will consider additional factors in determining whether there is reasonable potential to cause toxicity, such as:

- whether the facility has an approved pretreatment program
- existing data from discharge monitoring reports
- compliance history
- whether WQBELs for the protection of aquatic life (derived from Table 1 criteria of the Standards) are required, based on data submitted during the application process.

The TCEQ may require more frequent WET testing for permittees that have historical WET testing problems.

### ***During a TRE***

The TCEQ will require all dischargers to perform WET tests at least once per quarter if they are conducting a toxicity reduction evaluation (TRE). This frequency only applies to the species that demonstrated significant lethality. For more information on TREs, see the section entitled “Toxicity Reduction Evaluations” on page 111.

### ***With a WET Limit***

Permittees will be required to perform quarterly testing for at least three years whenThe minimum testing frequency in a permit with a WET limit is added to the permit, once per quarter for five years following the effective date of the WET limit. This frequency only applies to the species with to which the WET limit. Best professional judgement (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. applies. If no significant lethal effects are demonstrated at or below the critical dilution in any tests for the affected species within five years of the effective date of the WET limit, the discharger may provide a written request to reduce the frequency to twice per year until the permit expiration date. WET

~~testing frequencies may be specified on a case-by-case basis where seasonal toxicity is apparent. TCEQ staff will use best professional judgement to establish testing frequencies when a chemical specific (CS) limit or best management practice (BMP) is placed in the permit to control effluent toxicity at the conclusion of a TRE.~~

## ***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 average permitted 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 ~~for survival~~ 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. ~~all of the following conditions were met:~~

- ~~• a synthetic lab water control was performed in addition to the receiving water control~~
- ~~• the test indicating receiving water toxicity was carried out to completion~~
- ~~• the permittee submitted all test results indicating receiving water toxicity with the reports and information required by the permit.~~

Upon demonstrating that the receiving water is toxic, the permittee may, ~~upon TCEQ approval,~~ 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. ~~Permittees should submit the substitution request in writing.~~

### *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 consider salinities at or above 2,000 mg/L (2 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 ~~NO SIGNIFICANT~~ AQUATIC LIFE USE**

Permittees that discharge into intermittent streams with a minimal ~~no significant~~ 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 significant 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 90<sup>th</sup> 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 64) to determine the percentage of effluent at the edge of the mixing zone (~~see the chapter in this document entitled “Mixing Zones and Critical Conditions” on page 39~~). 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 ( $\geq 400$  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 64) to determine the percentage of effluent at the edge of the mixing zone (~~see the chapter of this document entitled “Mixing Zones and Critical Conditions” on page 39~~). 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 64) 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 73 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. Screening for RP is intended to identify toxicity that has not yet been addressed by a WET limit or other toxicity control measure.

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 judgement 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 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 114.

### **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/lethality~~ occurs to either test species exposed to effluent at or below the critical dilution, the permittee will conduct two retests with that test species. ~~(A retest is another test performed on a sample taken on a different day.)~~ The ~~two~~ retests are to be conducted monthly during the next two consecutive months. If persistent significant toxicity/lethality is demonstrated by failure of one or both retests, the permittee may wish to ~~will~~ perform a TRE. A second retest is not required if the first retest confirms persistent toxicity. ~~Note that all test data must be submitted for review regardless of whether the test was valid or invalid.~~

### ***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, ~~and develop a schedule for taking corrective action.~~ ~~Persistent sublethal effects may also have to be addressed by a TRE.~~ 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.

~~All test data must be submitted for review regardless of whether the test was valid or invalid.~~ 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

### ***TRE Plan***

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

Within 90 days of the retest that confirms lethality, 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, ammonia, or Diazinon is discussed in the sections of this document entitled:

- 
- “Toxicity Attributable to Dissolved Salts” (see page 119)
  - “Ammonia Toxicity” (see page 124)
  - “Toxicity Attributable to Diazinon” (see page 126).

### ***Quarterly Reports***

As required by the permit, 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 28 months of the retest that confirms lethality. Permittees may request an extension to the 28-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 lethality to the test organisms. The permit defines a cessation of lethality as no significant lethality at the critical dilution, using test procedures specified in the permit, for a period of 12 consecutive months with at least monthly 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.~~

~~The permittee may only apply the cessation of lethality provision once every five years. If the effluent again demonstrates persistent, significant lethality to the same species within a five-year period, the TCEQ will amend the permit to add a WET limit with a compliance period (if appropriate). If the permittee can identify and confirm the toxicant and/or identify an appropriate control measure, the permittee may apply for a permit amendment before the effective date of the WET limit, removing the WET limit and replacing it with an alternate toxicity control measure.~~

~~When a permittee ceases TRE activities under the cessation of lethality provision, that permittee continues WET testing as required in the permit. This provision is not applicable if the lethality ceases for 12 consecutive months 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***

~~Near the conclusion of the TRE and associated corrective measures, the TCEQ may amend the permit to specify toxicity control measures. These may include a chemical-specific (CS) limit, a best management practice (BMP), or a WET limit, if appropriate, for one or both species demonstrating persistent significant lethality.~~

## ***Chemical-Specific Limit***

~~The TCEQ may use a the CS chemical specific limit in lieu of a WET limit if the CS chemical specific limit can adequately address toxicity. In order to be eligible for a CS chemical specific limit, the permittee has to demonstrate that one or more known toxicants caused the lethality and should attempt to determine a specific concentration of the toxicant that does not cause lethality.~~

## ***BMP***

~~The TCEQ may specify a permit requirement for a BMP if such a provision can adequately address toxicity. 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. If successful, the BMP becomes an enforceable part of the permit. A BMP does not include making housekeeping changes or operational changes 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~~

- ~~• reasonable potential has been demonstrated to violate the narrative criteria regarding toxicity in 30 TAC §307.6(b)(1) and/or (2) and~~
- ~~• 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). Upon reaching the effective date of the WET limit, a testing frequency of once per quarter is required for the next five years for the species to which the WET limit applies.~~

~~If the permittee does not comply with the WET limit (that is, fails a test), the permittee is considered in violation of the permit and receives a written Notice of Violation (NOV). The testing frequency for the species in question increases to monthly until compliance is demonstrated for a period of three consecutive months. After compliance is demonstrated, the permittee may resume quarterly testing. However, if the permittee fails a test during the increased monthly testing period, the permittee will be referred to TCEQ's Enforcement Division for formal enforcement action. This process is illustrated in Figure 9 on page.~~



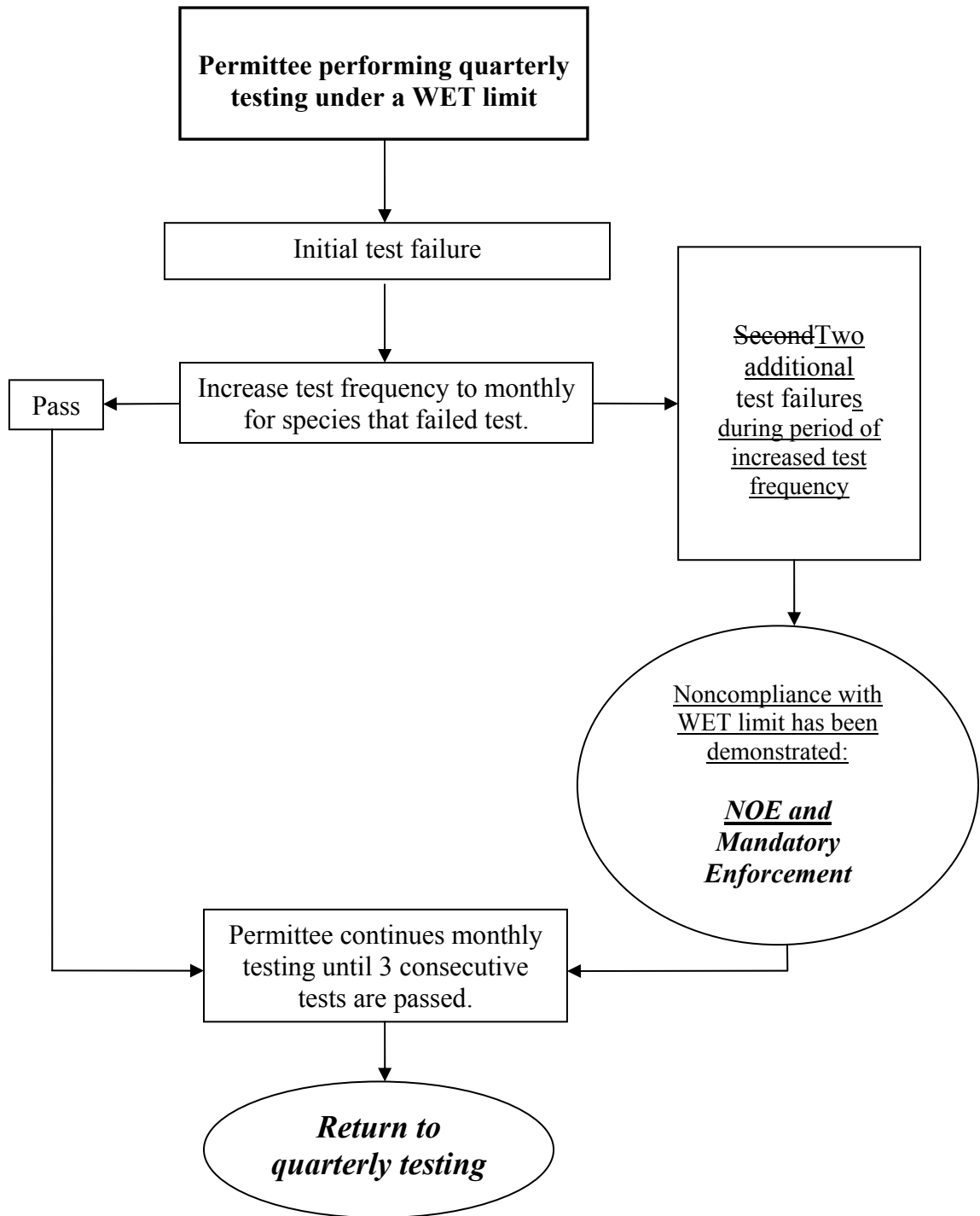


Figure 59. Procedure for Addressing WET Limit Violations

## 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 section 30 TAC §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 95), 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 97, *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 or the most recent version). The permittee may use a revised 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 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
- ~~24-hour *Ceriodaphnia dubia* (water flea) survival test. Use of this test species is only allowed where the permittee substitutes the results of the 7-day chronic test for this testing requirement as discussed in the section of this document entitled "Test Substitution" on page.~~

#### ***Marine receiving water (salinity ≥ 2 ppt):***

- 24-hour ~~*Americamysis*~~ *Mysidopsis 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 120 and “Site-Specific Standards for Total Toxicity” on page 208).

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 Criteria**

The permittee will have to repeat any toxicity test, ~~including the control~~, if the mean survival of the control is less than 90%. Any toxicity test that fails to meet the acceptability criterion is considered invalid. ~~Also note that tests should end within a period of one hour before the appropriate test end time to one hour afterward.~~

### **Test Frequencies**

The standard frequencies for 24-hour acute WET testings is once per six months unless otherwise specified (e.g., quarterly for WET limits). ~~are based on (1) previous WET testing results or (2) the results of two 24-hour WET tests performed by the applicant and submitted as part of the wastewater permit application.~~

- ~~• Permit applicants that **are** currently conducting WET tests do not need to resubmit test results or conduct the 24-hour WET tests specified in the permit application.~~
- ~~• Permit applicants that **are not** currently conducting WET tests but meet the criteria for performing WET tests as described in the permit application should conduct the appropriate 24-hour WET tests. These test results should be submitted with the application.~~

~~If both application tests pass (exceed 50% survival), the applicant will normally be required to conduct 24-hour acute WET tests at a frequency of once per six months.~~

~~If either application test fails, the permittee has the opportunity during the application process to conduct two retests in consecutive weeks for each species that failed. All test data must be submitted for review regardless of whether the test was valid or invalid.~~

~~If any of the retests fail, the permittee is required to initiate a TRE upon permit issuance. For more information, see the section of this document entitled "Toxicity Reduction Evaluations" on page 81.~~

~~If all retests pass, the permittee is required to conduct 24-hour acute WET tests at a minimum frequency of once per quarter for the species that initially failed and once per six months for the species that passed.~~

### **Control Measures for Mortality**

Permit applications are reviewed during renewal or amendment to determine if a 24-hour WET limit or other control measure is needed to preclude persistent significant mortality. The evaluation will be based on

representative data from the previous five years of 24-hour WET testing. New permit applications will not be screened, since there will be no data from previous WET testing. Mortality for new permits will be assessed by routine, periodic 24-hour WET testing after the permits are issued.

A 24-hour WET limit will be added to the permit if:

- three or more failures occurred in the last three years or
- two failures occurred in the last three years, but another failure followed by a retest failure occurred during the last five years

Additional factors may be considered using best professional judgement. A more detailed discussion of these factors may be found in the most current version of the “Standard Operating Procedures for WET Testing” maintained by the TCEQ’s Water Quality Division.

The permit will be issued for a five-year term, including an initial one-year investigative period for the permittee to conduct an initial mortality investigation. The investigative period will be followed by a three-year compliance period to allow completion of TRE studies (see page 118) and/or elimination of mortality 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 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.

### **Addressing 24-Hour WET Limit Violations**

If the permittee fails a WET test (that is, demonstrates significant mortality) 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 quarterly testing.

However, if the permittee fails a test during the increased 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 114.

### **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
- 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.

### **Toxicity Reduction Evaluations (TREs)**

The TCEQ suggests that a permittee initiate a TRE when persistent significant mortality occurs during routine 24-hour WET testing. A TRE may allow the permittee to avoid a WET limit as the toxicity control measure.

Failing a 24-hour acute WET test 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, 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 lethality, and the permittee may wish ~~is required to perform~~ initiate a TRE. Additional information about TREs can be found in the section of this document entitled “TRE Purpose and Content” on page 110. ~~From the date that lethality is confirmed, the permittee has three years to comply with 30 TAC §307.6(e)(2)(B) of the Standards. Permittees may request an extension to the three-year limit. As stated in the permit language, however, the extension must be warranted and is contingent upon permittees demonstrating (1) due diligence in pursuit of the TRE and (2) the existence of circumstances beyond their ability to control.~~

~~The 24-hour acute TRE requirements are similar but not identical to those for chronic or 48-hour TREs discussed in the section of this document entitled “Toxicity Reduction Evaluations” on page 109. Since the permittee should normally comply with 30 TAC §307.6(e)(2)(B) of the Standards within three years, the permit specifies completion of the TRE and submission of a final TRE report within 18 months of the failed retest. Permittees may request (in writing) an extension to the 18-month time limit. The extension, however, must be warranted and is contingent upon permittees demonstrating (1) due diligence in pursuit of the TRE and (2) the existence of circumstances beyond their ability to control.~~

~~The permit also specifies that the TRE continue unless the permittee demonstrates to TCEQ that the effluent has ceased to cause lethality. The permit defines a cessation of lethality as greater than 50% survival after 24 hours of exposure to 100% effluent for 12 consecutive weeks with at least weekly sampling and testing.~~

## ***Toxicity Control Measures***

~~Near the third year’s end, the TCEQ will amend the permit to include a CS chemical-specific limit, a BMP, or a WET limit.~~

~~A CS chemical specific limit or a BMP must adequately address the effluent’s toxicity. If not, the permit is amended to add a WET limit with a compliance period (if appropriate). Upon reaching the effective date of the WET limit, a testing frequency of once per quarter is required for the next five years.~~

~~If the permittee does not comply with the WET limit (that is, fails a test), the permittee is considered in violation of the permit and receives a written Notice of Violation (NOV). The testing frequency for the species in question increases to monthly until compliance is demonstrated for a period of three consecutive months. After compliance is demonstrated, the permittee may resume quarterly testing. If, however, the permittee fails a test during the increased testing period, the permittee will be referred to TCEQ’s Enforcement Division for potential formal enforcement action. This process is illustrated in Figure 9 on page 100.~~

## **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**

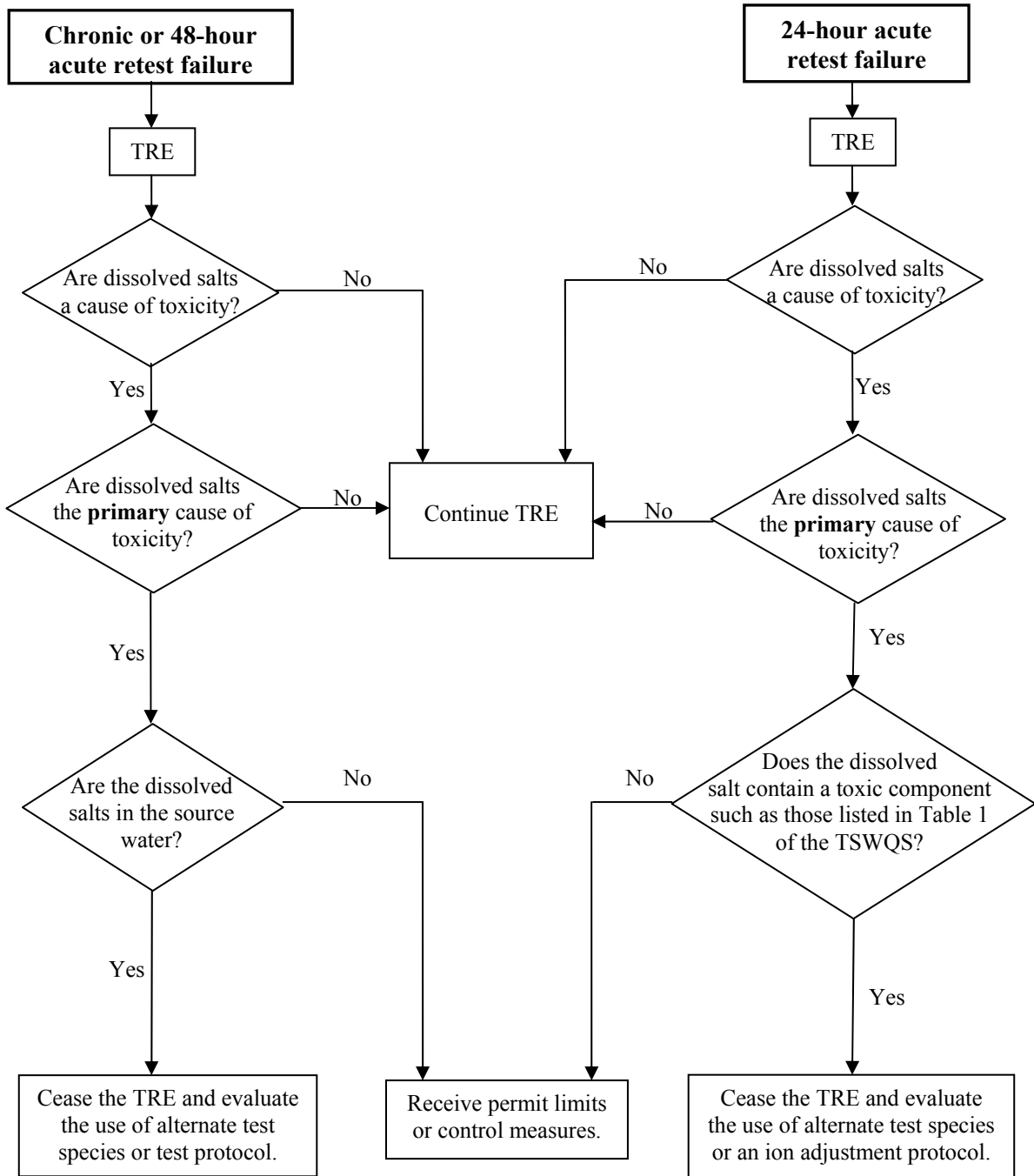
Permittees may be exempt from compliance with the total toxicity provisions in the Standards if they demonstrate that dissolved salts are causing the effluent to be toxic. This exemption is allowed under the definition of toxicity in the Standards and under the 24-hour, 100% end-of-pipe acute toxicity provisions (~~30 TAC §~~section 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 section 30 TAC §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 section 30 TAC §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.

Figure ~~640~~ on page 121 outlines the steps necessary for proving that dissolved salts are responsible for the toxicity and for receiving the exemption. The following two sections further explain the exemptions for dissolved salts.



**Figure 640. 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~~ will 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 requirements cease 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 ~~will~~ 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 122 to prove that dissolved salts are the primary cause of toxicity. If these techniques fail to do so, the permittee should ~~will~~ 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 ~~total dissolved solids~~ (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 instream toxicity, ~~some~~ 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~~ may 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, ~~when all of the following conditions are met:~~

- ~~the discharge is to freshwater and~~
- ~~the facility has a critical dilution of 50% or greater and~~
- ~~the facility has permitted ammonia limits to maintain instream dissolved oxygen criteria, or it has categorical ammonia limits.~~

The modified ammonia limits or WET limit ~~applies~~ apply to the following types of facilities that discharge to perennial waters or within 3 miles of perennial waters:

- major domestic facilities (~~design~~average permitted flow  $\geq$  1 MGD)
- minor domestic facilities (~~design~~average permitted 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
- ~~all major~~ 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 ~~thea~~ technology-based daily average ammonia-nitrogen limit of 3 mg/L included in most major domestic discharge permits generally precludes chronic toxicity to ~~freshwater~~ test species; ~~specifically the fathead minnow~~. Therefore, the TCEQ will implement this limit as ~~the TRE resolution for~~ to address chronic toxicity attributable to ammonia in domestic discharge permits. ~~This resolution applies solely to domestic wastewater treatment plants discharging to freshwater with ammonia as the primary toxicant.~~ 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 mg/L, the persistent ~~toxicity lethality~~ 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 mg/L, TCEQ staff will amend the permits to include this limit.
- ~~Facilities whose permits contain interim or final effluent phases that include seasonal ammonia-nitrogen limits or ammonia-nitrogen limits greater than 3 mg/L will be evaluated by TCEQ staff on a case-by-case basis for the appropriateness of the specified limit. If the limit appears incapable of precluding toxicity, TCEQ staff will amend the permit to include a daily average ammonia-nitrogen limit of 3 mg/L.~~

The 3 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 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 (~~30 TAC §section 307.6(e)(2)(E)~~) for those domestic wastewater facilities entering TREs due to demonstrating Diazinon as the primary cause of effluent 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.

~~Once the permittee demonstrates this, using standard TIE characterization tests and other analytical techniques, and also demonstrates that Diazinon is ubiquitous within the wastewater collection system, TCEQ will amend the permit. The amendment requires the permittee to address toxicity as follows:~~

- ~~1. **Public Education Program (PEP).** The permittee will be required to implement a PEP, emphasizing education and awareness to prevent Diazinon from entering the collection system. The PEP should include, but not be limited to, the following components:~~
  - ~~a. *Users Survey*— The permittee should survey all suspected users of Diazinon. The survey should be comprehensive, including individuals as well as businesses. The survey should identify those source groups and/or individuals that should receive the information described in 1.b.~~
  - ~~b. *Information Development*— The permittee should develop information for dissemination to source groups and individuals. This information should include best management practices for use of Diazinon and other pesticides and alternative methods of pest control besides the use of organophosphate pesticides.~~
  - ~~c. *Disseminating Information*— The targeted audience should be assured of receiving the developed information through a number of means, including the media, mailings, and public presentations.~~
- ~~2. **Diazinon Monitoring.** The permittee will monitor wastewater influent and effluent for Diazinon while continuing to biomonitor using the most sensitive species. The results of the WET testing and the Diazinon monitoring should be submitted in quarterly reports.~~

~~Should Diazinon not prove to be the primary cause of toxicity or not be ubiquitous within the wastewater collection system, the permittee will resume the TRE. In addition, should the permittee not address Diazinon toxicity as described above with due diligence, the TRE requirements remain in effect. In either case, TCEQ may amend the permit to specify appropriate toxicity control measures as given in 30 TAC §307.6(e)(2)(D).~~

# Toxic Pollutants

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## General Provisions

The Standards for toxic pollutants include general provisions, specific numerical criteria, and total (whole effluent) toxicity criteria. As stated in 30 TAC §section 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~~no significant~~ aquatic life uses.
- Water in the state shall be maintained to preclude adverse toxic effects on human health resulting from water contact~~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, ~~however,~~ apply within human health mixing zones ~~or below harmonic mean stream flows~~.
- 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 within three miles of perennial waters or perennial pools with significant aquatic life uses are designed to protect against chronic toxicity and to protect human health in those waters. Permits for discharges into classified and unclassified water bodies with significant aquatic life uses 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  $\geq$  0.5 MGD or (2) request a new, amended, or renewed permit with permitted flow  $\geq$  1 MGD will dechlorinate their effluent or use another form of disinfection. Domestic dischargers who renew a permit with a permitted flow  $\geq$  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 (~~30 TAC §section~~ 307.6(c) of the Standards) are expressed for freshwater acute, freshwater chronic, marine water acute, and marine water chronic conditions. The numerical criteria for the protection of human health (~~30 TAC §section~~ 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~~<sup>three</sup> categories of human health criteria given in the standards are (1) water and fish, and (2) ~~freshwater fish only, and (3) saltwater 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 for which there are 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 million gallons per day (MGD) and/or with an approved pretreatment program
- domestic facilities requesting a permitted average flow less than 1 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 use 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 apply acute criteria for discharges into intermittent streams with minimal~~no significant~~ aquatic life uses and assume a critical low-



flow of 0.0 ft<sup>3</sup>/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 these perennial waters.
- Permit limits are developed to ensure that intermittent streams with ~~significant~~ 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 apply 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 (~~TSS~~).

Fifteenth percentile (~~15<sup>th</sup>~~) values of segment hardness, pH, and TSS data are considered critical conditions (see ~~the Tables 5~~ in ~~Appendix C~~ of this document). Basin values are used when there is insufficient segment data.

The fiftieth (~~50<sup>th</sup>~~) percentile value of segment chloride data is used to implement the ~~freshwater~~ silver standard for aquatic life protection (see ~~Appendix D-Table 5~~). Basin values are used when there is insufficient segment data.

TCEQ staff usually obtain this information from ~~Table 5~~ 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 152.

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 67 (on page 156 in Appendix C of this document) 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 152.

The TCEQ evaluates metals not included in Table 67 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 ( $E_F$ ) ~~dilution~~ at the edge of the ZID. ~~The effluent fraction ( $E_F$ ) used in each WLA is calculated~~ as follows:

$$E_F \text{ at edge of MZ} = \frac{Q_E}{[Q_S + Q_E]}$$

$$E_F \text{ at edge of ZID} = \frac{Q_E}{[(0.25)(Q_S) + Q_E]}$$

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 ( $\geq$  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 chapter of this document entitled, “Mixing Zones and Critical Conditions” “Critical Conditions for Aquatic Life Protection” on page 63.

### ***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 first step in developing effluent limits based on water-quality criteria-based effluent limits (WQBELs) 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 155.) 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:

$$WLA_c = \frac{\text{Chronic Criterion}}{(\text{Bioavailable Fraction})(E_F \text{ at edge of MZ})}$$

where:  $WLAa$  = waste load allocation based on acute criterion  
 $WLAc$  = waste load allocation based on chronic criterion

$$WLAa = \frac{\text{Acute Criterion}}{(\text{Bioavailable Fraction})(E_F \text{ at edge of ZID})}$$

*Acute Criterion* = aquatic life acute numerical criterion

*Chronic Criterion* = aquatic life chronic numerical criterion

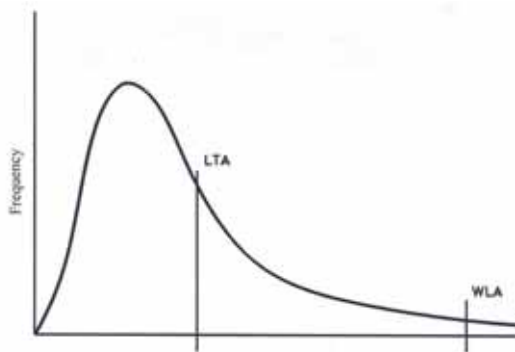
*Bioavailable Fraction* = fraction of the pollutant that is defined to be available to organisms

$E_F$  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 72 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 72. Probability Distribution that Describes Treatment System Performance**

The final equations used to calculate the LTAA and the LTAc are:

$$LTAA = 0.32 WLAa \quad (99\% \text{ probability})$$

$$LTAA = 0.573 WLAa \quad (90\% \text{ probability})$$

$$LTAc = 0.61 WLAc \quad (99\% \text{ probability})$$

$$LTAc = 0.770 WLAc \quad (90\% \text{ probability})$$

While the derivation of these equations is quite complex (see Figure 83 on page 135), 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:

$$DLY \text{ AVG} = 1.47 LTA \quad (n = 12)$$

$$DLY \text{ MAX} = 3.11 LTA \quad (n = 1)$$

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 94 on page 136 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):

$$u_n = \ln(WLAa) - (2.326)(0.555)$$

$$u_n = \ln(WLAa) - 1.291$$

$$LTAa = \exp[\ln(WLAa) - 1.291 + 0.5(0.307)]$$

$$LTAa = \exp[\ln(WLAa) - 1.137]$$

$$LTAa = WLAa/e^{1.137}$$

$$\mathbf{LTAa = 0.32 \times WLAa}$$

For Z = 1.282 (90% probability):

$$u_n = \ln(WLAa) - (1.282)(0.555)$$

$$u_n = \ln(WLAa) - 0.712$$

$$LTAa = \exp[\ln(WLAa) - 0.712 + 0.5(0.307)]$$

$$LTAa = \exp[\ln(WLAa) - 0.558]$$

$$LTAa = WLAa/e^{0.558}$$

$$\mathbf{LTAa = 0.573 \times WLAa}$$

### Chronic Criteria

$$s_n^2 = \ln [1 + (0.6^2/7)] = 0.050$$

$$s_n = 0.224$$

For Z = 2.326 (99% probability):

$$u_n = \ln(WLAc) - (2.326)(0.224)$$

$$u_n = \ln(WLAc) - 0.521$$

$$LTAc = \exp[\ln(WLAc) - 0.521 + 0.5(0.050)]$$

$$LTAc = \exp[\ln(WLAc) - 0.496]$$

$$LTAc = WLAc/e^{0.496}$$

$$\mathbf{LTAc = 0.61 \times WLAc}$$

For Z = 1.282 (90% probability):

$$u_n = \ln(WLAc) - (1.282)(0.224)$$

$$u_n = \ln(WLAc) - 0.287$$

$$LTAc = \exp[\ln(WLAc) - 0.287 + 0.5(0.050)]$$

$$LTAc = \exp[\ln(WLAc) - 0.262]$$

$$LTAc = WLAc/e^{0.262}$$

$$\mathbf{LTAc = 0.770 \times WLAc}$$

**Figure 83. Derivation of Equations Used to Calculate the Long-Term Average**

$$\begin{aligned} \text{LIMIT} &= \exp(u_n + Zs_n) \\ u_n &= \ln(\text{LTA}) - 0.5s_n^2 \\ s_n^2 &= \ln [1 + (\text{CV}^2/n)] \end{aligned}$$


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**Daily Average**

$$\begin{aligned} s_n^2 &= \ln [1 + (0.6^2/12)] = 0.030 \\ s_n &= 0.173 \\ u_n &= \ln(\text{LTA}) - (0.5)(0.030) \\ u_n &= \ln(\text{LTA}) - 0.015 \\ \text{DLY AVG} &= \exp[\ln(\text{LTA}) - 0.015 + (2.326)(0.173)] \\ \text{DLY AVG} &= \exp[\ln(\text{LTA}) + 0.387] \\ \text{DLY AVG} &= \text{LTA} \times e^{0.387} \\ \text{DLY AVG} &= 1.47 \times \text{LTA} \end{aligned}$$


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**Daily Maximum**

$$\begin{aligned} s_n^2 &= \ln [1 + (0.6^2/1)] = 0.307 \\ s_n &= 0.555 \\ u_n &= \ln(\text{LTA}) - (0.5)(0.307) \\ u_n &= \ln(\text{LTA}) - 0.154 \\ \text{DLY MAX} &= \exp[\ln(\text{LTA}) - 0.154 + (2.326)(0.555)] \\ \text{DLY MAX} &= \exp[\ln(\text{LTA}) + 1.137] \\ \text{DLY MAX} &= \text{LTA} \times e^{1.137} \\ \text{DLY MAX} &= 3.11 \times \text{LTA} \end{aligned}$$

**Figure 94. 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 23 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 an 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 (~~70 years~~).



## ***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:

$$E_F \text{ at edge of HH MZ} = \frac{Q_E}{[Q_{HM} + Q_E]}$$

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 ( $\geq 400$  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 chapter of this document entitled “Mixing Zones and Critical Conditions for Human Health Protection” on page 68.

## ***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~~first step in developing effluent limits based on water-quality criteria ~~-based effluent limits (WQBELs)~~ 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 155.) 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:

$$WLAh = \frac{HH \text{ Criterion}}{(Bioavailable \text{ Fraction})(E_F \text{ at edge of HH MZ})}$$

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 83 on page 135 and Figure 94 on page 136). The final equations are as follows:

$$\begin{aligned} LTAh &= 0.930 \text{ WLAh} & (n = 365) \\ DLY \text{ AVG} &= 1.47 \text{ LTAh} & (n = 12) \\ DLY \text{ MAX} &= 3.11 \text{ LTAh} & (n = 1) \end{aligned}$$

## 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 (as appropriate) in receiving waters at and above critical conditions. 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 61. As stated in ~~30 TAC §~~section 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:

$$ACUTE\ CRITERIA = 0.30 \times LC50\ of\ most\ sensitive\ species$$

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~~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.<sup>16</sup>
- A chemical is **bioaccumulative** if its ~~bioaccumulation factor (BAF)~~ or ~~bioconcentration factor (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 ~~30~~ TAC §section 307.6(c)(7) of the Standards.

#### **Nonpersistent toxic compounds:**

$$CHRONIC\ CRITERIA = 0.10 \times LC50 \text{ of most sensitive species}$$

#### **Persistent toxic compounds:**

$$CHRONIC\ CRITERIA = 0.05 \times LC50 \text{ of most sensitive species}$$

#### **Bioaccumulative toxic compounds:**

$$CHRONIC\ CRITERIA = 0.01 \times LC50 \text{ of most sensitive species}$$

### **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.

<sup>16</sup> Rand, Gary M. (ed.), 1995. *Fundamentals of Aquatic Toxicology (Second Edition)*. CRC Press.

- 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 logK<sub>ow</sub>-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 that may require 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 30 TAC §section 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 ~~30 TAC~~ section 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**

$$HH \text{ CRITERIA } (\mu\text{g} / \text{L}) = \frac{(RL)(BW)(U)}{CPF [WI + (FC)(LC)(BCF)]}$$

~~WATER AND FISH, NONCARCINOGENS~~

$$HH \text{ CRITERIA } (\mu\text{g} / \text{L}) = \frac{(RfD)(BW)(U)}{WI + (FC)(LC)(BCF)}$$

**FISH TISSUE ONLY, CARCINOGENS**

$$HH \text{ CRITERIA } (\mu\text{g} / \text{L}) = \frac{(RL)(BW)(U)}{(CPF)(FC)(LC)(BCF)}$$

~~TISSUE ONLY,~~

$$HH \text{ CRITERIA } (\mu\text{g} / \text{L}) = \frac{(RfD)(BW)(U)}{(FC)(LC)(BCF)}$$

~~— FISH  
NONCARCINOGENS~~

where:  $RL$  = risk level (1 in 100,000, or  $10^{-5}$ )  
 $RfD$  = reference dose (mg toxicant/kg human body weight/day)  
 $BW$  = body weight of average adult (70 kg)

- $U$  = unit conversion factor to express criteria in  $\mu\text{g/L}$  (1000  $\mu\text{g/mg}$ )  
 $CPF$  = carcinogenic potency factor (oral slope factor,  $\text{kg-day/mg}$ )  
 $WI$  = amount of water consumed per day (2 L/day)  
 $FC$  = amount of fish tissue consumed (~~0.0175 kg/day~~ ~~0.01 kg/day~~ for freshwater; 0.015 kg/day for saltwater)  
 $LC$  = lipid correction factor to adjust BCFs normalized to 7.6% lipids to represent a 3% lipid content ( $3\% \div 7.6\%$ )  
 $BCF$  = bioconcentration factor (L/kg)

---

### WATER AND FISH, NONCARCINOGENS

$$HH \text{ CRITERIA } (\mu\text{g} / \text{L}) = \frac{(RfD)(BW)(U)}{WI + (FC)(LC)(BCF)}$$

---

### FISH TISSUE ONLY, NONCARCINOGENS

$$HH \text{ CRITERIA } (\mu\text{g} / \text{L}) = \frac{(RfD)(BW)(U)}{(FC)(LC)(BCF)}$$

- 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  $\mu\text{g/L}$  (1000  $\mu\text{g/mg}$ )  
 $WI$  = 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 ( $3\% \div 7.6\%$ )  
 $BCF$  = bioconcentration factor (L/kg)

These formulas ~~shown on the previous page~~ 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 the development of effluent limits based on water-quality criteria-based effluent limits (WQBELs),~~ 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) segments 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 105 on page 148. If an approved ~~total maximum daily load (TMDL)~~ exists for a particular pollutant and ~~AU~~segment, 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 56 in ~~Appendix C of this document~~ on page 146 lists reliable background concentration data that are used routinely in application screening. Data are added to Table 56 as they become available.

When reliable background concentration data are not available, data are screened with the assumption that the background concentration is zero ~~and permits include a reopener clause~~. 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):

$$WLA = \frac{\textit{Criterion} - [(1 - E_F)(C_B)(\textit{Bioavailable Fraction})]}{(\textit{Bioavailable Fraction})(E_F)}$$

where:

- WLA* = waste load allocation (total concentration)
- Criterion* = appropriate numerical criterion (dissolved, free ion, or total concentration as specified in 30 TAC §307.6, Table 1 or 23 of the Standards)
- E<sub>F</sub>* = proportional contribution of effluent to receiving water
- C<sub>B</sub>* = background concentration of pollutant (total concentration)
- Bioavailable* = fraction of the pollutant that is defined to be available to



*Fraction* = organisms

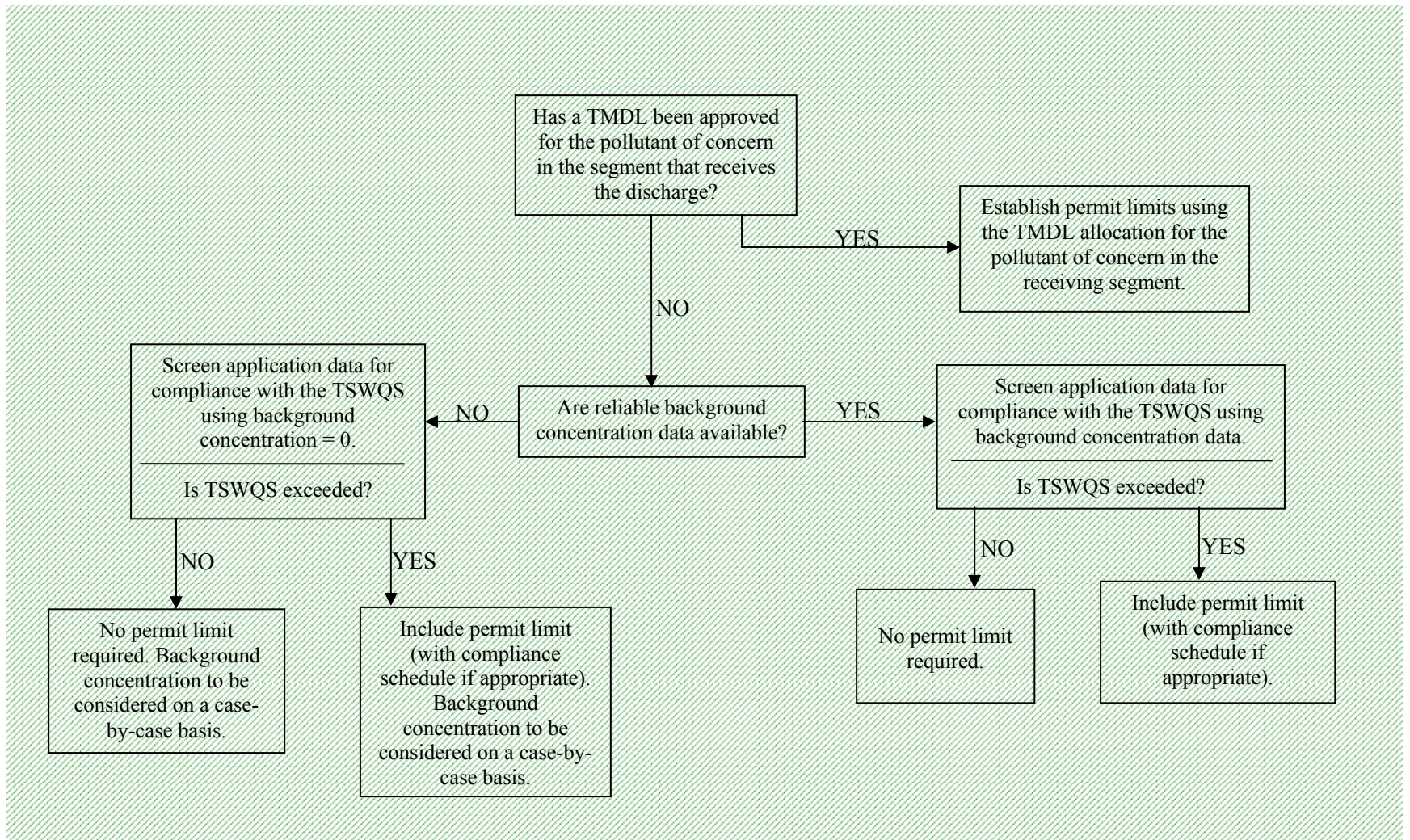
When the background concentration is assumed to be zero, the equation above reduces to those shown in the sections of this document entitled “Deriving Permit Limits for Aquatic Life Protection” on page 129 and “Deriving Permit Limits for Human Health Protection” on page 137.

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 45).

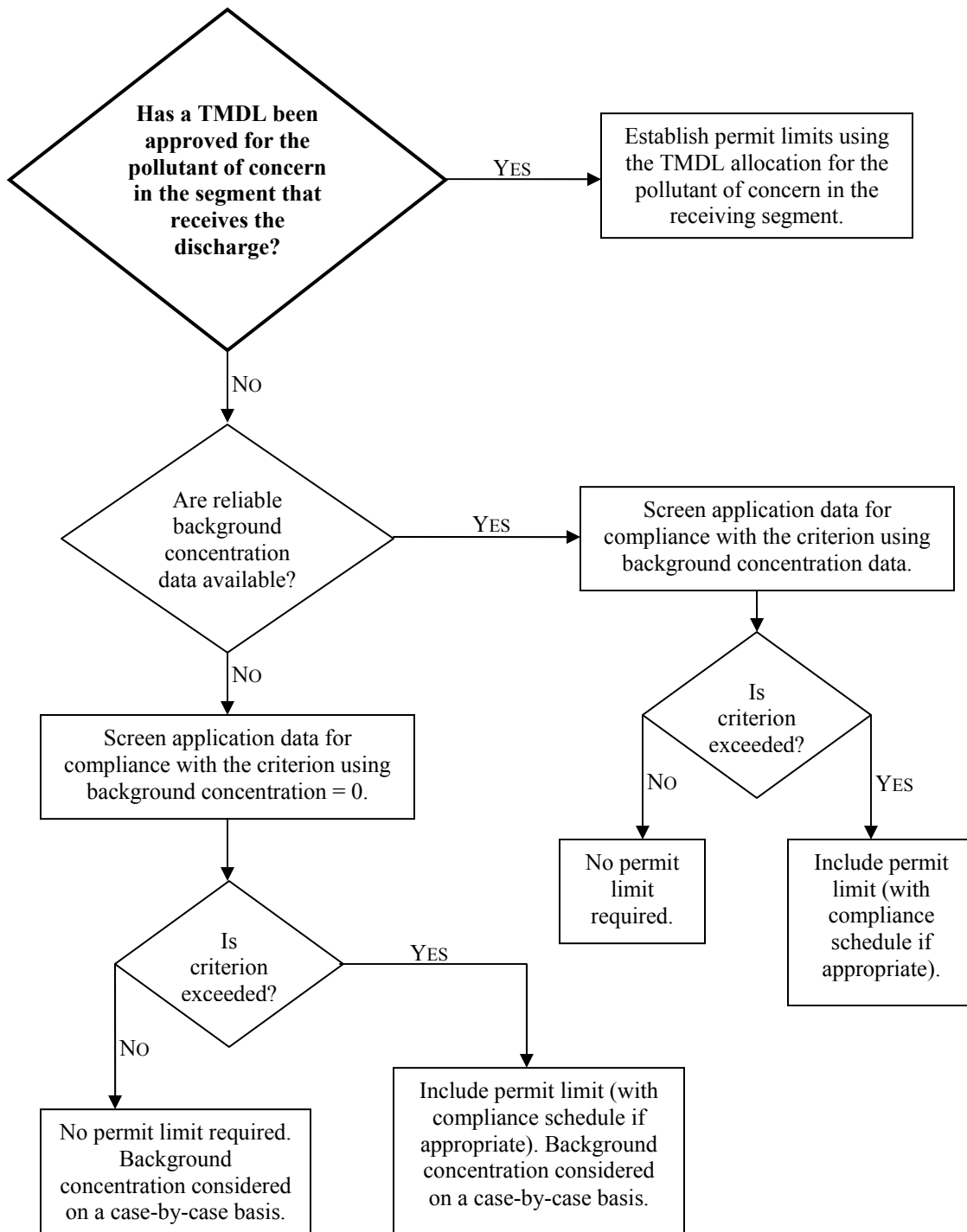
**Table 56. Background Concentrations of Toxic Metals in Texas Estuaries**

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 5. Protocol for the Inclusion of Background Concentrations in Establishing Permit Limits**



**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 8E-1 and Table 9E-2 in Appendix CE) 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 I: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue Manual, RG-415GI-252, Texas Natural Resource Conservation Commission on Environmental Quality, December 2003~~June 1999~~ (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 ~~30 TAC §section~~ 307.8(d) of the Standards, the TCEQ does not require effluent limits based on water-quality criteria-based effluent limits (WQBELs) 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 ~~WQBEL~~ effluent limits based on water quality criteria for the pollutant of concern, these limits will remain in the ~~reissued~~ new permit until sufficient monitoring has been conducted to support the exemption.
- If an existing permit does not include ~~WQBEL~~ 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 recommend granting or denying the exemption.

- If the exemption is approved, the permit is issued without ~~WQBELs~~ 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 ~~WQBELs~~ 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 5 in Appendix CD 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 155.

## ***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 15<sup>th</sup> 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 ~~30 TAC §section~~ 307.8(b) of the Standards and the section of this document entitled “Mixing Zones and ~~Critical Conditions~~ ZIDs for Aquatic Life Protection” on page 61.

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 hardness.

- Collect a minimum of 30 samples from the receiving water. The TCEQ prefers 30-50 samples to ensure that there are at least 30 valid data points and to get a more statistically reliable number for estimating the 15<sup>th</sup> percentile value. Samples should typically be taken a minimum of one week apart from one another.
- Measure hardness as mg/L of CaCO<sub>3</sub>.
- 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 15<sup>th</sup> 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 ~~30 TAC §~~section 307.8(b) of the Standards and the section of this document entitled, "Mixing Zones and ~~Critical Conditions~~ ZIDs for Aquatic Life Protection" on page 61. 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. The TCEQ prefers 30-50 samples to ensure that there are at least 30 valid data points and to get a more statistically reliable number for estimating the 15<sup>th</sup> percentile value. 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 50<sup>th</sup> 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 ~~30 TAC §~~section 307.8(b) of the Standards and the section of this document entitled, “Mixing Zones and ~~Critical Conditions~~ ZIDs for Aquatic Life Protection” on page 61.

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. The TCEQ prefers 30-50 samples to ensure that there are at least 30 valid data points and to get a more statistically reliable number for estimating the 50<sup>th</sup> percentile value. 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 67)  
 $TSS$  = total suspended solids (mg/L)  
 $m$  = slope (found in Table 67)

Table 67 in Appendix C of this document 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 5 in Appendix D of this document along with the values and equations in Table 67 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 132.

**Table 67. Slope ( $m$ ) and Intercept ( $b$ ) Values Used to Calculate Partition Coefficients for Metals in Streams, Lakes, and Estuarine Systems**

METAL	STREAMS <sup>1</sup>		LAKES <sup>1</sup>		ESTUARINE SYSTEMS <sup>2</sup>	
	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 <sup>3</sup>	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

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> 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.

**Example Calculation:**

Assume TSS = 15 mg/L in a river. Find  $K_p$  and  $C_d/C_T$  for Nickel.

$$K_p = 10^{5.69} \times 15^{-0.57} = 0.49 \times 10^6 \times 15^{-0.57} = 0.10467 \times 10^6$$

$$\frac{C_d}{C_T} = \frac{1}{1 + (0.10467 \times 10^6 \times 15 \times 10^{-6})} = 0.389$$

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 15<sup>th</sup> 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 15<sup>th</sup> 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 ~~30 TAC §section~~ 307.8(b) of the Standards and the section of this document entitled, "Mixing Zones and ~~Critical Conditions~~ ZIDs for Aquatic Life Protection" on page 61.

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. The TCEQ prefers 30-50 samples to ensure that there are at least 30 valid data points and to get a more statistically reliable number for estimating the 15<sup>th</sup> percentile value. Samples should typically be taken a minimum of one week apart from one another.

- If the permit includes whole effluent toxicity (WET)-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 67, 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 samples from the receiving water. The TCEQ prefers 30-50 samples to ensure that there are at least 30 valid data points and to get a more statistically reliable estimate of the 85<sup>th</sup> percentile value of the dissolved-to-total ratio.
- 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 85<sup>th</sup> 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 132.)

~~For aluminum, available information indicates that measurements of the dissolved portion of the metal may underestimate the bioavailable fraction. Therefore, the permittee will need to demonstrate that the use of an aluminum partition coefficient different from the default value of one used by the TCEQ will not cause instream effects.~~

## 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) 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 this,~~ 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 waste water, 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 155. The number of data points needed 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.

$$\frac{\text{WATER COLUMN CRITERION (mg/L)}}{\text{BAF or BCF (L/kg)}} = \text{TISSUE CRITERION (mg/kg)}$$

In accordance with EPA’s 2000 guidance for developing human health

criteria<sup>17</sup>, 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, the 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.

<u>Pollutant</u>	<u>BCF (L/kg)</u>
<u>DDT</u>	<u><math>5.36 \times 10^4</math></u>
<u>DDD</u>	<u><math>5.36 \times 10^4</math></u>
<u>DDE</u>	<u><math>5.36 \times 10^4</math></u>
<u>Dioxin</u>	<u><math>5.0 \times 10^3</math></u>
<u>Mercury</u>	<u><math>3.3 \times 10^4</math></u>
<u>PCB</u>	<u><math>3.12 \times 10^4</math></u>

While the 2001 final EPA methylmercury criteria document<sup>18</sup> 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  $3.3 \times 10^4$ , which is also discussed in the final EPA criteria document, will 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 137.

### **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 toxicity equivalency factors (TEFs). The World Health Organization updated EPA has listed TEFs for

<sup>17</sup> 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.

<sup>18</sup> 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.



4,4-dioxin/furans in 2005 and also included TEF values for dioxin-like PCBs. ~~the document titled Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans and 1989 Update, EPA/625/3-89/016.~~ The Standards contain TEFs for ~~fifteen~~ seventeen 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	<del>10.5</del>
2378 HxCDDs	0.1
<u>1234678 HpCDD</u>	<u>0.01</u>
<u>OCDD</u>	<u>0.0003</u>
2378 TCDF	0.1
12378 PeCDF	<del>0.030.05</del>
23478 PeCDF	<del>0.30.5</del>
2378 HxCDFs	0.1
<u>23478 HpCDFs</u>	<u>0.01</u>
<u>OCDF</u>	<u>0.0003</u>
<u>PCB 77</u>	<u>0.0001</u>
<u>PCB 81</u>	<u>0.0003</u>
<u>PCB 126</u>	<u>0.1</u>
<u>PCB 169</u>	<u>0.03</u>

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 toxicity 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.

~~Dioxin/furan 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 136)~~

### **Calculating Permit Limits for Silver**

The Standards express aquatic life criteria~~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 155.)

For silver, the TCEQ uses partition coefficient slopes and intercepts (see ~~Table 67 in Appendix C of this document on page 156~~) derived from data collected by the Texas Environmental Advisory Council (~~TEAC~~). 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.<sup>19</sup>

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.<sup>20</sup> 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:

$$Y = e^{e^{\left(\frac{1}{0.6659+0.0044 Cl}\right)}}$$

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 50<sup>th</sup> percentile value of dissolved chloride concentrations for each segment (shown in ~~Table 5 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 153).

When the 50<sup>th</sup> 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 155 for ~~variable~~ definitions of  $C_d$

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*Fraction Available* =  $\frac{C_d}{C_t} \times \frac{Y}{100}$   
<sup>19</sup> 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.

<sup>20</sup> *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Part I*, U.S. Environmental Protection Agency, EPA 600/6-85-002a, 1985.

and  $C_T$ ):

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 Dioxin/Furan***

[Moved to section “Calculating Permit Limits for Mercury, PCBs, Dioxins/Furans, DDT, DDD, and DDE.”]

### ***Calculating Permit Limits for Chromium***

The Standards for the protection of aquatic life are expressed as dissolved concentrations for hexavalent chromium ( $\text{Cr}^{+6}$ ) and trivalent chromium ( $\text{Cr}^{+3}$ ). The method to calculate permit limits for total recoverable concentrations of  $\text{Cr}^{+3}$  and dissolved concentrations for  $\text{Cr}^{+6}$  is described in this section.

As part of the permit application, permittees analyze their effluent for dissolved  $\text{Cr}^{+6}$  and total recoverable chromium. Total recoverable chromium is the sum of dissolved  $\text{Cr}^{+6}$ , adsorbed  $\text{Cr}^{+6}$ , dissolved  $\text{Cr}^{+3}$ , and adsorbed  $\text{Cr}^{+3}$ :

$$\text{total recoverable Cr} = \text{dissolved Cr}^{+6} + \text{adsorbed Cr}^{+6} \\ + \text{dissolved Cr}^{+3} + \text{adsorbed Cr}^{+3}$$

The analytical method for  $\text{Cr}^{+6}$  measures only for the dissolved form. The TCEQ assumes that the amount of adsorbed  $\text{Cr}^{+6}$  is negligible. Therefore, total  $\text{Cr}^{+3}$  is calculated by subtracting dissolved  $\text{Cr}^{+6}$  from the total recoverable chromium:

$$\text{total Cr}^{+3} = \text{total recoverable Cr} - \text{dissolved Cr}^{+6}$$

The ~~slope and intercept values~~~~partition coefficient~~ for chromium, listed in Table 67 in Appendix C on page 156, ~~are~~ is not applicable to  $\text{Cr}^{+6}$  because dissolved concentrations alone are measured. Therefore, the  $\text{Cr}^{+6}$  permit limit is calculated using standard procedures and assuming 100% of  $\text{Cr}^{+6}$  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~~~~partition coefficient~~ in Table 67 and standard procedures are used to calculate  $\text{Cr}^{+3}$  permit limits. The calculated permit limit is compared to the total  $\text{Cr}^{+3}$  concentration in the effluent to determine whether monitoring requirements or permit limits are needed.

The slope and intercept values ~~partition coefficient~~ in Table 67 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 ~~30 TAC §~~section 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 Section 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.

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 ~~30 TAC 307~~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 8E-1 in Appendix E for general MALs for permit application screening, and See Table 9E-2 in Appendix 9E for MALs and analytical methods for the determination of pollutants regulated by section 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 ~~30 TAC §section 307.6 of the Standards~~. One of the goals of establishing the MALs has been 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 168). 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 the reported MAL 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 163) 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 an MAL of 20 µg/L. Test method SM3113B is used and the laboratory reports nondetect at the associated MAL of 20 µg/L. The TCEQ will evaluate this analytical result as a detection at 20 µg/L. Comparing the 20 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*

### **Alternate Analytical Test Procedures Methods**

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 ~~analytical-test procedures methods~~ 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 Section 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.

~~Because analysis of cyanide by the amenable to chlorination method has frequent interferences from organics, the Standards indicate that compliance can be determined using either this method or the weak acid dissociable method.~~

### ***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 ~~Analytical~~ Test Procedures ~~Methods~~” (see page 168).

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

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## 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 ~~30~~ FAC §section 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  $\geq 1$  MGD, all industrial majors, and industrial minors on a case-by-case basis ~~that discharge process water~~.

## *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 do 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 173 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 181 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 165) 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 ~~Figure 7~~ 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** 
$$C_{TDS} = \frac{C_C}{500 \text{ mg/L}} \times 2,500 \text{ mg/L}$$

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.

<b>If <math>C_{TDS}</math></b>	<b>then <math>C_{sv} =</math></b>
$\leq 2,500$ mg/L	2,500 mg/L
$> 2,500$ mg/L but $\leq 6,000$ 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:

<b>Other Specific Types of Intermittent Streams</b>	<b>If <math>C_{TDS}</math></b>	<b>then <math>C_{sv} =</math></b>
Intermittent streams that are demonstrated to be dry except for very short-term flow in immediate response to rainfall	$< 4,000$ mg/L $\geq 4,000$ mg/L	$4,000$ mg/L $C_{TDS} \geq 4,000$ mg/L
Constructed ditches that convey storm water and/or wastewater effluent that are considered water in the state	$< 4,000$ mg/L $\geq 4,000$ mg/L	$4,000$ mg/L $C_{TDS} \geq 4,000$ mg/L
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<sub>4</sub>) 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.

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**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<sup>3</sup>/s) of the perennial stream or river
- $C_A$  = ambient TDS concentration (mg/L)
- $Q_E$  = effluent flow (ft<sup>3</sup>/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 71.
- $C_A$**  The ambient TDS concentration is the median (50<sup>th</sup> percentile) concentration of TDS for the first downstream segment. Sources for determining the median TDS concentration include: (1) the Tables 5 in Appendix E of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database ~~(telephone 239-~~

~~DATA~~); 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<sub>E</sub>** 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<sub>E</sub>** 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<sub>C</sub>** 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<sub>F</sub>** 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 68.
- C<sub>E</sub>** The effluent TDS concentration is based on the average effluent data provided in the permit application.
- C<sub>A</sub>** 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 5~~ in Appendix ~~CD~~ of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database ~~(telephone 239-239-2399)~~; 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 (~~SMCLs~~, 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 5~~ in Appendix ~~CD~~ of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database ~~(telephone 239-DATA)~~; 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 (SMCLs, 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 5~~ in Appendix ~~CD~~ of this document; (2) the most recent five years of TDS data in the Surface Water Quality Monitoring Information System (SWQMIS) database ~~(telephone 239-DATA)~~; 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/Identifying 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 116 on page 181).

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.

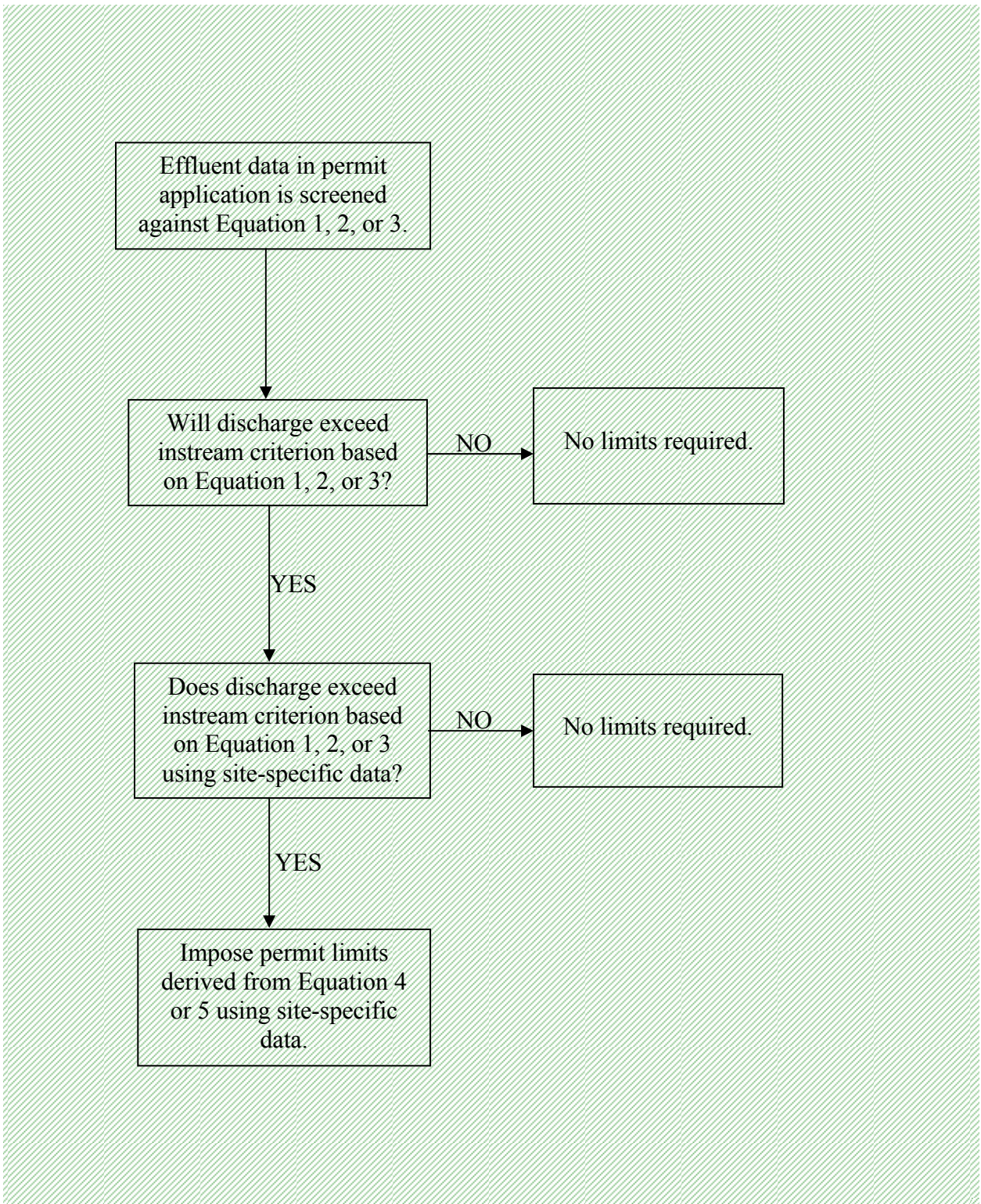
## **Establishing Permit Limits for TDS**

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 ~~Figure 7~~ Table 7 on page 185 for a summary of permit limit calculation methods as they apply to different types of water bodies.

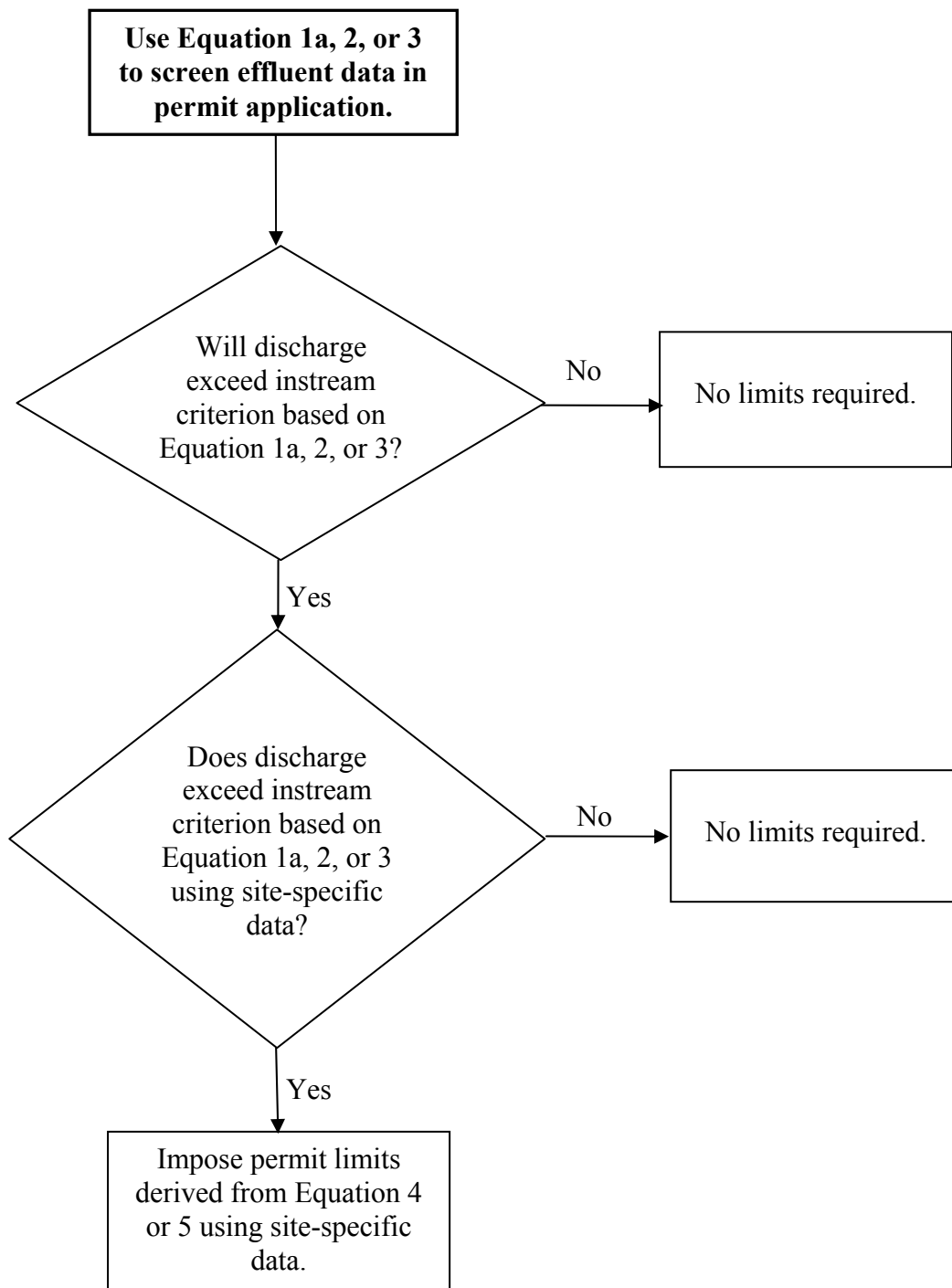
### ***Unclassified Intermittent Streams***

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 consider 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 137.



**Figure 6. Establishing Permit Limits for Total Dissolved Solids**



**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:

$$\text{Equation 4} \quad C_E = \frac{(C_C)(Q_E + Q_S) - (Q_S)(C_A)}{Q_E}$$

where:

- $C_E$  = calculated effluent TDS concentration (mg/L)
- $C_C$  = segment TDS criterion (mg/L)
- $Q_E$  = effluent flow (ft<sup>3</sup>/s)
- $Q_S$  = harmonic mean flow (ft<sup>3</sup>/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:

$$\text{Equation 5} \quad C_E = \frac{C_C - (1 - E_F)(C_A)}{E_F}$$

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 137.

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 165.

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. The resolution, however, 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 ~~30-TAC~~ §section 307.5 of the Standards and in the chapter of this document entitled “Antidegradation” (see page 45) are also applicable.

**Table 7. Summary of TDS Screening and Limit Calculation Methods**

Water Body Type	Screening Method	Limit Calculation Method
<b>Intermittent stream</b> (see page 173)	If $C_E < C_{SV}$ , a TDS limit is usually not required, where:  $C_{SV} = 2,500 \text{ mg/L}$ if $C_{TDS} \leq 2,500 \text{ mg/L}$ , $C_{SV} = C_{TDS}$ if $2,500 \text{ mg/L} < C_{TDS} \leq 6,000 \text{ mg/L}$ , $C_{SV} = 6,000 \text{ mg/L}$ if $C_{TDS} > 6,000 \text{ mg/L}$ .  $C_{TDS} = \frac{(C_C)(2,500 \text{ mg/L})}{500 \text{ mg/L}}$  See page 174 for exceptions to these values.	$C_E = C_{SV}$ , or  $C_E = \text{other appropriate site-specific value.}$
<b>Perennial stream</b> (see page 175 and page 176)	If $C_C \geq \frac{Q_S C_A + Q_E C_E}{Q_E + Q_S}$ ,  a TDS limit is usually not required.	$C_E = \frac{(C_C)(Q_E + Q_S) - (Q_S)(C_A)}{Q_E}$
<b>Intermittent stream within three miles of a perennial stream</b> (see page 176)  or  <b>Intermittent stream with perennial pools</b> (see page 176)	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:  $C_{SV} = 2,500 \text{ mg/L}$ if $C_{TDS} \leq 2,500 \text{ mg/L}$ , $C_{SV} = C_{TDS}$ if $2,500 \text{ mg/L} < C_{TDS} \leq 6,000 \text{ mg/L}$ , $C_{SV} = 6,000 \text{ mg/L}$ if $C_{TDS} > 6,000 \text{ mg/L}$ .  $C_{TDS} = \frac{(C_C)(2,500 \text{ mg/L})}{500 \text{ mg/L}}$  See page 174 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  $C_E = \text{other appropriate site-specific value, whichever is smaller.}$
<b>Lake</b> (see page 176 and page 177)	If $C_C \geq (E_F)(C_E) + (1 - E_F)(C_A)$ ,  a TDS limit is usually not required.	$C_E = \frac{C_C - (1 - E_F)(C_A)}{E_F}$
<b>Bay or wide tidal river</b> (see page 178)	Compare $C_E$ to median and maximum segment TDS concentrations.	Avoid adverse effects of excessively high or excessively low effluent TDS concentrations.

**Figure 7. Summary of TDS Screening and Limit Calculation Methods**



# TPDES Storm Water Permits

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## 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 ~~regulated discharges of storm water~~ from municipal separate storm sewer systems (MS4s). These types of discharges are identified by state and federal regulation (30 TAC Section 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. 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 implementation plan
- the anti-backsliding policy—see 40 CFR 122.44(l)
- a history of substantive noncompliance
- 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 165) because storm water discharges are normally intermittent and occur during wet weather conditions.

As stated in ~~30 TAC §section~~ 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), ~~implementation of~~ incorporation of effluent limits based on water quality criteria in storm water permits ~~includes~~ 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) Sections 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
- 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 ~~based effluent limits (WQBELs)~~. 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. Nothing in this ~~chapter document~~, however, precludes the TCEQ from ~~implementing~~ assigning effluent limits based on water quality criteria to ~~WQBELs on 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
- 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), ~~or 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 ~~should~~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 ~~30 TAC §section 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 ~~are~~ 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 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<sup>2+</sup> is only eligible for coverage under a general storm water permit if:

- it is consistent with the approved TMDL or and the TMDL implementation plan **and**
- the ~~facility~~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

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<sup>2+</sup>~~According to the November 22, 2002, EPA letter approving this document, permits must be issued in accordance with the TMDL, regardless of whether a separate implementation plan will be developed.~~

## **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

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## General Provisions

As stated in ~~30 TAC §section~~ 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 ~~30 TAC §section~~ 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 196), “Site-Specific Standards for Recreational Use” (see page 201), “Site-Specific Numerical Standards for Aquatic Life” (see page 203), and “Site-Specific Standards for Total Toxicity” (see page 208).

## 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 ~~30 TAC §section~~ 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 permit, 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 ~~30 TAC §section~~ 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 ~~30 TAC §section~~ 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 ~~M~~ memorandum of ~~A~~ agreement (MOA) with the EPA on assumption of the NPDES program, the TCEQ agreed that the 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 the EPA, along with the technical information that the permittee provides to support the variance request. The 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, the 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 12).

## 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 ~~30 TAC~~ §section 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
- Controls more stringent than those required by sections 301(b) and 306 of the federal Clean Water Act would result in substantial and widespread economic and social impact.

In accordance with ~~30 TAC~~ §section 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 ~~30 TAC~~ §section 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 §section 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 3. 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
- the kinds of site complications that require additional analysis.

### **Aquatic Life UAA Review and Approval Procedure**

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 198 and provides a response to the TCEQ. Additional time may be needed for EPA review of streams with "site complications" (see page 200 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 the 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.

Data collection, compilation, and analysis may be conducted by TCEQ, the

applicant, river authorities, or governmental or other entities. TCEQ staff review each UAA in order to ensure conformance with the basic protocol. If TCEQ decides a lower aquatic life use designation is justified, then TCEQ sends the UAA to EPA Region 6 for review and preliminary approval.

*UAAs for unclassified streams.* Within 30 days after receiving a UAA for a “typical site” on an unclassified stream, EPA reviews the UAA in accordance with the protocol entitled “UAA for Typical Sites (Unclassified Streams)” on page 167 and provides a response to the TCEQ. Additional time may be needed for EPA review of streams with “site complications” (see page 169 for more information). Preliminary approval of a UAA by 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.

TCEQ will designate site-specific aquatic life uses in 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 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).

*UAAs for classified streams.* For classified streams, 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.

The TCEQ reviews the UAA to ensure conformance with basic protocol. If the UAA indicates that the attainable use is lower than the designated use, the TCEQ sends the UAA to EPA. After reviewing the UAA, EPA sends a response to the TCEQ. Preliminary approval of a UAA by 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 (Unclassified Streams)**

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. and so on~~) 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 *TNRCC Receiving Water Assessment Procedures Manual*, GI-253, June 1999~~ most recent version of the TCEQ's *Surface Water Quality Monitoring Procedures, Volumes 1 and 2*, RG-415 and RG-416 ~~or the most recent publication~~. This document is available ~~upon request from TCEQ's Water Quality Standards Team; or, 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 ~~GI-253~~RG-416 (see preceding bulleted item).
  - Apply quantitative indices in accordance with the ~~GI-253~~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 Chief Engineer's Office for review.  
~~TCEQ sends the results of the UAA to EPA as a summary report with the presentation of results on a standardized receiving water assessment form (Appendix D of GI-253, cited above).~~

### ***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 sections 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 Chief Engineer's Office. 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.

### **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 ~~30 TAC~~ section 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 evaluate 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***

~~*of concern in receiving waters, sediment, and/or indigenous biota.*~~ (See ~~30 TAC §~~section 307.6(c)(10)(A) of the Standards.) 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. 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***

~~*materials.*~~ (See ~~30 TAC §~~section 307.6(c)(10)(B) of the Standards.) 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. 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).

~~*Synergistic, additive, or antagonistic i*~~

### ***Interactions of Toxic Substances with Other Toxic or Nontoxic Materials***

(See ~~30 TAC §~~section 307.6(c)(10)(C) of the Standards.) 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. 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. A synergistic interaction may, however, necessitate stricter permit limits to protect the receiving waters.

### ***Measurements of Total Effluent Toxicity***

(See ~~30 TAC §~~section 307.6(c)(10)(D) of the Standards.) To demonstrate that a site-specific standard may be appropriate, an applicant may perform WET tests using indigenous receiving water species. 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***

~~*that may have different responses to particular toxic materials.*~~ (See ~~30 TAC §~~section 307.6(c)(10)(E) of the Standards.) 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. 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***

(See ~~30 TAC §~~section 307.6(c)(10)(F) of the Standards.) 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. 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 water-quality-based effluent limits (WQBELs).~~

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***

~~of concern, as determined by water-effect ratio tests or other analyses approved by the agency.~~ (See ~~30 TAC §~~section 307.6(c)(10)(G) of the Standards.) 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. 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 is successful, 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 (~~SMAV~~). 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 ~~particular~~ Substance***

(See ~~30 TAC §section~~ 307.6(c)(10)(H) of the Standards.) 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. 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 ~~30 TAC §section~~ 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 evaluate 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***

(See ~~30 TAC §section~~ 307.6(e)(2)(F)(i) of the Standards.) 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. The applicant should demonstrate

background toxicity by assessing toxicity in an area unimpacted by the discharge.

### ***Persistence and Degradation Rate of Principal Toxic Materials***

~~that are contributing to the total toxicity of the discharge.~~ (See ~~30 TAC §section~~ 307.6(e)(2)(F)(ii) of the Standards.) 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. 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***

~~in the discharge.~~ (See ~~30 TAC §section~~ 307.6(e)(2)(F)(iii) of the Standards.) An applicant may demonstrate that existing receiving-water-specific variables alter the toxic impacts of an effluent. The applicant should use receiving water biological studies or should perform whole effluent toxicity (WET) tests at critical conditions on receiving water samples collected immediately within the discharge plume to the end of the mixing zone.

### ***Indigenous Aquatic Organisms***

~~that may have different levels of sensitivity than the species used for total toxicity testing.~~ (See ~~30 TAC §section~~ 307.6(e)(2)(F)(iv) of the Standards.) 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. 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***

(See ~~30 TAC §section~~ 307.6(e)(2)(F)(v) of the Standards.) If the permittee cannot achieve the required total toxicity or chemical-specific permit limits with best available technology (BAT), then the permittee may apply for a modification of the effluent limit. 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 water quality based effluent limits (WQBELs)~~. The applicant should show that existing or designated receiving water quality uses are not impaired due to the modified permit limits.

# ~~Appendix A. Abbreviations~~

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# Appendix AB. Playa Lake Policy Statement

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# 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.

  
\_\_\_\_\_  
Dai Pearson, Executive Director  
TNRCC

10/20/97  
\_\_\_\_\_  
Date

**Appendix B. Locations of Federally  
Endangered and Threatened Aquatic  
and Aquatic-Dependent Species in  
Texas**

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**Table B3. Locations of Federally Endangered and Threatened Aquatic and Aquatic-Dependent Species in Texas**

Segment No.	Common Name	County	Water Body- <sup>1</sup>
0101	Arkansas River shiner	Hemphill Hutchinson Roberts	<u>Canadian River Below Lake Meredith</u>
0103	Arkansas River shiner	Oldham Potter	<u>Canadian River Above Lake Meredith</u>
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	<u>Colorado River Above Lake Buchanan</u>
1410	Concho water snake	Brown Coleman McCulloch Mills San Saba	<u>Colorado River Below O. H. Ivie Reservoir</u>
1411	Concho water snake	Coke	<u>E. V. Spence Reservoir</u>
1412	Concho water snake	Coke Mitchell	<u>Colorado River Below Lake J. B. Thomas</u>
1416	Clear Creek gambusia	Menard	Clear Creek <u>Wilkinson Spring (headspring of Clear Creek)</u>
1421	Concho water snake	Concho	<del>including</del> <u>Concho River</u> Dry Hollow in <del>Concho Co.</del> Kickapoo Creek
		Tom Green	<u>Concho River</u>
1426	Concho water snake	Coke	<del>including</del> <u>Colorado River Below E. V. Spence Reservoir</u>
		Runnels	<u>Colorado River Below E. V. Spence Reservoir</u> Ballinger Municipal Lake in <del>Runnels Co.</del> Bluff Creek Coyote Creek Elm Creek
1426	<del>Concho water snake</del>	Concho	<del>Kickapoo Creek</del>
1427	<u>Barton Springs salamander</u> <sup>1</sup>	<u>Blanco</u>	<u>Onion Creek</u>

Segment No.	Common Name	County	Water Body <sup>1</sup>
		<u>Hays</u>	<u>Bear Creek</u> <u>Little Bear Creek</u> <u>Onion Creek</u>
		<u>Travis</u>	<u>Bear Creek</u> <u>Onion Creek</u> <u>Slaughter Creek</u> <u>Williamson Creek</u>
1430	Barton Springs salamander <sup>21</sup>	Hays	<del><u>Barton Creek</u></del> <del>including:</del>
		Travis	<u>Barton Creek</u> <u>Upper Barton Spring</u> 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	<u>O. H. Ivie Reservoir</u>
1434	Houston Toad	Bastrop	Alum Creek Copperas Creek Gills Branch Piney Creek Price Creek Puss Hollow
1605	Houston toad	Lavaca	Laughlin's Sandy Creek
1809	Comal Springs dryopid beetle <sup>21</sup>	Hays	Fern Bank Springs
1811	Peck's Cave amphipod <sup>21</sup>	Comal	Comal Springs
1811	Comal Springs dryopid beetle <sup>21</sup>	Comal	Comal Springs
1811	Comal Springs riffle beetle <sup>21</sup>	Comal	Comal Springs
1811	Fountain darter <sup>21</sup>	Comal	<del>including</del> <u>Comal River</u> Landa Lake
1812	Peck's Cave amphipod <sup>21</sup>	Comal	Hueco Springs
1814	Comal Springs riffle beetle <sup>21</sup>	Hays	San Marcos Springs <u>Spring Lake</u>
1814	Fountain darter <sup>21</sup>	Hays	<del>including</del> <u>Upper San Marcos River</u> <u>Purgatory Creek</u> <u>San Marcos National Fish Hatchery refugium</u> <u>Sessom Creek</u> Spring Lake <u>Willow Spring Creek</u>
1814	San Marcos gambusia <sup>21</sup>	Hays	<del>including</del> <u>Upper San Marcos River</u> Spring Lake
1814	San Marcos salamander <sup>21</sup>	Hays	<del>including</del> <u>Upper San Marcos River</u> San Marcos National Fish Hatchery refugium San Marcos Springs outflows San Marcos Springs Spring Lake

Segment No.	Common Name	County	Water Body- <sup>1</sup>
1814	Texas blind salamander <sup>21</sup>	Hays	<u>Upper San Marcos River</u> Ezell's Cave pool F. Johnson's fissure pool Primer's fissure pool Rattlesnake Cave pool <u>San Marcos National Fish Hatchery refugium</u> San Marcos Springs San Marcos Springs outflows SWTSU artesian well outlet
1814	Texas wild-rice <sup>21</sup>	Hays	<del>including-Upper San Marcos River</del> San Marcos National Fish Hatchery refugium Spring Lake
2109	Fountain darter <sup>21</sup>	Uvalde	Uvalde National Fish Hatchery refugium
2109	Comanche Springs pupfish	Uvalde	Uvalde National Fish Hatchery refugium
2109	Texas wild-rice <sup>21</sup>	Uvalde	Uvalde National Fish Hatchery refugium
2304	Devil's River minnow	Kinney	Las Moras Creek <u>Las Moras Spring</u> <u>Pinto Creek</u> <u>Pinto Spring</u> <u>Sycamore Creek</u>
		Val Verde	Sycamore Creek
2306	Big Bend gambusia	Brewster	<u>Spring 1 (Rio Grande Village, Big Bend NP)</u> Big Bend National Park refugium
<del>2309</del>	<del>Devil's River minnow</del>	<del>Kinney</del>	<del>Phillips Creek</del>
2309	Devil's River minnow	Val Verde	<u>Devils River</u> <u>Dolan Creek</u> <u>Finegan Spring</u> <u>Pecan Springs</u> <u>Phillips Creek</u>
<del>2311</del>	<del>Pecos pupfish</del>	<del>Culberson</del>	<del>Salt Creek</del>
2311	Pecos gambusia	Jeff Davis	<del>Balmorhea irrigation canals</del> <del>Phantom Lake Spring and canal system</del>
		Pecos	Diamond Y Draw Diamond Y Spring <u>Leon Creek</u>
		Reeves	Balmorhea irrigation canals East Sandia Spring <u>Giffin Spring and canal system</u> <u>San Salomon Spring (Balmorhea State Park)</u> <u>San Solomon Spring (Balmorhea State Park)</u> Toyah Creek
2311	Little Aguja pondweed	Jeff Davis	Little Aguja Creek
2311	Comanche Springs pupfish	Jeff Davis	<del>Balmorhea irrigation canals</del> <del>Phantom Lake Spring and canal system in Jeff Davis Co.</del>



Segment No.	Common Name	County	Water Body <sup>1</sup>
		Reeves	Balmorhea irrigation canals Giffin Spring and canal system San Solomon Spring (Balmorhea State Park) in <del>Reeves Co.</del> Toyah Creek
2311	Leon Springs pupfish	Pecos	Diamond Y Draw Diamond Y Spring <u>Leon Creek</u>
<del>2311</del>	<del>Pecos pupfish</del>	<del>Reeves</del>	<del>Salt Creek</del>
<u>2311</u>	<u>Pecos assiminea snail</u>	<u>Pecos</u>	<u>Upper Pecos River</u> <u>Diamond Y Draw</u> <u>East Sandia Spring</u>
<u>2311</u>	<u>Puzzle sunflower</u>	<u>Pecos</u>	<u>Diamond Y Spring</u>
2313	Devil's River minnow	Val Verde	San Felipe Creek
2411	Piping plover <sup>2</sup>	Jefferson	<u>Sabine Pass</u> <del>Petroleum facilities<sup>3</sup></del>
2421	Piping plover <sup>2</sup>	Chambers Galveston	<u>Upper Galveston Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2422	Piping plover <sup>2</sup>	Chambers Galveston	<u>Trinity Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2423	Piping plover <sup>2</sup>	Galveston	<u>East Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2424	Piping plover <sup>2</sup>	Brazoria Galveston	<u>West Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2432	Piping plover <sup>2</sup>	Brazoria	<u>Chocolate Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2433	Piping plover <sup>2</sup>	Brazoria	<u>Bastrop Bay/Oyster Lake</u> <del>Petroleum facilities<sup>3</sup></del>
2434	Piping plover <sup>2</sup>	Brazoria	<u>Christmas Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2435	Piping plover <sup>2</sup>	Brazoria	<u>Drum Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2439	Piping plover <sup>2</sup>	Galveston	<u>Lower Galveston Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2441	Piping plover <sup>2</sup>	Matagorda	<u>East Matagorda Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2442	Piping plover <sup>2</sup>	Brazoria Matagorda	<u>Cedar Lakes</u> <del>Petroleum facilities<sup>3</sup></del>
2451	Piping plover <sup>2</sup>	Calhoun Matagorda	<u>Matagorda Bay/Powderhorn Lakes</u> <del>Petroleum facilities<sup>3</sup></del>
2452	Piping plover <sup>2</sup>	Matagorda	<u>Tres Palacios Bay/Turtle Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2461	Piping plover <sup>2</sup>	Calhoun	<u>Espiritu Santo Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2461	Whooping crane	Calhoun	<u>Espiritu Santo Bay</u>
2462	Piping plover <sup>2</sup>	Calhoun	<u>San Antonio Bay/Hynes Bay/Guadalupe Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2462	Whooping crane	Calhoun	<u>San Antonio Bay/Hynes Bay/Guadalupe Bay</u>
2463	Piping plover <sup>2</sup>	Aransas	<u>Mesquite Bay/Carlos Bay/Ayres Bay</u> <del>Petroleum facilities<sup>3</sup></del>
2463	Whooping crane	Aransas	<u>Mesquite Bay/Carlos Bay/Ayres Bay</u>

Segment No.	Common Name	County	Water Body <sup>1</sup>
2471	Piping plover <sup>2</sup>	Aransas	<u>Aransas Bay</u> <del>Petroleum facilities</del> <sup>3</sup>
2471	Whooping crane	Aransas	<u>Aransas Bay</u>
<u>2472</u>	<u>Piping plover</u> <sup>2</sup>	<u>Aransas Refugio</u>	<u>Copano Bay/Port Bay/Mission Bay</u>
2472	Whooping crane	Aransas Refugio	<u>Copano Bay/Port Bay/Mission Bay</u>
2473	Whooping crane	Aransas	<u>St. Charles Bay</u>
2481	Piping plover <sup>2</sup>	Nueces	<u>Corpus Christi Bay</u> <del>Petroleum facilities</del> <sup>3</sup>
2483	Piping plover <sup>2</sup>	Nueces	<u>Redfish Bay</u> <del>Petroleum facilities</del> <sup>3</sup>
<u>2485</u>	<u>Piping plover</u> <sup>2</sup>	<u>Nueces</u>	<u>Oso Bay</u>
2491	Piping plover <sup>2</sup>	Cameron Kenedy Kleberg Nueces Willacy	<u>Laguna Madre</u> <del>Petroleum facilities</del> <sup>3</sup>
2492	Piping plover <sup>2</sup>	Kenedy Kleberg	<u>Baffin Bay/Alazan Bay/Cayo del Grullo/Laguna Salada</u> <del>Petroleum facilities</del> <sup>3</sup>
2493	Piping plover <sup>2</sup>	Cameron	<u>South Bay</u> <del>Petroleum facilities</del> <sup>3</sup>
<u>2494</u>	<u>Piping plover</u> <sup>2</sup>	<u>Cameron</u>	<u>Brownsville Ship Channel</u>
<u>2501</u>	<u>Piping plover</u> <sup>2</sup>	<u>Cameron</u>	<u>Gulf of Mexico</u>

<sup>1</sup> The water bodies listed in this column are where the endangered, threatened, or proposed species are known to occur. Unless the word “including” is used, the species are not found in the segment, only in watersheds that drain to the segment.

<sup>21</sup> Includes segments that cross the contributing and recharge zones of the southern section of the Edwards Aquifer (see Table 34 on page 14) as well as the Comal River (Segment 1811) and Lower San Marcos River (Segment 1808).

<sup>32</sup> 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. Tables~~

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~~Table 1. Aquatic Life Use Subcategories~~

~~[Moved to the Chapter “Determining Water Quality Uses and Criteria.”]~~

~~Table 2. Critical Low-flow Values for Dissolved Oxygen for the Eastern and Southern Texas Ecoregions as Described in 30 TAC §307.7(b)(3)(A)(ii)~~

~~[Moved to the Chapter “Dissolved Oxygen Modeling.”]~~

~~Table 4. Segments that Cross the Contributing and Recharge Zones of the Southern Section of the Edwards Aquifer~~

~~[Moved to the Chapter “Evaluating Impacts on Water Quality.”]~~

~~Table 6. Background Concentrations of Toxic Metals in Texas Estuaries<sup>1</sup>~~

~~[Moved to the Chapter “Toxic Pollutants.”]~~

~~Table 7. Slope and Intercept Values Used to Calculate Partition Coefficients for Metals in Streams,~~

~~Lakes, and Estuarine Systems~~

~~[Moved to the Chapter “Toxic Pollutants.”]~~

# **Appendix C. Critical Low-Flows and Harmonic Mean Flows for Classified Segments**

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**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/ivers 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.

<u>Seg- ment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low- Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
0101	<u>Canadian River</u>	<u>07228000</u>	<u>Hemphill</u>	<u>1980</u>	<u>2007</u>	<u>5.8</u>	<u>2.0</u>
0103	<u>Canadian River</u>	<u>07227500</u>	<u>Potter</u>	<u>1978</u>	<u>2007</u>	<u>0.23</u>	<u>1.3</u>
0104	<u>Wolf Creek</u>	<u>07235000</u>	<u>Lipscomb</u>	<u>1979</u>	<u>2007</u>	<u>0.38</u>	<u>1.1</u>
0201	<u>Red River</u>	<u>07337000</u>	<u>Bowie</u>	<u>1979</u>	<u>2007</u>	<u>1714</u>	<u>5017</u>
0202	<u>Red River</u>	<u>07336820</u>	<u>Bowie</u>	<u>1974</u> <u>2005</u>	<u>1998</u> <u>2008</u>	<u>1108</u>	<u>4431</u>
		<u>07335500</u>	<u>Lamar</u>	<u>1980</u>	<u>2008</u>	<u>817</u>	<u>2895</u>
		<u>07331600</u>	<u>Grayson</u>	<u>1973</u> <u>1997</u>	<u>1989</u> <u>2008</u>	<u>143</u>	<u>479</u>
0204	<u>Red River</u>	<u>07316000</u>	<u>Cooke</u>	<u>1980</u>	<u>2008</u>	<u>268</u>	<u>672</u>
		<u>07315500</u>	<u>Montague</u>	<u>1979</u>	<u>2007</u>	<u>160</u>	<u>497</u>
0205	<u>Red River</u>	<u>07308500</u>	<u>Wichita</u>	<u>1979</u>	<u>2007</u>	<u>61</u>	<u>46</u>
0206	<u>Red River</u>	<u>07299570</u>	<u>Hardeman</u>	<u>1960</u>	<u>1982</u>	<u>0.11</u>	<u>0.57</u>
0207	<u>Prairie Dog Town Fork Red River</u>	<u>07299540</u>	<u>Childress</u>	<u>1979</u>	<u>2007</u>	<u>0.75</u>	<u>2.2</u>
		<u>07298500</u>	<u>Hall</u>	<u>2003</u>	<u>2007</u>	<u>0.10*</u>	<u>0.21</u>
0211	<u>Little Wichita River</u>	<u>07314900</u>	<u>Clay</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.19</u>
0214	<u>Wichita River</u>	<u>07312700</u>	<u>Clay</u>	<u>1979</u>	<u>2007</u>	<u>43</u>	<u>110</u>
		<u>07312500</u>	<u>Wichita</u>	<u>1979</u>	<u>2007</u>	<u>18</u>	<u>53</u>
		<u>07312130</u>	<u>Wichita</u>	<u>1996</u>	<u>2002</u>	<u>2.4</u>	<u>5.1</u>
0216	<u>Wichita River</u>	<u>07312100</u>	<u>Baylor</u>	<u>1979</u>	<u>2007</u>	<u>0.44</u>	<u>1.4</u>
0218	<u>Wichita River</u>	<u>07311900</u>	<u>Baylor</u>	<u>1962</u> <u>1997</u>	<u>1979</u> <u>2007</u>	<u>1.6</u>	<u>6.2</u>
		<u>07311700</u>	<u>Knox</u>	<u>1979</u>	<u>2007</u>	<u>6.4</u>	<u>14</u>
0218	<u>North Fork Wichita River</u>	<u>07311600</u>	<u>Cottle</u>	<u>1961</u> <u>1995</u>	<u>1982</u> <u>2007</u>	<u>4.3***</u>	<u>8.8</u>
0220	<u>Pease River</u>	<u>07307800</u>	<u>Cottle</u>	<u>1979</u>	<u>2007</u>	<u>1.0</u>	<u>3.3</u>

<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
<u>0222</u>	<u>Salt Fork Red River</u>	<u>07300000</u>	<u>Collingsworth</u>	<u>1979</u>	<u>2007</u>	<u>2.3</u>	<u>9.6</u>
<u>0224</u>	<u>North Fork Red River</u>	<u>07301300</u>	<u>Wheeler</u>	<u>1970</u> <u>2001</u>	<u>1991</u> <u>2007</u>	<u>0.10*</u>	<u>0.17</u>
<u>0226</u>	<u>South Fork Wichita River</u>	<u>07311800</u>	<u>Knox</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.86</u>
		<u>07311783</u>	<u>King</u>	<u>1986</u>	<u>2005</u>	<u>0.10*</u>	<u>0.10*</u>
		<u>07311782</u>	<u>King</u>	<u>1985</u> <u>1987</u>	<u>1986</u> <u>2005</u>	<u>0.10*</u>	<u>2.5</u>
<u>0229</u>	<u>Prairie Dog Town Fork Red River</u>	<u>07297910</u>	<u>Armstrong</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.61</u>
<u>0230</u>	<u>Pease River</u>	<u>07308200</u>	<u>Wilbarger</u>	<u>1970</u> <u>1992</u>	<u>1982</u> <u>2007</u>	<u>0.10*</u>	<u>0.67</u>
<u>0301</u>	<u>Sulphur River</u>	<u>07344200<sup>a</sup></u>	<u>Bowie</u>	<u>1980</u> <u>1982</u>	<u>1980</u> <u>2008</u>	<u>57</u>	<u>82</u>
<u>0303</u>	<u>Sulphur River</u>	<u>07343200</u>	<u>Franklin</u>	<u>1993</u>	<u>2007</u>	<u>7.3</u>	<u>1.8</u>
	<u>South Sulphur River</u>	<u>07342500</u>	<u>Delta</u>	<u>1993</u>	<u>2007</u>	<u>1.8</u>	<u>2.6</u>
<u>0305</u>	<u>North Sulphur River</u>	<u>07343000</u>	<u>Delta</u>	<u>1979</u>	<u>2007</u>	<u>0.00</u>	<u>0.45</u>
<u>0306</u>	<u>South Sulphur River</u>	<u>07342465</u>	<u>Hunt</u>	<u>1992</u>	<u>2007</u>	<u>0.10*</u>	<u>0.17</u>
<u>0402</u>	<u>Big Cypress Creek</u>	<u>07346000</u>	<u>Marion</u>	<u>1980</u>	<u>2007</u>	<u>18</u>	<u>23</u>
<u>0404</u>	<u>Big Cypress Creek</u>	<u>07344493<sup>b</sup></u>	<u>Camp</u>	<u>1968</u> <u>2005</u>	<u>1989</u> <u>2007</u>	<u>3.7</u>	<u>12</u>
<u>0409</u>	<u>Little Cypress Bayou (Creek)</u>	<u>07346070</u>	<u>Marion</u>	<u>1979</u>	<u>2007</u>	<u>0.53</u>	<u>0.95</u>
		<u>07346050</u>	<u>Upshur</u>	<u>1971</u>	<u>1999</u>	<u>0.10*</u>	<u>1.1</u>
<u>0410</u>	<u>Black Cypress Bayou (Creek)</u>	<u>07346045</u>	<u>Marion</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.57</u>
<u>0502</u>	<u>Sabine River</u>	<u>08030500</u>	<u>Newton</u>	<u>1980</u>	<u>2008</u>	<u>1138</u>	<u>3298</u>
<u>0503</u>	<u>Sabine River</u>	<u>08028500</u>	<u>Newton</u>	<u>1980</u>	<u>2008</u>	<u>788</u>	<u>2323</u>
		<u>08026000</u>	<u>Newton</u>	<u>1980</u>	<u>2008</u>	<u>352</u>	<u>1226</u>
		<u>08025360</u>	<u>Newton</u>	<u>1980</u>	<u>2008</u>	<u>181</u>	<u>537</u>
<u>0505</u>	<u>Sabine River</u>	<u>08022040</u>	<u>Panola</u>	<u>1979</u>	<u>2007</u>	<u>79</u>	<u>262</u>
		<u>08020900</u>	<u>Gregg</u>	<u>1996</u>	<u>2007</u>	<u>89</u>	<u>207</u>
<u>0506</u>	<u>Sabine River</u>	<u>08020000</u>	<u>Gregg</u>	<u>1979</u>	<u>2007</u>	<u>59</u>	<u>190</u>
		<u>08019200</u>	<u>Wood</u>	<u>1998</u>	<u>2007</u>	<u>55</u>	<u>128</u>
		<u>08018500</u>	<u>Wood</u>	<u>1979</u>	<u>2007</u>	<u>6.2</u>	<u>8.3</u>
		<u>08017410</u>	<u>Van Zandt</u>	<u>1979</u>	<u>2007</u>	<u>0.30</u>	<u>0.89</u>
<u>0513</u>	<u>Big Cow Creek</u>	<u>08029500</u>	<u>Newton</u>	<u>1980</u>	<u>2008</u>	<u>34</u>	<u>65</u>
<u>0514</u>	<u>Big Sandy Creek</u>	<u>08019500</u>	<u>Upshur</u>	<u>1979</u>	<u>2007</u>	<u>12</u>	<u>31</u>
<u>0515</u>	<u>Lake Fork Creek</u>	<u>08019000</u>	<u>Wood</u>	<u>1986</u>	<u>2007</u>	<u>11</u>	<u>32</u>
<u>0602</u>	<u>Neches River</u>	<u>08041000</u>	<u>Jasper</u>	<u>1979</u>	<u>2007</u>	<u>2084</u>	<u>3387</u>
		<u>08040600<sup>c</sup></u>	<u>Jasper</u>	<u>1979</u>	<u>2007</u>	<u>1854</u>	<u>2822</u>
<u>0604</u>	<u>Neches River</u>	<u>08033500</u>	<u>Tyler</u>	<u>1979</u>	<u>2007</u>	<u>123</u>	<u>415</u>
		<u>08032000</u>	<u>Anderson</u>	<u>1979</u>	<u>2007</u>	<u>82</u>	<u>179</u>
<u>0607</u>	<u>Pine Island Bayou</u>	<u>08041700</u>	<u>Hardin</u>	<u>1979</u>	<u>2007</u>	<u>3.7</u>	<u>18</u>
<u>0608</u>	<u>Village Creek</u>	<u>08041500</u>	<u>Hardin</u>	<u>1979</u>	<u>2007</u>	<u>79</u>	<u>253</u>

<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
<u>0611</u>	<u>Angelina River</u>	<u>08036500</u>	<u>Cherokee</u>	<u>1979</u>	<u>2007</u>	<u>41</u>	<u>104</u>
<u>0612</u>	<u>Attoyac Bayou</u>	<u>08038000</u>	<u>Nacogdoches</u>	<u>1960</u>	<u>1985</u>	<u>26</u>	<u>67</u>
<u>0802</u>	<u>Trinity River</u>	<u>08066500</u>	<u>Liberty</u>	<u>1979</u>	<u>2007</u>	<u>775</u>	<u>2416</u>
		<u>08066250</u>	<u>Polk</u>	<u>1979</u>	<u>2007</u>	<u>728</u>	<u>2133</u>
<u>0804</u>	<u>Trinity River</u>	<u>08065350</u>	<u>Leon</u>	<u>1981</u>	<u>2008</u>	<u>825</u>	<u>2152</u>
		<u>08065000</u>	<u>Anderson</u>	<u>1982</u>	<u>2008</u>	<u>748</u>	<u>1812</u>
		<u>08062700</u>	<u>Henderson</u>	<u>1982</u>	<u>2007</u>	<u>722</u>	<u>1554</u>
<u>0805</u>	<u>Trinity River</u>	<u>08062500</u>	<u>Kaufman</u>	<u>1982</u>	<u>2007</u>	<u>678</u>	<u>1440</u>
		<u>08057410</u>	<u>Dallas</u>	<u>1975</u> <u>2003</u>	<u>1998</u> <u>2007</u>	<u>503</u>	<u>953</u>
		<u>08057000</u>	<u>Dallas</u>	<u>1989</u>	<u>2007</u>	<u>396</u>	<u>768</u>
<u>0806</u>	<u>West Fork Trinity River</u>	<u>08048543</u>	<u>Tarrant</u>	<u>1979</u>	<u>2007</u>	<u>13</u>	<u>38</u>
		<u>08048000</u>	<u>Tarrant</u>	<u>1979</u>	<u>2007</u>	<u>12</u>	<u>24</u>
<u>0810</u>	<u>West Fork Trinity River</u>	<u>08044500</u>	<u>Wise</u>	<u>1979</u>	<u>2007</u>	<u>7.0</u>	<u>3.9</u>
<u>0812</u>	<u>West Fork Trinity River</u>	<u>08042800</u>	<u>Jack</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.14</u>
<u>0814</u>	<u>Chambers Creek</u>	<u>08064100</u>	<u>Navarro</u>	<u>1984</u>	<u>2007</u>	<u>0.10*</u>	<u>0.71</u>
<u>0819</u>	<u>East Fork Trinity River</u>	<u>08062000</u>	<u>Kaufman</u>	<u>1993</u>	<u>2007</u>	<u>64</u>	<u>138</u>
		<u>08061750</u>	<u>Kaufman</u>	<u>2003</u>	<u>2007</u>	<u>25</u>	<u>55</u>
<u>0822</u>	<u>Elm Fork Trinity River</u>	<u>08055500</u>	<u>Dallas</u>	<u>1979</u>	<u>2007</u>	<u>15</u>	<u>15</u>
		<u>08053000</u>	<u>Denton</u>	<u>1979</u>	<u>2007</u>	<u>61</u>	<u>98</u>
<u>0824</u>	<u>Elm Fork Trinity River</u>	<u>08050400</u>	<u>Cooke</u>	<u>1998</u>	<u>2007</u>	<u>0.10*</u>	<u>0.23</u>
<u>0825</u>	<u>Denton Creek</u>	<u>08055000</u>	<u>Denton</u>	<u>1966</u> <u>2004</u>	<u>1990</u> <u>2007</u>	<u>11</u>	<u>21</u>
<u>0829</u>	<u>Clear Fork Trinity River</u>	<u>08047500</u>	<u>Tarrant</u>	<u>1979</u>	<u>2007</u>	<u>4.4</u>	<u>5.6</u>
		<u>08047000</u>	<u>Tarrant</u>	<u>1979</u>	<u>2007</u>	<u>1.6</u>	<u>2.7</u>
<u>0831</u>	<u>Clear Fork Trinity River</u>	<u>08045850</u>	<u>Parker</u>	<u>1980</u> <u>1991</u> <u>1993</u> <u>1998</u> <u>2001</u>	<u>1985</u> <u>1992</u> <u>1996</u> <u>1999</u> <u>2005</u>	<u>0.20</u>	<u>0.90</u>
<u>0835</u>	<u>Richland Creek</u>	<u>08064550<sup>d</sup></u>	<u>Freestone</u>	<u>1994</u>	<u>2008</u>	<u>5.0</u>	<u>6.5</u>
<u>0837</u>	<u>Richland Creek</u>	<u>08063100</u>	<u>Navarro</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.25</u>
<u>0839</u>	<u>Elm Fork Trinity River</u>	<u>08051100<sup>e</sup></u>	<u>Denton</u>	<u>1988</u>	<u>2008</u>	<u>2.0</u>	<u>5.9</u>
<u>0841</u>	<u>West Fork Trinity River</u>	<u>08049500</u>	<u>Dallas</u>	<u>1979</u>	<u>2007</u>	<u>140</u>	<u>270</u>
<u>0902</u>	<u>Cedar Bayou</u>	<u>08067500</u>	<u>Harris</u>	<u>1972</u> <u>2002</u>	<u>1991</u> <u>2007</u>	<u>0.27</u>	<u>1.1</u>
<u>1003</u>	<u>East Fork San Jacinto River</u>	<u>08070200</u>	<u>Montgomery</u>	<u>1984</u>	<u>2007</u>	<u>23</u>	<u>57</u>
		<u>08070000</u>	<u>Liberty</u>	<u>1979</u>	<u>2007</u>	<u>18</u>	<u>47</u>
<u>1004</u>	<u>West Fork San Jacinto River</u>	<u>08068090</u>	<u>Montgomery</u>	<u>1984</u>	<u>2007</u>	<u>26</u>	<u>77</u>
		<u>08068000</u>	<u>Montgomery</u>	<u>1979</u>	<u>2007</u>	<u>21</u>	<u>58</u>
		<u>08067650</u>	<u>Montgomery</u>	<u>1975</u> <u>1998</u>	<u>1989</u> <u>2000</u>	<u>0.10*</u>	<u>1.5</u>
<u>1008</u>	<u>Spring Creek</u>	<u>08068500<sup>f</sup></u>	<u>Montgomery</u>	<u>1979</u>	<u>2007</u>	<u>18</u>	<u>48</u>



<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
		<u>08068275</u>	<u>Montgomery</u>	<u>2000</u>	<u>2007</u>	<u>1.1</u>	<u>0.93</u>
<u>1009</u>	<u>Cypress Creek</u>	<u>08069000</u>	<u>Harris</u>	<u>1996</u>	<u>2007</u>	<u>27</u>	<u>57</u>
		<u>08068800</u>	<u>Harris</u>	<u>2002</u>	<u>2008</u>	<u>5.4</u>	<u>16</u>
		<u>08068740</u>	<u>Harris</u>	<u>1979</u>	<u>2007</u>	<u>0.33</u>	<u>0.85</u>
		<u>08068720</u>	<u>Harris</u>	<u>1979</u> <u>1984</u>	<u>1983</u> <u>2007</u>	<u>0.10*</u>	<u>0.31</u>
<u>1010</u>	<u>Caney Creek</u>	<u>08070500</u>	<u>Montgomery</u>	<u>1979</u>	<u>2007</u>	<u>14</u>	<u>30</u>
<u>1011</u>	<u>Peach Creek</u>	<u>08071000</u>	<u>Montgomery</u>	<u>1960</u> <u>1999</u>	<u>1977</u> <u>2007</u>	<u>11</u>	<u>21</u>
<u>1014</u>	<u>Buffalo Bayou</u>	<u>08073700</u>	<u>Harris</u>	<u>1985</u>	<u>2007</u>	<u>51</u>	<u>124</u>
		<u>08073600</u>	<u>Harris</u>	<u>1979</u>	<u>2007</u>	<u>44</u>	<u>106</u>
		<u>08073500</u>	<u>Harris</u>	<u>1979</u>	<u>2007</u>	<u>23</u>	<u>66</u>
<u>1016</u>	<u>Greens Bayou</u>	<u>08076000</u>	<u>Harris</u>	<u>1979</u>	<u>2007</u>	<u>22</u>	<u>39</u>
		<u>08075900</u>	<u>Harris</u>	<u>1984</u> <u>2007</u>	<u>1992</u> <u>2008</u>	<u>12</u>	<u>21</u>
<u>1017</u>	<u>Whiteoak Bayou</u>	<u>08074500</u>	<u>Harris</u>	<u>1980</u>	<u>2007</u>	<u>31</u>	<u>53</u>
		<u>08074020</u>	<u>Harris</u>	<u>2002</u>	<u>2007</u>	<u>14</u>	<u>26</u>
<u>1102</u>	<u>Clear Creek</u>	<u>08076997<sup>s</sup></u>	<u>Harris</u>	<u>1965</u> <u>2007</u>	<u>1992</u> <u>2008</u>	<u>0.53</u>	<u>2.2</u>
<u>1108</u>	<u>Chocolate Bayou</u>	<u>08078000</u>	<u>Brazoria</u>	<u>1979</u>	<u>2007</u>	<u>1.7</u>	<u>5.7</u>
<u>1202</u>	<u>Brazos River</u>	<u>08116650</u>	<u>Fort Bend</u>	<u>1976</u> <u>1984</u>	<u>1980</u> <u>2007</u>	<u>689</u>	<u>1608</u>
		<u>08114000</u>	<u>Fort Bend</u>	<u>1979</u>	<u>2007</u>	<u>753</u>	<u>2041</u>
		<u>08111500</u>	<u>Waller</u>	<u>1979</u>	<u>2007</u>	<u>841</u>	<u>1863</u>
<u>1204</u>	<u>Brazos River</u>	<u>08091000</u>	<u>Somervell</u>	<u>1979</u>	<u>2007</u>	<u>16</u>	<u>50</u>
<u>1206</u>	<u>Brazos River</u>	<u>08090800</u>	<u>Parker</u>	<u>1979</u>	<u>2007</u>	<u>37</u>	<u>129</u>
		<u>08089000</u>	<u>Palo Pinto</u>	<u>1979</u>	<u>2007</u>	<u>32</u>	<u>96</u>
		<u>08088610<sup>h</sup></u>	<u>Palo Pinto</u>	<u>1979</u>	<u>2007</u>	<u>25</u>	<u>62</u>
<u>1208</u>	<u>Brazos River</u>	<u>08088000</u>	<u>Young</u>	<u>1979</u>	<u>2007</u>	<u>4.6</u>	<u>5.8</u>
		<u>08082500</u>	<u>Baylor</u>	<u>1979</u>	<u>2007</u>	<u>0.16</u>	<u>2.0</u>
<u>1209</u>	<u>Navasota River</u>	<u>08110800</u>	<u>Robertson</u>	<u>1997</u>	<u>2007</u>	<u>12</u>	<u>47</u>
		<u>08110500</u>	<u>Leon</u>	<u>1980</u>	<u>2007</u>	<u>7.6</u>	<u>12</u>
<u>1211</u>	<u>Yegua Creek</u>	<u>08110000</u>	<u>Burleson</u>	<u>1969</u>	<u>1991</u>	<u>0.10*</u>	<u>0.33</u>
<u>1213</u>	<u>Little River</u>	<u>08106500</u>	<u>Milam</u>	<u>1979</u>	<u>2007</u>	<u>70</u>	<u>226</u>
		<u>08104500</u>	<u>Bell</u>	<u>1979</u>	<u>2007</u>	<u>68</u>	<u>169</u>
<u>1214</u>	<u>San Gabriel River</u>	<u>08106310</u>	<u>Milam</u>	<u>1981</u>	<u>1992</u>	<u>4.7</u>	<u>13</u>
		<u>08105700</u>	<u>Williamson</u>	<u>1981</u>	<u>2007</u>	<u>3.6</u>	<u>3.6</u>
<u>1215</u>	<u>Lampasas River</u>	<u>08104100</u>	<u>Bell</u>	<u>1970</u> <u>1999</u>	<u>1989</u> <u>2007</u>	<u>4.8</u>	<u>11</u>
<u>1217</u>	<u>Lampasas River</u>	<u>08103800</u>	<u>Lampasas</u>	<u>1979</u>	<u>2007</u>	<u>12</u>	<u>27</u>
<u>1219</u>	<u>Leon River</u>	<u>08102500</u>	<u>Bell</u>	<u>1980</u>	<u>2008</u>	<u>3.4</u>	<u>6.2</u>
<u>1221</u>	<u>Leon River</u>	<u>08100500</u>	<u>Coryell</u>	<u>1979</u>	<u>2007</u>	<u>4.7</u>	<u>3.2</u>

<u>Seg- ment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low- Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
		<u>08100000</u>	<u>Hamilton</u>	<u>1973</u>	<u>2001</u>	<u>0.10*</u>	<u>1.1</u>
<u>1223</u>	<u>Leon River</u>	<u>08099100</u>	<u>Comanche</u>	<u>1961</u>	<u>1986</u>	<u>0.10*</u>	<u>0.28</u>
<u>1226</u>	<u>North Bosque River</u>	<u>08095200</u>	<u>Bosque</u>	<u>1977</u>	<u>2005</u>	<u>7.4</u>	<u>3.3</u>
		<u>08095000</u>	<u>Bosque</u>	<u>1979</u>	<u>2007</u>	<u>2.6</u>	<u>1.9</u>
		<u>08094800</u>	<u>Hamilton</u>	<u>1969</u>	<u>1999</u>	<u>0.45</u>	<u>1.5</u>
<u>1227</u>	<u>Nolan River</u>	<u>08092000</u>	<u>Hill</u>	<u>1963</u> <u>1993</u> <u>1998</u>	<u>1985</u> <u>1996</u> <u>1999</u>	<u>1.2</u>	<u>2.5</u>
<u>1229</u>	<u>Paluxy River</u>	<u>08091500</u>	<u>Somervell</u>	<u>1979</u>	<u>2007</u>	<u>1.6</u>	<u>1.3</u>
<u>1232</u>	<u>Clear Fork Brazos River</u>	<u>08085500</u>	<u>Shackelford</u>	<u>1993</u>	<u>2008</u>	<u>1.5</u>	<u>2.7</u>
		<u>08084000</u>	<u>Jones</u>	<u>1994</u>	<u>2008</u>	<u>0.10*</u>	<u>0.35</u>
		<u>08083230</u>	<u>Jones</u>	<u>2002</u>	<u>2008</u>	<u>0.10*</u>	<u>0.10*</u>
		<u>08083100</u>	<u>Fisher</u>	<u>1994</u>	<u>2008</u>	<u>0.10*</u>	<u>0.10*</u>
<u>1238</u>	<u>Salt Fork Brazos River</u>	<u>08082000</u>	<u>Stonewall</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.31</u>
<u>1241</u>	<u>Double Mountain Fork Brazos River</u>	<u>08080500</u>	<u>Stonewall</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.62</u>
<u>1242</u>	<u>Brazos River</u>	<u>08110200</u>	<u>Washington</u>	<u>1966</u>	<u>1983</u>	<u>526</u>	<u>1536</u>
		<u>08108700<sup>l</sup></u>	<u>Brazos</u>	<u>1979</u>	<u>2007</u>	<u>489</u>	<u>1129</u>
		<u>08098290</u>	<u>Falls</u>	<u>1979</u>	<u>2007</u>	<u>167</u>	<u>459</u>
		<u>08096500</u>	<u>McLennan</u>	<u>1979</u>	<u>2007</u>	<u>52</u>	<u>128</u>
<u>1243</u>	<u>Salado Creek</u>	<u>08104310</u>	<u>Bell</u>	<u>1984</u>	<u>1996</u>	<u>16<sup>***</sup></u>	<u>32</u>
		<u>08104290</u>	<u>Bell</u>	<u>1984</u>	<u>1996</u>	<u>2.5<sup>†</sup></u>	<u>2.6</u>
<u>1244</u>	<u>Brushy Creek</u>	<u>08106300</u>	<u>Milam</u>	<u>1968</u>	<u>1980</u>	<u>3.4</u>	<u>6.2</u>
<u>1246</u>	<u>Middle Bosque River</u>	<u>08095300</u>	<u>McLennan</u>	<u>1960</u>	<u>1985</u>	<u>0.10*</u>	<u>0.46</u>
<u>1248</u>	<u>San Gabriel River</u>	<u>08104700</u> , <u>08104900<sup>l</sup></u>	<u>Williamson</u>	<u>1981</u>	<u>2007</u>	<u>3.5</u>	<u>7.6</u>
	<u>North Fork San Gabriel River</u>	<u>08104700</u>	<u>Williamson</u>	<u>1981</u>	<u>2007</u>	<u>1.1</u>	<u>1.9</u>
<u>1250</u>	<u>South Fork San Gabriel River</u>	<u>08104900</u>	<u>Williamson</u>	<u>1979</u>	<u>2007</u>	<u>0.25</u>	<u>0.67</u>
<u>1253</u>	<u>Navasota River</u>	<u>08110325</u>	<u>Limestone</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.23</u>
<u>1255</u>	<u>North Bosque River</u>	<u>08093700</u>	<u>Erath</u>	<u>1960</u>	<u>1979</u>	<u>0.10*</u>	<u>0.10*</u>
<u>1257</u>	<u>Brazos River</u>	<u>08093100</u>	<u>Hill</u>	<u>1979</u>	<u>2007</u>	<u>26</u>	<u>84</u>
<u>1302</u>	<u>San Bernard River</u>	<u>08117500</u>	<u>Fort Bend</u>	<u>1979</u>	<u>2007</u>	<u>14</u>	<u>59</u>
<u>1402</u>	<u>Colorado River</u>	<u>08162500</u>	<u>Matagorda</u>	<u>1980</u>	<u>2008</u>	<u>206</u>	<u>471</u>
		<u>08162000</u>	<u>Wharton</u>	<u>1980</u>	<u>2008</u>	<u>419</u>	<u>950</u>
		<u>08161000</u>	<u>Colorado</u>	<u>1980</u>	<u>2008</u>	<u>378</u>	<u>1005</u>
		<u>08160400</u>	<u>Fayette</u>	<u>1988</u>	<u>2008</u>	<u>341</u>	<u>919</u>
<u>1409</u>	<u>Colorado River</u>	<u>08147000</u>	<u>San Saba</u>	<u>1980</u>	<u>2008</u>	<u>34</u>	<u>27</u>
<u>1410</u>	<u>Colorado River</u>	<u>08138000</u>	<u>Brown</u>	<u>1998</u>	<u>2007</u>	<u>0.10*</u>	<u>1.5</u>
		<u>08136700</u>	<u>Coleman</u>	<u>1990</u>	<u>2008</u>	<u>3.9</u>	<u>7.7</u>
<u>1412</u>	<u>Colorado River</u>	<u>08123850</u>	<u>Coke</u>	<u>1993</u>	<u>2008</u>	<u>0.10*</u>	<u>0.38</u>

<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
		<u>08121000</u>	<u>Mitchell</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.14</u>
		<u>08119500</u>	<u>Scurry</u>	<u>1960</u>	<u>1989</u>	<u>0.10*</u>	<u>0.13</u>
<u>1414</u>	<u>Pedernales River</u>	<u>08153500</u>	<u>Blanco</u>	<u>1980</u>	<u>2008</u>	<u>4.2</u>	<u>6.6</u>
		<u>08152900</u>	<u>Gillespie</u>	<u>1980</u> <u>1998</u>	<u>1992</u> <u>2008</u>	<u>2.9</u>	<u>5.3</u>
<u>1415</u>	<u>Llano River</u>	<u>08151500</u>	<u>Llano</u>	<u>1980</u>	<u>2008</u>	<u>55</u>	<u>85</u>
		<u>08150700</u>	<u>Mason</u>	<u>1974</u> <u>1998</u>	<u>1992</u> <u>2007</u>	<u>82</u>	<u>149</u>
		<u>08150000</u>	<u>Kimble</u>	<u>1974</u> <u>1998</u>	<u>1992</u> <u>2007</u>	<u>80</u>	<u>124</u>
	<u>South Llano River</u>	<u>08149400</u>	<u>Edwards</u>	<u>1959</u>	<u>2008</u>	<u>13***</u>	<u>22</u>
	<u>North Llano River</u>	<u>08148500</u>	<u>Kimble</u>	<u>1960</u> <u>2002</u>	<u>1977</u> <u>2007</u>	<u>2.7</u>	<u>4.2</u>
<u>1416</u>	<u>San Saba River</u>	<u>08146000</u>	<u>San Saba</u>	<u>1975</u> <u>1998</u>	<u>1993</u> <u>2008</u>	<u>21</u>	<u>29</u>
		<u>08144600</u>	<u>McCulloch</u>	<u>1980</u> <u>1998</u>	<u>1993</u> <u>2008</u>	<u>1.3</u>	<u>2.0</u>
		<u>08144500</u>	<u>Menard</u>	<u>1975</u> <u>1998</u>	<u>1993</u> <u>2007</u>	<u>9.7</u>	<u>18</u>
<u>1417</u>	<u>Pecan Bayou</u>	<u>08143600</u>	<u>Mills</u>	<u>1979</u>	<u>2007</u>	<u>1.6</u>	<u>2.4</u>
<u>1420</u>	<u>Pecan Bayou</u>	<u>08140700</u>	<u>Brown</u>	<u>1968</u>	<u>1978</u>	<u>0.10*</u>	<u>0.10*</u>
<u>1421</u>	<u>Concho River</u>	<u>08136500</u>	<u>Concho</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.61</u>
		<u>08136000</u>	<u>Tom Green</u>	<u>1980</u>	<u>2008</u>	<u>0.10</u>	<u>0.24</u>
	<u>North Concho River</u>	<u>08135000</u>	<u>Tom Green</u>	<u>1960</u>	<u>1990</u>	<u>0.12</u>	<u>0.32</u>
<u>1424</u>	<u>Middle Concho River</u>	<u>08128400</u>	<u>Irion</u>	<u>1975</u> <u>2001</u>	<u>1995</u> <u>2008</u>	<u>0.10*</u>	<u>0.55</u>
	<u>South Concho River</u>	<u>08128000</u>	<u>Tom Green</u>	<u>1930</u> <u>2001</u>	<u>1995</u> <u>2008</u>	<u>2.4***</u>	<u>6.9</u>
<u>1426</u>	<u>Colorado River</u>	<u>08126380</u>	<u>Runnels</u>	<u>1979</u>	<u>2007</u>	<u>0.89</u>	<u>1.8</u>
		<u>08124000</u>	<u>Coke</u>	<u>1980</u>	<u>2008</u>	<u>0.41</u>	<u>0.26</u>
<u>1427</u>	<u>Onion Creek</u>	<u>08159000</u>	<u>Travis</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.79</u>
		<u>08158827</u>	<u>Travis</u>	<u>2003</u> <u>2005</u>	<u>2003</u> <u>2008</u>	<u>0.10*</u>	<u>0.24</u>
		<u>08158800</u>	<u>Hays</u>	<u>1980</u> <u>1992</u>	<u>1983</u> <u>1995</u>	<u>0.10*</u>	<u>0.10*</u>
		<u>08158700</u>	<u>Hays</u>	<u>1980</u>	<u>2008</u>	<u>0.19</u>	<u>0.61</u>
<u>1428</u>	<u>Colorado River</u>	<u>08158000</u>	<u>Travis</u>	<u>1980</u>	<u>2008</u>	<u>105</u>	<u>300</u>
<u>1430</u>	<u>Barton Springs</u>	<u>08155500</u>	<u>Travis</u>	<u>1978</u>	<u>2007</u>	<u>11**</u>	<u>49</u>
	<u>Barton Creek</u>	<u>08155400</u>	<u>Travis</u>	<u>1999</u>	<u>2007</u>	<u>0.10*</u>	<u>0.32</u>
		<u>08155300</u>	<u>Travis</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.19</u>
		<u>08155240</u>	<u>Travis</u>	<u>1989</u>	<u>2007</u>	<u>0.13</u>	<u>0.54</u>
		<u>08155200</u>	<u>Travis</u>	<u>1978</u> <u>1989</u>	<u>1982</u> <u>2007</u>	<u>0.10*</u>	<u>0.37</u>
<u>1432</u>	<u>Pecan Bayou</u>	<u>08143500</u>	<u>Brown</u>	<u>1960</u>	<u>1983</u>	<u>0.10*</u>	<u>0.43</u>
<u>1434</u>	<u>Colorado River</u>	<u>08159500</u>	<u>Bastrop</u>	<u>1998</u>	<u>2008</u>	<u>355</u>	<u>969</u>

<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
		<u>08159200</u>	<u>Bastrop</u>	<u>1980</u>	<u>2008</u>	<u>305</u>	<u>787</u>
<u>1502</u>	<u>Tres Palacios River</u>	<u>08162600</u>	<u>Matagorda</u>	<u>1979</u>	<u>2007</u>	<u>7.3</u>	<u>16</u>
<u>1602</u>	<u>Lavaca River</u>	<u>08164000</u>	<u>Jackson</u>	<u>1979</u>	<u>2007</u>	<u>16</u>	<u>1.4</u>
		<u>08163500</u>	<u>Lavaca</u>	<u>1964</u>	<u>1992</u>	<u>0.74</u>	<u>1.6</u>
<u>1605</u>	<u>Navidad River</u>	<u>08164390</u>	<u>Jackson</u>	<u>1997</u>	<u>2007</u>	<u>4.3</u>	<u>1.2</u>
		<u>08164300</u>	<u>Lavaca</u>	<u>1979</u>	<u>2007</u>	<u>1.5</u>	<u>1.6</u>
<u>1802</u>	<u>Guadalupe River</u>	<u>08188800</u>	<u>Calhoun</u>	<u>2001</u>	<u>2007</u>	<u>930</u>	<u>1690</u>
<u>1803</u>	<u>Guadalupe River</u>	<u>08176500</u>	<u>Victoria</u>	<u>1979</u>	<u>2007</u>	<u>525</u>	<u>850</u>
		<u>08175800</u>	<u>De Witt</u>	<u>1979</u>	<u>2007</u>	<u>525</u>	<u>804</u>
		<u>08173900</u>	<u>Gonzales</u>	<u>1997</u>	<u>2007</u>	<u>489</u>	<u>902</u>
<u>1806</u>	<u>Guadalupe River</u>	<u>08167500</u>	<u>Comal</u>	<u>1980</u>	<u>2008</u>	<u>74</u>	<u>115</u>
		<u>08167000</u>	<u>Kendall</u>	<u>1980</u>	<u>2008</u>	<u>55</u>	<u>100</u>
		<u>08166200</u>	<u>Kerr</u>	<u>1987</u>	<u>2007</u>	<u>47</u>	<u>84</u>
		<u>08166140</u>	<u>Kerr</u>	<u>1978</u> <u>1999</u>	<u>1985</u> <u>2007</u>	<u>52</u>	<u>78</u>
		<u>08165500</u>	<u>Kerr</u>	<u>1979</u>	<u>2007</u>	<u>30</u>	<u>47</u>
<u>1807</u>	<u>Coleta Creek</u>	<u>08177500</u>	<u>Victoria</u>	<u>1980</u>	<u>2007</u>	<u>2.2</u>	<u>2.2</u>
		<u>08176900</u>	<u>Victoria</u>	<u>1980</u>	<u>2007</u>	<u>1.2</u>	<u>0.90</u>
<u>1808</u>	<u>San Marcos River</u>	<u>08172000</u>	<u>Caldwell</u>	<u>1939</u>	<u>2007</u>	<u>81<sup>***</sup></u>	<u>185</u>
<u>1809</u>	<u>Blanco River</u>	<u>08171300</u>	<u>Hays</u>	<u>1980</u>	<u>2008</u>	<u>6.0</u>	<u>3.6</u>
<u>1810</u>	<u>Plum Creek</u>	<u>08173000</u>	<u>Caldwell</u>	<u>1971</u> <u>2002</u>	<u>1993</u> <u>2007</u>	<u>2.3</u>	<u>7.2</u>
		<u>08172400</u>	<u>Caldwell</u>	<u>1979</u>	<u>2007</u>	<u>0.10<sup>*</sup></u>	<u>0.23</u>
<u>1811</u>	<u>Comal River</u>	<u>08169000</u>	<u>Comal</u>	<u>1928</u>	<u>2008</u>	<u>64<sup>**</sup></u>	<u>226</u>
		<u>08168710</u>	<u>Comal</u>	<u>1928</u>	<u>2008</u>	<u>13<sup>**</sup></u>	<u>241</u>
<u>1812</u>	<u>Guadalupe River</u>	<u>08168500</u>	<u>Comal</u>	<u>1980</u>	<u>2008</u>	<u>112</u>	<u>178</u>
		<u>08167800</u>	<u>Comal</u>	<u>1980</u>	<u>2008</u>	<u>96</u>	<u>137</u>
<u>1813</u>	<u>Blanco River</u>	<u>08171000</u>	<u>Hays</u>	<u>1928</u>	<u>2008</u>	<u>9.4<sup>***</sup></u>	<u>31</u>
<u>1814</u>	<u>San Marcos River</u>	<u>08170000</u>	<u>Hays</u>	<u>1957</u>	<u>2008</u>	<u>55<sup>**</sup></u>	<u>155</u>
<u>1816</u>	<u>Johnson Creek</u>	<u>08166000</u>	<u>Kerr</u>	<u>1974</u> <u>1999</u>	<u>1993</u> <u>2007</u>	<u>11</u>	<u>20</u>
<u>1817</u>	<u>North Fork Guadalupe River</u>	<u>08165300</u>	<u>Kerr</u>	<u>1967</u>	<u>2007</u>	<u>13<sup>***</sup></u>	<u>24</u>
<u>1901</u>	<u>San Antonio River</u>	<u>08188500</u>	<u>Goliad</u>	<u>1979</u>	<u>2007</u>	<u>205</u>	<u>403</u>
<u>1902</u>	<u>Cibolo Creek</u>	<u>08186000</u>	<u>Karnes</u>	<u>1979</u>	<u>2007</u>	<u>15</u>	<u>28</u>
<u>1903</u>	<u>Medina River</u>	<u>08181500</u>	<u>Bexar</u>	<u>1979</u>	<u>2007</u>	<u>78</u>	<u>137</u>
		<u>08180800</u>	<u>Bexar</u>	<u>1973</u> <u>1998</u>	<u>1995</u> <u>2003</u>	<u>42</u>	<u>78</u>
		<u>08180700</u>	<u>Bexar</u>	<u>1981</u> <u>1997</u>	<u>1995</u> <u>2007</u>	<u>34</u>	<u>61</u>
		<u>08180640</u>	<u>Medina</u>	<u>1987</u>	<u>2000</u>	<u>29</u>	<u>42</u>
		<u>08180500</u>	<u>Medina</u>	<u>1960</u> <u>2001</u>	<u>1973</u> <u>2007</u>	<u>20</u>	<u>31</u>

<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
<u>1905</u>	<u>Medina River</u>	<u>08178880</u>	<u>Bandera</u>	<u>1983</u>	<u>2008</u>	<u>8.2<sup>***</sup></u>	<u>12</u>
<u>1906</u>	<u>Leon Creek</u>	<u>08181480</u>	<u>Bexar</u>	<u>1985</u>	<u>2007</u>	<u>2.5</u>	<u>5.7</u>
<u>1908</u>	<u>Cibolo Creek</u>	<u>08183900</u>	<u>Kendall</u>	<u>1965</u>	<u>1995</u>	<u>1.1</u>	<u>1.8</u>
		<u>08183850</u>	<u>Kendall</u>	<u>1997</u>	<u>2006</u>	<u>0.15</u>	<u>0.41</u>
<u>1910</u>	<u>Salado Creek</u>	<u>08178800</u>	<u>Bexar</u>	<u>1980</u>	<u>2008</u>	<u>3.9</u>	<u>5.4</u>
		<u>08178700</u>	<u>Bexar</u>	<u>1978</u>	<u>2006</u>	<u>0.10*</u>	<u>0.10</u>
<u>1911</u>	<u>San Antonio River</u>	<u>08183500</u>	<u>Karnes</u>	<u>1980</u>	<u>2008</u>	<u>144</u>	<u>321</u>
		<u>08181800</u>	<u>Bexar</u>	<u>1980</u>	<u>2008</u>	<u>136</u>	<u>299</u>
		<u>08178565</u>	<u>Bexar</u>	<u>1987</u>	<u>2007</u>	<u>13</u>	<u>36</u>
		<u>08178050</u>	<u>Bexar</u>	<u>1993</u>	<u>2007</u>	<u>8.7</u>	<u>20</u>
<u>1912</u>	<u>Medio Creek</u>	<u>08180750</u>	<u>Bexar</u>	<u>1987</u>	<u>1995</u>	<u>4.0</u>	<u>5.8</u>
<u>1913</u>	<u>Cibolo Creek</u>	<u>08185000</u>	<u>Bexar</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.10*</u>
<u>2002</u>	<u>Mission River</u>	<u>08189500</u>	<u>Refugio</u>	<u>1979</u>	<u>2007</u>	<u>4.7</u>	<u>1.2</u>
<u>2004</u>	<u>Aransas River</u>	<u>08189700</u>	<u>Bee</u>	<u>1979</u>	<u>2007</u>	<u>1.5</u>	<u>2.3</u>
<u>2102</u>	<u>Nueces River</u>	<u>08211500</u>	<u>San Patricio</u>	<u>1990</u>	<u>2007</u>	<u>0.10*</u>	<u>1.1</u>
		<u>08211200</u>	<u>San Patricio</u>	<u>2000</u>	<u>2007</u>	<u>66</u>	<u>137</u>
		<u>08211000</u>	<u>San Patricio</u>	<u>2000</u>	<u>2007</u>	<u>53</u>	<u>121</u>
<u>2104</u>	<u>Nueces River</u>	<u>08194600</u>	<u>Live Oak</u>	<u>1965</u>	<u>1977</u>	<u>0.10*</u>	<u>0.37</u>
		<u>08194500</u>	<u>McMullen</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.29</u>
<u>2105</u>	<u>Nueces River</u>	<u>08194000</u>	<u>La Salle</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.32</u>
		<u>08193000</u>	<u>Dimmit</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.12</u>
<u>2106</u>	<u>Nueces River</u>	<u>08210000</u>	<u>Live Oak</u>	<u>1984</u>	<u>2007</u>	<u>35</u>	<u>36</u>
		<u>08206910</u>	<u>Live Oak</u>	<u>1992</u>	<u>2008</u>	<u>29</u>	<u>35</u>
<u>2107</u>	<u>Atascosa River</u>	<u>08208000</u>	<u>Live Oak</u>	<u>1979</u>	<u>2007</u>	<u>0.44</u>	<u>1.0</u>
		<u>08207500</u>	<u>Atascosa</u>	<u>2003</u>	<u>2008</u>	<u>2.0</u>	<u>2.4</u>
<u>2108</u>	<u>San Miguel Creek</u>	<u>08206700</u>	<u>McMullen</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>0.16</u>
<u>2109</u>	<u>Leona River</u>	<u>08204005</u>	<u>Uvalde</u>	<u>2003</u>	<u>2008</u>	<u>9.7<sup>***</sup></u>	<u>27</u>
<u>2110</u>	<u>Sabinal River</u>	<u>08198500</u>	<u>Uvalde</u>	<u>1980</u>	<u>2008</u>	<u>0.63</u>	<u>1.2</u>
<u>2111</u>	<u>Sabinal River</u>	<u>08198000</u>	<u>Uvalde</u>	<u>1980</u>	<u>2008</u>	<u>8.8</u>	<u>1.8</u>
<u>2112</u>	<u>Nueces River</u>	<u>08192000</u>	<u>Uvalde</u>	<u>1980</u>	<u>2008</u>	<u>15</u>	<u>25</u>
		<u>08190000</u>	<u>Uvalde</u>	<u>1980</u>	<u>2008</u>	<u>41</u>	<u>74</u>
<u>2113</u>	<u>Frio River</u>	<u>08195000</u>	<u>Uvalde</u>	<u>1924</u>	<u>2008</u>	<u>13<sup>***</sup></u>	<u>31</u>
<u>2114</u>	<u>Hondo Creek</u>	<u>08200720<sup>k</sup></u>	<u>Medina</u>	<u>1978</u> <u>2007</u>	<u>2005</u> <u>2008</u>	<u>0.10*</u>	<u>0.10*</u>
		<u>08200000</u>	<u>Medina</u>	<u>1980</u>	<u>2008</u>	<u>1.0</u>	<u>1.0</u>
<u>2115</u>	<u>Seco Creek</u>	<u>08202700</u>	<u>Medina</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.10*</u>
		<u>08201500</u>	<u>Medina</u>	<u>1980</u>	<u>2008</u>	<u>0.71</u>	<u>0.56</u>
<u>2117</u>	<u>Frio River</u>	<u>08206600</u>	<u>McMullen</u>	<u>1979</u>	<u>2007</u>	<u>0.11</u>	<u>0.67</u>
		<u>08205500</u>	<u>Frio</u>	<u>1979</u>	<u>2007</u>	<u>0.10*</u>	<u>1.0</u>
		<u>08197500</u>	<u>Uvalde</u>	<u>1980</u>	<u>2008</u>	<u>0.10*</u>	<u>0.10*</u>

<u>Segment</u>	<u>Stream/River</u>	<u>Gage</u>	<u>County</u>	<u>Period of Record</u>		<u>Crit. Low-Flow (ft<sup>3</sup>/s)</u>	<u>Harmonic Mean Flow (ft<sup>3</sup>/s)</u>
				<u>Starts</u>	<u>Ends</u>		
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	1988 1989	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<sup>3</sup>/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 5<sup>th</sup> percentile of the data for the given period of record at the USGS gage.

† 7Q2 is estimated as the 10<sup>th</sup> percentile value of the available flow data.

<sup>a</sup> Data from U.S. Army Corp of Engineers – gated releases from Lake Wright Patman.

<sup>b</sup> 1968-1989 data from discontinued USGS gage 07344500.

<sup>c</sup> 1978-1989 data from discontinued USGS gage 08040500.

<sup>d</sup> Data from U.S. Army Corp of Engineers – gated releases from Richland-Chambers Reservoir.

<sup>e</sup> Data from U.S. Army Corp of Engineers – gated releases from Ray Roberts Lake.

<sup>f</sup> 1978-1995 data from discontinued USGS gage 08068520.

<sup>g</sup> 1965-1992 data from discontinued USGS gage 08077000.

<sup>h</sup> 1978-1989 data from discontinued USGS gage 08088600.

<sup>i</sup> 1978-1996 data from discontinued USGS gage 08109000.

<sup>j</sup> Daily average flows from each gage were added together, then the 7Q2 and harmonic mean flows were determined using the combined flows.

<sup>k</sup> 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.**

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**Table 5. Segment Specific Values for TSS, pH, Total Hardness, TDS, Chloride, and Sulfate**

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
0101	8	7.5	540	2910	840	439
0102	3	8.1	218	1170	335	275
0103	18	7.9	190	2080	610	369
0104	3	7.6	190 <sup>(a)</sup>	848	278	65
0105	21	8.3	194 <sup>(a)</sup>	740	45	43
0201	27	7.0	169 <sup>(a)</sup>	598	142	112.5
0202	24	7.1	160	760	180	140
0203	3	7.6	53 <sup>(a)</sup>	1242	330	219
0204	30	7.8	360	2750	1040	600
0205	33	7.8	790	4350	1700	1075
0206	11	7.5	169 <sup>(a)</sup>	13300	6520	2440
0207	15	7.5	1900	15900	17000	3060
0208	10	6.7	53 <sup>(a)</sup>	132	5	14
0209	4	6.7	53 <sup>(a)</sup>	104	7	15
0210	3	7.6	53 <sup>(a)</sup>	494	124	40
0211	28	7.2	36	430	67	12
0212	4	7.9	53 <sup>(a)</sup>	418	139	11
0213	5	8.0	53 <sup>(a)</sup>	306 <sup>(b)</sup>	49	13
0214	17	7.5	990	3010	1200	570
0215	4	7.8	53 <sup>(a)</sup>	3100	1130	725
0216	5	7.5	830	3120	1110.1	750
0217	4	7.52	53 <sup>(a)</sup>	3130	1135	784
0218	8	7.6	460	8060	4100	2100
0219	22	7.5	53 <sup>(a)</sup>	1004 <sup>(b)</sup>	340	65
0220	14	7.55	1148 <sup>(c)</sup>	21690	9600	2678
0221	7	7.4	169 <sup>(a)</sup>	2632 <sup>(b)</sup>	735	1070
0222	5	7.7	1500	2750	269	1350
0223	3	7.75	53 <sup>(a)</sup>	396	45	85
0224	5	7.6	169 <sup>(a)</sup>	1610	440	510
0225	12	6.4	169 <sup>(a)</sup>	120	15	6
0226	5	7.5	940	22400	5309.1	2600
0227	9 <sup>(a)</sup>	7.4 <sup>(a)</sup>	169 <sup>(a)</sup>	2360 <sup>(a)</sup>	944 <sup>(a)</sup>	690 <sup>(a)</sup>
0228	2	7.6	53 <sup>(a)</sup>	374	10	90

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
0229	8	7.7	169 <sup>(a)</sup>	1010	164	250
0230	9	7.4	1148 <sup>(a)</sup>	7530	3580	1690
0301	10	6.8	54 <sup>(a)</sup>	163	11	18
0302	7	7.0	57 <sup>(a)</sup>	132	11	17
0303	22	7.0	79	246	15	36
0304	6	6.5	54 <sup>(a)</sup>	300	76	31
0305	10	7.3	99	453	31	140
0306	25	7.4	54 <sup>(a)</sup>	418	27	58
0307	7 <sup>(a)</sup>	7.1	57 <sup>(a)</sup>	142 <sup>(b)</sup>	5.8	12
0401	3	5.9	17.8	88	13	12
0402	2	6.06	20.2 <sup>(a)</sup>	82	15	16
0403	2	6.4	27.5	110	15	24
0404	7	6.4	38	184	32	40
0405	3	6.6	23 <sup>(a)</sup>	92	15	17
0406	5	6.2	20.2	94	11	6
0407	5	5.9	20.2 <sup>(a)</sup>	76	20	6
0408	1	6.5	35	95	15	24
0409	3	6.1	28	122	19	17
0501	6	6.6	24	438	158	30.5
0502	12	6.5	24	108	16	14.9
0503	3	6.7	29	117	17	16
0504	1.5	6.5	28	126	19	15.4
0505	16	6.7	41	237	42	26
0506	16	6.8	50	201	35	27
0507	5	7.3	70	148	6	12
0508	11	6.4	36.4	406	66	26.7
0509	5	6.7	33 <sup>(a)</sup>	160	25	22
0510	3	6.2	33 <sup>(a)</sup>	98 <sup>(b)</sup>	28	14
0511	8	6.3	36	3110	317	30
0512	1.5	6.8	43	130	15	16
0513	5	6.02	12	32 <sup>(b)</sup>	5.01	2.5
0514	3	6.4	24	104	18.9	14
0515	11	6.7	51	216	42	30
0601	8	6.5	32	2540	590	100

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
0602	16	6.5	24	111	19	19
0603	6	6.4	26 <sup>(a)</sup>	101 <sup>(b)</sup>	17	19
0604	10	6.5	36	82	24	20
0605	4	6.6	32	112	24	27
0606	5	6.5	23 <sup>(a)</sup>	238	33	34
0607	10	6.22	25	168	23	10
0608	6	5.9	12	84	15	5
0609	2	6.4	20	114	16	18
0610	3	6.5	29.8	146	22	21
0611	9	6.3	30	141	20	22
0612	9	6.5	28	100	10	15
0613	2	6.5	26 <sup>(a)</sup>	73	10.4	9
0614	2	6.4	26 <sup>(a)</sup>	62	7	7
0615	7.45	6.5	29.8 <sup>(d)</sup>	224.5	42	40.6
0701	12	6.66	64	260	68	34
0702	13	6.8	104 <sup>(a)</sup>	11143	4200	566
0703	11	6.7	104 <sup>(a)</sup>	8060	4800	640
0704	11	6.7	74	232	50	37
0801	22	7.4	88	286	40.5	34
0802	8.4	7.4	92	204	26	35
0803	7	7.3	94	236	28	40
0804	40	7.2	116	338	40	58
0805	23	7.1	134	404	52	76.1
0806	10	7.4	140	282	35	38
0807	6	7.59	94 <sup>(a)</sup>	284 <sup>(b)</sup>	35	25
0808	5	7.5	76 <sup>(a)</sup>	268	36	22.7
0809	5	7.75	94 <sup>(a)</sup>	270	36	25.5
0810	12	7.5	76 <sup>(a)</sup>	488	57	40
0811	2	7.58	94 <sup>(a)</sup>	222	32.7	20
0812	28	7.13	76 <sup>(a)</sup>	530	60	40
0813	1.5	6.4	94 <sup>(a)</sup>	81	12	9
0814	16	7.5	76 <sup>(a)</sup>	316	21	66.9
0815	5	7.4	94 <sup>(a)</sup>	202 <sup>(b)</sup>	12	26
0816	4	7.2	94 <sup>(a)</sup>	187 <sup>(b)</sup>	7	15

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
0817	5	7.5	94 <sup>(a)</sup>	214 <sup>(b)</sup>	14	39
0818	5.5	7.2	94 <sup>(a)</sup>	114	12.7	25.4
0819	16	7.3	110	358	43	46
0820	5	7.5	94 <sup>(a)</sup>	179	11	26
0821	5	7.7	94 <sup>(a)</sup>	203	8	23
0822	12	7.53	100	269	23	40
0823	5	7.5	94 <sup>(a)</sup>	239	17	29
0824	5	7.6	140	620	57	51
0825	12	7.5	76 <sup>(a)</sup>	244	25	34
0826	5	7.4	94 <sup>(a)</sup>	200	21	27.5
0827	8	7.2	94 <sup>(a)</sup>	198 <sup>(b)</sup>	13	31
0828	5	7.5	101	209 <sup>(b)</sup>	19	29
0829	8	7.5	76 <sup>(a)</sup>	284	22	30
0830	6.1	7.6	94 <sup>(a)</sup>	215	23.9	27
0831	6	7.7	140	396	41	44
0832	4	7.6	94 <sup>(a)</sup>	294 <sup>(b)</sup>	44	31
0833	7	7.66	156	588	95	67
0834	2	7.1	94 <sup>(a)</sup>	185 <sup>(b)</sup>	30	11
0835	9	7.2	110	244 <sup>(b)</sup>	40	42
0836	2	7.25	94 <sup>(a)</sup>	182	12	33.3
0837	25	7.2	76 <sup>(a)</sup>	292	23	42
0838	4	7.5	156	358	21	110
0839	10	7.6	76 <sup>(a)</sup>	322 <sup>(a)</sup>	21	22
0840	3	7.2	94 <sup>(a)</sup>	190 <sup>(b)</sup>	17	16
0841	16	7.1	140	480	75	74
0901	18	7.5	1700	6760	2570	218
0902	4	7.14	54	322	81	17
1001	9	6.4	52	3250	2200	250
1002	9	6.79	40	167	26	9
1003	10	6.4	33	152	35	6
1004	12	6.8	60	194	40	10
1005	13	7.5	734	13088	6750	935
1006	11	7.1	419	5750	3700	570
1007	9	7.0	104	2360	1080	189

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
1008	13	6.7	30	239	53	10
1009	14	6.9	34	364	57	19
1010	6	6.5	37 <sup>(a)</sup>	105	16	5
1011	4	6.4	37 <sup>(a)</sup>	93	19	4
1012	3	7.0	61	135	16	4
1013	13	7.2	55	395	52	19
1014	18	7.2	43	396	74	25
1015	10	6.41	41	135 <sup>(b)</sup>	41	10
1016	19	7.5	78	502	86	45
1017	10	7.4	50	500	88.4	28
1101	17	7.4	492	1478	620	86
1102	19	7.3	136	521	120	40
1103	10	7.3	127	3550	2095	320
1104	13	7.2	158	538	108	62
1105	15	7.3	356	4936	2009	220
1107	19	7.6	2400	10500	4951	620
1108	12	7.2	170	461	110	48
1109	14	7.4	160	4660	1792	300
1110	15	7.3	133	302	68	30
1111	9	7.8	3644	27100	13880	2010
1113	16	7.5	161 <sup>(a)</sup>	2900	1187	145
1201	10	7.5	378	6912	3500	500
1202	33	7.6	160	437	92	67
1203	4	7.5	104 <sup>(a)</sup>	828	367	209
1204	5	7.8	230	1170	473	248
1205	5	7.5	104 <sup>(a)</sup>	1560 <sup>(b)</sup>	460	250
1206	7	7.7	230	1500	590	306
1207	2	7.4	104 <sup>(a)</sup>	2268	652.3	370
1208	19	7.7	430	4240	1900	900
1209	28.6	7.25	82	326	55	49
1210	18	7.4	104 <sup>(a)</sup>	176	9.4	12
1211	22	7.3	160 <sup>(a)</sup>	278 <sup>(b)</sup>	54	67
1212	8	7.2	104 <sup>(a)</sup>	280	43	56.3
1213	31	7.6	158	325	42	36

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
1214	15	7.4	170	424	23	28
1215	2	7.6	160 <sup>(a)</sup>	292	40	19
1216	3	7.5	104 <sup>(a)</sup>	396	57	21
1217	4	7.7	160 <sup>(a)</sup>	624	204	26
1218	4	7.2	160 <sup>(a)</sup>	390	51	47
1219	7	7.2	160 <sup>(a)</sup>	358	39	33
1220	3	7.5	104 <sup>(a)</sup>	282	39	29
1221	10	7.5	160 <sup>(a)</sup>	484	81	48
1222	10	7.66	104 <sup>(a)</sup>	450	101.2	47
1223	4	7.62	160 <sup>(a)</sup>	712	260	81.5
1224	4	7.4	104 <sup>(a)</sup>	382	95	48
1225	5	7.5	126	228	19	24
1226	4	7.4	160 <sup>(a)</sup>	295	25	29
1227	5	7.2	160 <sup>(a)</sup>	339	38	45
1228	6	7.5	104 <sup>(a)</sup>	193 <sup>(b)</sup>	12	15
1229	4	7.8	160 <sup>(a)</sup>	430	25	46.5
1230	5	7.2	104 <sup>(a)</sup>	312 <sup>(b)</sup>	42	35
1231	5	7.7	104 <sup>(a)</sup>	396 <sup>(b)</sup>	121	20
1232	16.8	7.7	580	2550	573	876
1233	3	7.7	216	632	242	63.6
1234	2	7.5	104 <sup>(a)</sup>	216	27	37
1235	12	7.8	104 <sup>(a)</sup>	1040	170	191
1236	5	7.8	200	494	94	78
1237	5	7.8	104 <sup>(a)</sup>	804	187	125
1238	5	7.5	1680	36400	15000	2410
1239	4	7.5	160 <sup>(a)</sup>	641 <sup>(b)</sup>	119	160
1240	4	7.9	104 <sup>(a)</sup>	482	102	41
1241	8	7.7	540	4380	1310	1380
1242	12	7.7	231.2	776	193	114
1243	0.94	7.3	160 <sup>(a)</sup>	290	14	16.8
1244	2.5	7.4	160 <sup>(a)</sup>	452	69	41
1245	16	7.2	140	376	73	50
1246	4	7.6	160 <sup>(a)</sup>	348	17	56
1247	8	7.6	104 <sup>(a)</sup>	270	20	24

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
1248	3	7.7	170	283	18	20
1249	2.5	7.4	104 <sup>(a)</sup>	288	11.8	17
1250	2	7.7	160 <sup>(a)</sup>	276	18	23
1251	0.5	7.8	200	284	13	22
1252	4	7.1	66	174	23	18
1253	17	7.3	66	276	25	16
1254	5	7.5	104 <sup>(a)</sup>	228	12	53
1255	5	7.4	160 <sup>(a)</sup>	597 <sup>(b)</sup>	102	49
1256	7.3	7.7	227.2	610	240	108
1257	2.25	7.6	230 <sup>(c)</sup>	631 <sup>(c)</sup>	317	190
1301	12	7.3	230	2090	2920	215
1302	18	7.2	65	280	54	18
1304	13	7.33	124	1120	182	61
1305	16	7.3	65 <sup>(a)</sup>	346	45	15
1401	10	7.55	224	9650	330	90
1402	10	7.8	200	334	54	42
1403	1	7.6	180	306	60	39
1404	1	7.44	190	304	65	38.8
1405	2.5	7.6	176	322	73	43
1406	3	7.4	179	304	72.8	43
1407	2	7.5	181	388	100	67
1408	2	7.54	195	414	106	66
1409	17	7.71	252	496	114	79
1410	15	7.6	320	1198 <sup>(d)</sup>	360 <sup>(d)</sup>	242 <sup>(d)</sup>
1411	5	7.8	188 <sup>(a)</sup>	2963	730	445
1412	11	7.6	610	5020	1600	990
1413	7	7.8	188 <sup>(a)</sup>	341 <sup>(b)</sup>	43	61
1414	5	8.0	184	420	56	32.1
1415	2.5	7.9	150	239	22	14
1416	10	7.8	174 <sup>(a)</sup>	310	24	18
1417	12	7.8	140	578 <sup>(b)</sup>	125	71
1418	5	7.48	188 <sup>(a)</sup>	306	80	39
1419	3	7.4	188 <sup>(a)</sup>	342	73	47
1420	10	7.4	174 <sup>(a)</sup>	640	147	102



Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
1421	13	7.69	381	1220	475	250
1422	9	7.9	188 <sup>(a)</sup>	600	185	81
1423	5	7.85	188 <sup>(a)</sup>	472	102	51
1424	2.5	7.6	174 <sup>(a)</sup>	372	49	16
1425	5	7.7	188 <sup>(a)</sup>	531	85	44
1426	15	7.68	190	2460 <sup>(a)</sup>	850 <sup>(a)</sup>	774 <sup>(a)</sup>
1427	2	7.5	170	283	23	32
1428	4	7.4	180	348	57.8	42
1429	2	7.5	199	328	52.1	39
1430	2	7.4	79	258	18	28
1431	5	7.25	174 <sup>(a)</sup>	690	213	89
1432	5	7.6	174 <sup>(a)</sup>	540	101	73
1433	2	7.5	188 <sup>(a)</sup>	1050	336	224
1434	5	7.8	190	346	59	44.1
1501	17	7.35	173 <sup>(a)</sup>	512	290	60.9
1502	14	7.5	111 <sup>(a)</sup>	514	117	23
1601	10	7.57	50 <sup>(a)</sup>	452	92	27
1602	7	7.6	150	441	71	24
1603	6.9	7.6	50	265 <sup>(b)</sup>	58	43
1604	7.4	7.15	54.4	145 <sup>(b)</sup>	19	11
1605	5	7.55	146	480	81	17
1701	31	7.85	— <sup>(a)</sup>	5800	1305	220
1801	43	7.55	157	430	72	51
1802	41.8	7.7	200.6	327 <sup>(b)</sup>	65.2	52
1803	11.14	7.76	190.9	325	36	30
1804	5	7.58	199	296	20.4	24
1805	2.3	7.6	159	222	15	18
1806	3	7.8	196	286	18	13
1807	4.1	7.65	88	498	102	24
1808	8	7.7	214	330	25.9	27
1809	2	7.6	156 <sup>(a)</sup>	240	13	23
1810	12	7.5	202	783	172	88
1811	1	7.2	221	313	16	24
1812	2.1	7.78	178	249	15	18

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
1813	4	7.7	166	280	13	25
1814	2	7.4	226	359	19	22.4
1815	0.5	7.5	191	298	13	15
1816	3.1	7.9	156 <sup>(+)</sup>	314	23	10
1817	0.5	7.6	156 <sup>(+)</sup>	286	11	5
1818	0.55	7.8	188	318	10.8	5
1901	37	7.6	298	618	100	99
1902	11	7.6	248	680	114	175
1903	9	7.4	240	408	45	63
1904	2	7.6	212 <sup>(+)</sup>	256	14	44
1905	1.8	7.5	240	339	13	77
1906	6	7.2	248	490	65	69
1907	0.5	7.32	200 <sup>(+)</sup>	404	20	56
1908	1	7.38	150	288	18	26
1909	2	7.5	212 <sup>(+)</sup>	272	12	40
1910	4	7.17	204	372	45	52.9
1911	7	7.3	200	472	53.1	54
1912	13	7.9	228	422	63	63
1913	5	7.2	256	510	57.5	44
2001	14	7.6	170 <sup>(+)</sup>	3450	1240	96
2002	11	7.5	370	1220	570	42
2003	11	7.6	170 <sup>(+)</sup>	964	194	39.6
2004	10	7.6	252 <sup>(+)</sup>	910	289	60
2101	31	7.9	160 <sup>(+)</sup>	12150	2030	300
2102	7.5	7.8	166	617	134	54
2103	5	7.8	174 <sup>(+)</sup>	575	71	45
2104	8	7.6	134	505	115	50
2105	5	7.6	160 <sup>(+)</sup>	356	50	43
2106	14	7.6	152	436	130	70
2107	12	7.5	130	988	245	206
2108	10	7.46	187	850	242	300
2109	13	7.6	160 <sup>(+)</sup>	456	88	153
2110	2	7.2	232	586	112	40
2111	0.5	7.61	220	280	13	27

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
2112	4	7.5	160 <sup>(#)</sup>	244	16	15
2113	0.5	7.7	160 <sup>(#)</sup>	236	13	14
2114	0.5	7.8	160 <sup>(#)</sup>	244	12	34
2115	0.5	7.79	170	248	11.7	40
2116	4	7.3	174	1000	159	78
2117	6.5	7.6	184	800	280	125
2201	12	7.7	371 <sup>(#)</sup>	11500	4990	1232
2202	61	7.4	750	2950	900	820
2203	41	7.83	371 <sup>(#)</sup>	29100 <sup>(#)</sup>	13600 <sup>(#)</sup>	1240 <sup>(#)</sup>
2204	15	7.5	198	8770 <sup>(#)</sup>	3480 <sup>(#)</sup>	546 <sup>(#)</sup>
2301	23	7.7	250 <sup>(#)</sup>	3630	610	358
2302	6	7.61	260	778	150	260
2303	5	7.9	250 <sup>(#)</sup>	724	116	233
2304	5	7.8	250	680	119	220
2305	2	7.9	250 <sup>(#)</sup>	670	121	227
2306	51	7.5	250	1030	118	376
2307	83	7.3	373	1970	556	544
2308	20	7.5	266	908	178	263
2309	4	7.5	180	215	14	9
2310	3	7.8	640	2420	890	510
2311	5	7.6	2128	9652	4030	2360
2312	6	7.6	1839	5244	1983	1500
2313	5	7.6	250 <sup>(#)</sup>	300	18	23
2314	25	7.8	250	736	110	235
2411	11	7.2	1100 <sup>(#)</sup>	11700	7200	980
2412	8	6.8	1100 <sup>(#)</sup>	5780	3400	437
2421	10	7.8	755	12700	7843	1025
2422	9	7.8	137	5290	2730	374
2423	12	7.8	872	11000	7040	923
2424	12	7.86	3390	26400	13300	1812
2425	16	7.9	690	13598	6040	800
2426	16	7.6	908	14400	5970	815
2427	10	7.5	826	12650	5660	810
2428	20	7.8	1100 <sup>(#)</sup>	13200	6400	838

Segment Number	TSS <sup>1</sup> (mg/L)	pH <sup>1</sup> (s.u.)	Total Hardness <sup>1</sup> (mg/L as CaCO <sub>3</sub> )	TDS <sup>2</sup> (mg/L)	Chloride <sup>2</sup> (mg/L)	Sulfate <sup>2</sup> (mg/L)
2429	10	7.4	1100 <sup>(+)</sup>	11960	5625	815
2430	10	7.4	1100 <sup>(+)</sup>	11740	4998	712
2431	13	7.9	1100 <sup>(+)</sup>	17250	8660	1225
2432	13	7.8	3563	18100	9630	1320
2433	10	7.8	1100 <sup>(+)</sup>	27717	13200	1860
2434	14	7.9	3800	26500	14300	1930
2435	29	7.8	1100 <sup>(+)</sup>	27830	14300	1910
2436	9	7.6	1100 <sup>(+)</sup>	14814	6570	900
2437	9	7.9	1780	24800	12300	1725
2438	9	7.7	2260	18193	7420	1048
2439	10	7.9	1320	18900	10397	1420
2441	26	7.9	1100 <sup>(+)</sup>	19000	10290	1380
2442	20	7.7	1100 <sup>(+)</sup>	22700	11800	1295
2451	12	7.9	1100 <sup>(+)</sup>	25800	13400	1840
2452	10	7.8	1100 <sup>(+)</sup>	23400	11543	1600
2453	12	7.8	1538	18400	9900	1300
2454	11	8.0	1700	20900	11600	1550
2455	11	8.0	1100 <sup>(+)</sup>	22500	11390	1500
2456	26	7.85	1100 <sup>(+)</sup>	5180	2690	400
2461	10	8.0	1100 <sup>(+)</sup>	23400	14300	1900
2462	16	7.95	1100 <sup>(+)</sup>	15100	7650	1070
2463	18	7.9	1100 <sup>(+)</sup>	21100	10400	1400
2471	10	7.9	1100 <sup>(+)</sup>	28700	14000	1960
2472	16	7.9	1100 <sup>(+)</sup>	18400	7260	961
2473	16	7.9	1100 <sup>(+)</sup>	21400	10200	1400
2481	11	7.9	4940	35100	16756	2320
2482	19	7.9	1100 <sup>(+)</sup>	32100	15700	2130
2483	11	7.9	1100 <sup>(+)</sup>	30300	15600	2219
2484	11	7.8	5000	35200	16600	2310
2485	34	7.9	1100 <sup>(+)</sup>	42500	17430	2440
2491	13	7.9	1100 <sup>(+)</sup>	35400	18100	2611
2492	19	7.86	1100 <sup>(+)</sup>	39900	21000	3030
2493	16	7.8	1100 <sup>(+)</sup>	34900	18734	2610
2494	13	7.9	1100 <sup>(+)</sup>	35200	17600	2500

<b>Segment Number</b>	<b>TSS<sup>1</sup> (mg/L)</b>	<b>pH<sup>1</sup> (s.u.)</b>	<b>Total Hardness<sup>1</sup> (mg/L as CaCO<sub>3</sub>)</b>	<b>TDS<sup>2</sup> (mg/L)</b>	<b>Chloride<sup>2</sup> (mg/L)</b>	<b>Sulfate<sup>2</sup> (mg/L)</b>
2501	10	7.5	1100 <sup>(a)</sup>	29242	15600	2230

<sup>1</sup>—Values are the (lower) 15<sup>th</sup> percentile and should be used in place of the basin values found in Table 2 of the Standards.

<sup>2</sup>—Values are the 50<sup>th</sup> percentile.

<sup>(a)</sup>—Basin-specific value; insufficient segment data available.

<sup>(b)</sup>—Insufficient segment TDS data available; calculated as  $(0.65) \times (50^{\text{th}} \text{ percentile conductivity for segment})$ .

<sup>(c)</sup>—Data from Segments 0220 and 0230 combined.

<sup>(d)</sup>—Data from Segment 0610.

<sup>(e)</sup>—Data from Segments 1256 and 1257 combined.

<sup>(f)</sup>—Period of record limited to five years (1995-1999) to reflect changes in the watershed.

<sup>(g)</sup>—No data available.

<sup>(h)</sup>—Data from Segments 1802 and 1803 combined.

**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 15<sup>th</sup> percentile values.
- 2) Total dissolved solids (TDS), chloride, and sulfate are 50<sup>th</sup> 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  $(0.65) \times (50^{\text{th}} \text{ percentile conductivity for segment})$

**Table D-1 Segment-Specific Values for Basin 1, Canadian River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
0101	6.0	7.6	196 <sup>(a)</sup>	2651	828	374
0102	2.0	8.2	223	1238	357	288
0103	13	7.9	196 <sup>(a)</sup>	2410	700	382
0104	2.0	7.8	196 <sup>(a)</sup>	805	272	65
0105	28	8.1	221 <sup>(a)</sup>	784	54	48

**Table D-2 Segment-Specific Values for Basin 2, Red River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
0201	27	7.1	175 <sup>(c)</sup>	610	147	117
0202	19	7.3	175 <sup>(c)</sup>	784	197	150
0203	3.0	7.9	175 <sup>(c)</sup>	1070	345	228
0204	31	7.8	552 <sup>(a)</sup>	2880	1080	605
0205	29	7.8	937	4510	1800	1095
0206	11	7.6	1100 <sup>(d)</sup>	12900	6290	2355
0207	16	7.6	1925	15900	15000	3000
0208	10	6.9	44 <sup>(e)</sup>	72 <sup>(b)</sup>	5.0	14
0209	4.0	7.1	44 <sup>(e)</sup>	101	7.0	14
0210	3.0	7.9	44 <sup>(e)</sup>	462 <sup>(b)</sup>	143	41
0211	16	7.3	44 <sup>(e)</sup>	364	70	12
0212	4.9	8.0	44 <sup>(e)</sup>	494 <sup>(b)</sup>	127	13
0213	5.0	8.1	44 <sup>(e)</sup>	289 <sup>(b)</sup>	49	14
0214	19	7.6	780 <sup>(f)</sup>	2951	1200	573
0215	5.0	7.7	780 <sup>(f)</sup>	3042 <sup>(b)</sup>	1103	714
0216	5.0	7.6	770	3088 <sup>(b)</sup>	1130	744

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0217</u>	<u>3.0</u>	<u>7.8</u>	<u>780</u> <sup>(f)</sup>	<u>2940</u>	<u>1100</u>	<u>751</u>
<u>0218</u>	<u>6.0</u>	<u>7.7</u>	<u>1100</u>	<u>8060</u>	<u>4365</u>	<u>2195</u>
<u>0219</u>	<u>23</u>	<u>7.6</u>	<u>168</u> <sup>(g)</sup>	<u>1002</u> <sup>(b)</sup>	<u>390</u>	<u>118</u>
<u>0220</u>	<u>5.0</u>	<u>7.6</u>	<u>1120</u> <sup>(h)</sup>	<u>18200</u>	<u>9255</u>	<u>2630</u>
<u>0221</u>	<u>8.0</u>	<u>7.5</u>	<u>1120</u> <sup>(h)</sup>	<u>2616</u> <sup>(b)</sup>	<u>735</u>	<u>1070</u>
<u>0222</u>	<u>4.0</u>	<u>7.7</u>	<u>1300</u>	<u>2760</u>	<u>270</u>	<u>1380</u>
<u>0223</u>	<u>2.0</u>	<u>7.9</u>	<u>168</u> <sup>(g)</sup>	<u>416</u>	<u>46</u>	<u>88</u>
<u>0224</u>	<u>5.0</u>	<u>7.6</u>	<u>330</u> <sup>(i)</sup>	<u>1650</u>	<u>439</u>	<u>481</u>
<u>0225</u>	<u>12</u>	<u>6.5</u>	<u>44</u> <sup>(e)</sup>	<u>96</u> <sup>(b)</sup>	<u>15</u>	<u>6.0</u>
<u>0226</u>	<u>9.0</u>	<u>7.5</u>	<u>2300</u>	<u>16250</u> <sup>(b)</sup>	<u>9500</u>	<u>2800</u>
<u>0227</u>	<u>7.9</u> <sup>(i)</sup>	<u>7.5</u> <sup>(j)</sup>	<u>1120</u> <sup>(h)</sup>	<u>2398</u> <sup>(b,j)</sup>	<u>640</u> <sup>(j)</sup>	<u>1020</u> <sup>(j)</sup>
<u>0228</u>	<u>2.0</u>	<u>8.1</u>	<u>168</u> <sup>(g)</sup>	<u>416</u>	<u>11</u>	<u>94</u>
<u>0229</u>	<u>5.0</u>	<u>7.6</u>	<u>330</u> <sup>(i)</sup>	<u>1280</u>	<u>290</u>	<u>292</u>
<u>0230</u>	<u>8.0</u>	<u>7.5</u>	<u>1120</u> <sup>(h)</sup>	<u>7600</u>	<u>3510</u>	<u>1690</u>

(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**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0301</u>	<u>10</u>	<u>6.9</u>	<u>54</u> <sup>(a)</sup>	<u>150</u>	<u>11</u>	<u>18</u>
<u>0302</u>	<u>8.6</u>	<u>7.2</u>	<u>54</u> <sup>(a)</sup>	<u>137</u>	<u>10</u>	<u>17</u>
<u>0303</u>	<u>22</u>	<u>7.1</u>	<u>54</u> <sup>(a)</sup>	<u>219</u>	<u>15</u>	<u>34</u>
<u>0304</u>	<u>2.5</u>	<u>6.5</u>	<u>54</u> <sup>(a)</sup>	<u>262</u>	<u>60</u>	<u>32</u>
<u>0305</u>	<u>5.6</u>	<u>7.5</u>	<u>54</u> <sup>(a)</sup>	<u>490</u>	<u>30</u>	<u>150</u>
<u>0306</u>	<u>24</u>	<u>7.5</u>	<u>54</u> <sup>(a)</sup>	<u>326</u>	<u>29</u>	<u>54</u>
<u>0307</u>	<u>9.0</u>	<u>7.5</u>	<u>54</u> <sup>(a)</sup>	<u>143</u>	<u>5.7</u>	<u>12</u>

**Table D-4 Segment-Specific Values for Basin 4, Cypress Creek**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
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 <sup>(a)</sup>	82	9.0	6.0
0407	5.0	5.9	12	72	15	5.0
0408	2.0	7.1	24 <sup>(a)</sup>	91	15	22
0409	5.0	6.2	19 <sup>(a)</sup>	116	16	14
0410	3.8	5.9	19 <sup>(a)</sup>	80	6	6

**Table D-5 Segment-Specific Values for Basin 5, Sabine River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
0501	6.0	6.7	28	618 <sup>(b)</sup>	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 <sup>(a)</sup>	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 <sup>(b)</sup>	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**



<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0601</u>	<u>8.0</u>	<u>6.6</u>	<u>38</u> <sup>(a)</sup>	<u>2240</u>	<u>600</u>	<u>101</u>
<u>0602</u>	<u>17</u>	<u>6.5</u>	<u>27</u>	<u>112</u>	<u>18</u>	<u>19</u>
<u>0603</u>	<u>8.0</u>	<u>6.5</u>	<u>27</u> <sup>(a)</sup>	<u>115</u>	<u>17</u>	<u>19</u>
<u>0604</u>	<u>10</u>	<u>6.5</u>	<u>36</u>	<u>92</u>	<u>24</u>	<u>20</u>
<u>0605</u>	<u>4.0</u>	<u>6.8</u>	<u>27</u> <sup>(a)</sup>	<u>143</u>	<u>25</u>	<u>24</u>
<u>0606</u>	<u>5.0</u>	<u>6.4</u>	<u>42</u> <sup>(c)</sup>	<u>232</u>	<u>34</u>	<u>36</u>
<u>0607</u>	<u>10</u>	<u>6.5</u>	<u>26</u>	<u>168</u>	<u>22</u>	<u>8.0</u>
<u>0608</u>	<u>6.0</u>	<u>6.0</u>	<u>14</u>	<u>83</u>	<u>14</u>	<u>5.0</u>
<u>0609</u>	<u>2.0</u>	<u>6.4</u>	<u>22</u>	<u>91</u> <sup>(b)</sup>	<u>15</u>	<u>18</u>
<u>0610</u>	<u>2.0</u>	<u>6.9</u>	<u>27</u> <sup>(a)</sup>	<u>90</u>	<u>16</u>	<u>20</u>
<u>0611</u>	<u>8.0</u>	<u>6.4</u>	<u>38</u> <sup>(c)</sup>	<u>134</u>	<u>19</u>	<u>22</u>
<u>0612</u>	<u>9.3</u>	<u>6.5</u>	<u>20</u> <sup>(a)</sup>	<u>100</u>	<u>10</u>	<u>16</u>
<u>0613</u>	<u>2.0</u>	<u>6.8</u>	<u>27</u> <sup>(a)</sup>	<u>71</u>	<u>11</u>	<u>8.8</u>
<u>0614</u>	<u>1.0</u>	<u>7.1</u>	<u>27</u> <sup>(a)</sup>	<u>61</u>	<u>7.0</u>	<u>6.0</u>
<u>0615</u>	<u>8.0</u>	<u>6.6</u>	<u>27</u> <sup>(a)</sup>	<u>193</u>	<u>30</u>	<u>35</u>

<sup>(c)</sup> Data from tributaries included.

**Table D-7 Segment-Specific Values for Basin 7, Neches-Trinity Coastal**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0701</u>	<u>12</u>	<u>6.7</u>	<u>56</u>	<u>246</u>	<u>54</u>	<u>32</u>
<u>0702</u>	<u>14</u>	<u>6.8</u>	<u>288</u> <sup>(c)</sup>	<u>10872</u>	<u>4700</u>	<u>690</u>
<u>0703</u>	<u>11</u>	<u>6.6</u>	<u>288</u> <sup>(c)</sup>	<u>9000</u>	<u>4780</u>	<u>650</u>
<u>0704</u>	<u>12</u>	<u>6.7</u>	<u>74</u>	<u>249</u>	<u>56</u>	<u>33</u>

<sup>(c)</sup> Data from Segments 0702 (including tributaries), 0703, 2411, and 2412

**Table D-8 Segment-Specific Values for Basin 8, Trinity River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0801</u>	<u>18</u>	<u>7.3</u>	<u>84</u>	<u>224</u>	<u>36</u>	<u>33</u>
<u>0802</u>	<u>9.0</u>	<u>7.4</u>	<u>94</u>	<u>205</u>	<u>26</u>	<u>35</u>
<u>0803</u>	<u>7.3</u>	<u>7.4</u>	<u>94</u>	<u>240</u>	<u>29</u>	<u>43</u>
<u>0804</u>	<u>41</u>	<u>7.2</u>	<u>122</u>	<u>338</u>	<u>42</u>	<u>60</u>
<u>0805</u>	<u>23</u>	<u>7.2</u>	<u>148</u>	<u>408</u>	<u>52</u>	<u>77</u>
<u>0806</u>	<u>10</u>	<u>7.5</u>	<u>136</u>	<u>287</u>	<u>35</u>	<u>38</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
0807	6.9	7.9	96 <sup>(a)</sup>	231	34	26
0808	5.0	7.5	98 <sup>(a)</sup>	260 <sup>(b)</sup>	36	23
0809	5.0	7.9	96 <sup>(a)</sup>	249	34	26
0810	16	7.5	98 <sup>(a)</sup>	425	53	39
0811	2.0	7.9	96 <sup>(a)</sup>	212	28	20
0812	28	7.2	98 <sup>(a)</sup>	490	59	36
0813	1.5	6.8	96 <sup>(a)</sup>	73	11	9.0
0814	18	7.5	120 <sup>(c)</sup>	349	23	70
0815	6.1	7.9	96 <sup>(a)</sup>	202 <sup>(b)</sup>	14	35
0816	4.7	7.8	96 <sup>(a)</sup>	179 <sup>(b)</sup>	8.0	17
0817	6.1	7.9	110	208 <sup>(b)</sup>	11	31
0818	5.4	7.5	96 <sup>(a)</sup>	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 <sup>(a)</sup>	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 <sup>(d)</sup>	231	25	35
0826	5.0	7.9	118	208	24	30
0827	8.7	7.5	96 <sup>(a)</sup>	188 <sup>(b)</sup>	13	31
0828	6.0	7.9	100	187	18	28
0829	8.0	7.5	98 <sup>(a)</sup>	289	22	33
0830	6.0	7.9	96 <sup>(a)</sup>	205	22	27
0831	5.0	7.5	160	408	42	45
0832	5.0	8.0	96 <sup>(a)</sup>	283 <sup>(b)</sup>	41	31
0833	6.7	7.5	98 <sup>(a)</sup>	561	92	67
0834	2.0	7.7	96 <sup>(a)</sup>	182 <sup>(b)</sup>	27	12
0835	10 <sup>(e)</sup>	7.3 <sup>(e)</sup>	120 <sup>(c)</sup>	232 <sup>(e)</sup>	28 <sup>(e)</sup>	40 <sup>(e)</sup>
0836	2.0	7.7	96 <sup>(a)</sup>	170	11	33
0837	10 <sup>(e)</sup>	7.3 <sup>(e)</sup>	120 <sup>(c)</sup>	232 <sup>(e)</sup>	28 <sup>(e)</sup>	40 <sup>(e)</sup>
0838	4.0	7.9	153	342	21	102
0839	9.0	7.6	98 <sup>(a)</sup>	188 <sup>(b)</sup>	20	22
0840	4.0	7.7	95	179	18	16

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0841</u>	<u>16</u>	<u>7.3</u>	<u>160</u>	<u>467</u>	<u>74</u>	<u>68</u>

(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**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>0901</u>	<u>18</u>	<u>7.4</u>	<u>930</u> <sup>(c)</sup>	<u>8400</u>	<u>2875</u>	<u>261</u>
<u>0902</u>	<u>3.0</u>	<u>7.1</u>	<u>40</u> <sup>(d)</sup>	<u>373</u>	<u>83</u>	<u>17</u>

(c) Data from Segment 2426

(d) Data from Basin 10

**Table D-10 Segment-Specific Values for Basin 10, San Jacinto River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1001</u>	<u>8.0</u>	<u>7.5</u>	<u>44</u>	<u>940</u>	<u>2765</u>	<u>246</u>
<u>1002</u>	<u>10</u>	<u>7.0</u>	<u>46</u>	<u>186</u>	<u>25</u>	<u>9.0</u>
<u>1003</u>	<u>7.0</u>	<u>6.6</u>	<u>37</u>	<u>144</u>	<u>32</u>	<u>5.0</u>
<u>1004</u>	<u>11</u>	<u>6.9</u>	<u>65</u>	<u>187</u>	<u>38</u>	<u>10</u>
<u>1005</u>	<u>11</u>	<u>7.5</u>	<u>620</u>	<u>10800</u>	<u>6190</u>	<u>838</u>
<u>1006</u>	<u>10</u>	<u>7.2</u>	<u>412</u>	<u>2920</u>	<u>2090</u>	<u>215</u>
<u>1007</u>	<u>8.0</u>	<u>7.1</u>	<u>108</u>	<u>1100</u>	<u>482</u>	<u>94</u>
<u>1008</u>	<u>10</u>	<u>6.8</u>	<u>48</u>	<u>241</u>	<u>47</u>	<u>10</u>
<u>1009</u>	<u>13</u>	<u>7.0</u>	<u>44</u>	<u>388</u>	<u>57</u>	<u>19</u>
<u>1010</u>	<u>5.0</u>	<u>6.6</u>	<u>28</u>	<u>99</u>	<u>15</u>	<u>5.0</u>
<u>1011</u>	<u>3.0</u>	<u>6.4</u>	<u>21</u>	<u>88</u>	<u>17</u>	<u>4.0</u>
<u>1012</u>	<u>3.0</u>	<u>7.3</u>	<u>65</u>	<u>131</u>	<u>17</u>	<u>6.0</u>
<u>1013</u>	<u>14</u>	<u>7.2</u>	<u>78</u> <sup>(a)</sup>	<u>381</u>	<u>60</u>	<u>24</u>
<u>1014</u>	<u>17</u>	<u>7.1</u>	<u>40</u> <sup>(a)</sup>	<u>368</u>	<u>64</u>	<u>23</u>
<u>1015</u>	<u>10</u>	<u>6.6</u>	<u>40</u> <sup>(a)</sup>	<u>168</u> <sup>(b)</sup>	<u>43</u>	<u>9.7</u>
<u>1016</u>	<u>12</u>	<u>7.5</u>	<u>40</u> <sup>(a)</sup>	<u>456</u>	<u>82</u>	<u>38</u>
<u>1017</u>	<u>10</u>	<u>7.6</u>	<u>40</u> <sup>(a)</sup>	<u>463</u>	<u>86</u>	<u>33</u>

**Table D-11 Segment-Specific Values for Basin 11, San Jacinto-Brazos Coastal**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1101</u>	<u>15</u>	<u>7.5</u>	<u>134</u>	<u>1720</u>	<u>460</u>	<u>92</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1102</u>	<u>15</u>	<u>7.4</u>	<u>126</u>	<u>568</u>	<u>125</u>	<u>38</u>
<u>1103</u>	<u>9.6</u>	<u>7.3</u>	<u>125</u>	<u>3142</u>	<u>1550</u>	<u>234</u>
<u>1104</u>	<u>12</u>	<u>7.3</u>	<u>116<sup>(a)</sup></u>	<u>493</u>	<u>99</u>	<u>58</u>
<u>1105</u>	<u>15</u>	<u>7.3</u>	<u>118<sup>(a)</sup></u>	<u>3149</u>	<u>2065</u>	<u>289</u>
<u>1107</u>	<u>19</u>	<u>7.6</u>	<u>118<sup>(a)</sup></u>	<u>10650</u>	<u>5327</u>	<u>705</u>
<u>1108</u>	<u>11</u>	<u>7.4</u>	<u>116<sup>(a)</sup></u>	<u>474</u>	<u>116</u>	<u>46</u>
<u>1109</u>	<u>15</u>	<u>7.5</u>	<u>118<sup>(a)</sup></u>	<u>7405</u>	<u>2590</u>	<u>411</u>
<u>1110</u>	<u>15</u>	<u>7.3</u>	<u>116<sup>(a)</sup></u>	<u>346</u>	<u>71</u>	<u>30</u>
<u>1111</u>	<u>9.0</u>	<u>7.9</u>	<u>3697</u>	<u>27700</u>	<u>14161</u>	<u>2020</u>
<u>1113</u>	<u>18</u>	<u>7.4</u>	<u>118<sup>(a)</sup></u>	<u>1913</u>	<u>902</u>	<u>120</u>

**Table D-12 Segment-Specific Values for Basin 12, Brazos River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1201</u>	<u>10</u>	<u>7.7</u>	<u>232<sup>(c)</sup></u>	<u>5150</u>	<u>3220</u>	<u>412</u>
<u>1202</u>	<u>36</u>	<u>7.6</u>	<u>160</u>	<u>438</u>	<u>88</u>	<u>60</u>
<u>1203</u>	<u>3.0</u>	<u>7.9</u>	<u>230<sup>(d)</sup></u>	<u>888</u>	<u>371</u>	<u>180</u>
<u>1204</u>	<u>4.3</u>	<u>7.8</u>	<u>230<sup>(d)</sup></u>	<u>1294</u>	<u>485</u>	<u>234</u>
<u>1205</u>	<u>4.0</u>	<u>7.9</u>	<u>230<sup>(d)</sup></u>	<u>1418</u>	<u>893</u>	<u>311</u>
<u>1206</u>	<u>7.0</u>	<u>7.8</u>	<u>230<sup>(d)</sup></u>	<u>1724</u>	<u>692</u>	<u>348</u>
<u>1207</u>	<u>2.0</u>	<u>8.1</u>	<u>230<sup>(d)</sup></u>	<u>1870</u>	<u>893</u>	<u>371</u>
<u>1208</u>	<u>17</u>	<u>7.7</u>	<u>473<sup>(e)</sup></u>	<u>4267</u>	<u>2000</u>	<u>900</u>
<u>1209</u>	<u>17</u>	<u>7.1</u>	<u>68<sup>(f)</sup></u>	<u>235</u>	<u>44</u>	<u>42</u>
<u>1210</u>	<u>19</u>	<u>7.6</u>	<u>68<sup>(f)</sup></u>	<u>182</u>	<u>10</u>	<u>14</u>
<u>1211</u>	<u>22</u>	<u>7.3</u>	<u>160<sup>(a)</sup></u>	<u>275</u>	<u>53</u>	<u>64</u>
<u>1212</u>	<u>7.0</u>	<u>7.6</u>	<u>120<sup>(a)</sup></u>	<u>256</u>	<u>46</u>	<u>59</u>
<u>1213</u>	<u>23</u>	<u>7.7</u>	<u>171<sup>(g)</sup></u>	<u>332</u>	<u>42</u>	<u>36</u>
<u>1214</u>	<u>17</u>	<u>7.5</u>	<u>170<sup>(h)</sup></u>	<u>392</u>	<u>25</u>	<u>30</u>
<u>1215</u>	<u>2.0</u>	<u>7.7</u>	<u>171<sup>(g)</sup></u>	<u>284</u>	<u>39</u>	<u>19</u>
<u>1216</u>	<u>2.0</u>	<u>8.1</u>	<u>171<sup>(g)</sup></u>	<u>257</u>	<u>55</u>	<u>22</u>
<u>1217</u>	<u>2.0</u>	<u>7.9</u>	<u>171<sup>(g)</sup></u>	<u>372</u>	<u>70</u>	<u>24</u>
<u>1218</u>	<u>4.0</u>	<u>7.2</u>	<u>171<sup>(g)</sup></u>	<u>390</u>	<u>53</u>	<u>46</u>
<u>1219</u>	<u>6.8</u>	<u>7.2</u>	<u>171<sup>(g)</sup></u>	<u>340</u>	<u>38</u>	<u>33</u>
<u>1220</u>	<u>2.0</u>	<u>8.0</u>	<u>120<sup>(a)</sup></u>	<u>223</u>	<u>31</u>	<u>27</u>
<u>1221</u>	<u>11</u>	<u>7.6</u>	<u>160<sup>(a)</sup></u>	<u>396</u>	<u>70</u>	<u>48</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1222</u>	<u>7.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>410</u>	<u>100</u>	<u>54</u>
<u>1223</u>	<u>4.0</u>	<u>7.6</u>	<u>160</u> <sup>(a)</sup>	<u>639</u>	<u>232</u>	<u>75</u>
<u>1224</u>	<u>4.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>296</u>	<u>73</u>	<u>46</u>
<u>1225</u>	<u>5.0</u>	<u>7.9</u>	<u>124</u>	<u>217</u>	<u>16</u>	<u>25</u>
<u>1226</u>	<u>3.0</u>	<u>7.7</u>	<u>160</u> <sup>(a)</sup>	<u>282</u>	<u>23</u>	<u>26</u>
<u>1227</u>	<u>4.4</u>	<u>7.4</u>	<u>160</u> <sup>(a)</sup>	<u>386</u>	<u>42</u>	<u>52</u>
<u>1228</u>	<u>8.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>202</u> <sup>(b)</sup>	<u>13</u>	<u>16</u>
<u>1229</u>	<u>2.0</u>	<u>7.9</u>	<u>160</u> <sup>(a)</sup>	<u>336</u>	<u>24</u>	<u>45</u>
<u>1230</u>	<u>5.0</u>	<u>8.0</u>	<u>230</u> <sup>(d)</sup>	<u>298</u> <sup>(b)</sup>	<u>39</u>	<u>37</u>
<u>1231</u>	<u>5.0</u>	<u>8.0</u>	<u>230</u> <sup>(d)</sup>	<u>416</u> <sup>(b)</sup>	<u>123</u>	<u>24</u>
<u>1232</u>	<u>16</u>	<u>7.6</u>	<u>584</u>	<u>1800</u>	<u>520</u>	<u>778</u>
<u>1233</u>	<u>3.0</u>	<u>7.9</u>	<u>218</u>	<u>715</u> <sup>(b)</sup>	<u>244</u>	<u>61</u>
<u>1234</u>	<u>2.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>263</u> <sup>(b)</sup>	<u>29</u>	<u>36</u>
<u>1235</u>	<u>10</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>716</u> <sup>(b)</sup>	<u>162</u>	<u>182</u>
<u>1236</u>	<u>5.0</u>	<u>8.0</u>	<u>203</u>	<u>458</u> <sup>(b)</sup>	<u>94</u>	<u>78</u>
<u>1237</u>	<u>5.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>699</u> <sup>(b)</sup>	<u>186</u>	<u>125</u>
<u>1238</u>	<u>8.7</u>	<u>7.5</u>	<u>1525</u> <sup>(i)</sup>	<u>37367</u>	<u>16000</u>	<u>2505</u>
<u>1239</u>	<u>4</u> <sup>(i)</sup>	<u>8.1</u> <sup>(i)</sup>	<u>160</u> <sup>(a)</sup>	<u>606</u> <sup>(i)</sup>	<u>111</u> <sup>(i)</sup>	<u>48</u> <sup>(i)</sup>
<u>1240</u>	<u>4.0</u>	<u>8.1</u>	<u>120</u> <sup>(a)</sup>	<u>606</u>	<u>111</u>	<u>47</u>
<u>1241</u>	<u>9.9</u>	<u>7.7</u>	<u>473</u> <sup>(e)</sup>	<u>4325</u>	<u>1400</u>	<u>1340</u>
<u>1242</u>	<u>11</u>	<u>7.7</u>	<u>221</u> <sup>(k)</sup>	<u>693</u>	<u>179</u>	<u>103</u>
<u>1243</u>	<u>0.5</u>	<u>7.3</u>	<u>160</u> <sup>(a)</sup>	<u>296</u>	<u>12</u>	<u>16</u>
<u>1244</u>	<u>2.0</u>	<u>7.6</u>	<u>160</u> <sup>(a)</sup>	<u>369</u>	<u>53</u>	<u>38</u>
<u>1245</u>	<u>12</u>	<u>7.4</u>	<u>140</u>	<u>352</u>	<u>70</u>	<u>46</u>
<u>1246</u>	<u>3.0</u>	<u>7.7</u>	<u>160</u> <sup>(a)</sup>	<u>327</u>	<u>16</u>	<u>52</u>
<u>1247</u>	<u>8.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>229</u>	<u>20</u>	<u>24</u>
<u>1248</u>	<u>3.0</u>	<u>7.7</u>	<u>170</u> <sup>(h)</sup>	<u>291</u>	<u>18</u>	<u>20</u>
<u>1249</u>	<u>2.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>202</u>	<u>12</u>	<u>16</u>
<u>1250</u>	<u>0.5</u>	<u>7.7</u>	<u>170</u> <sup>(h)</sup>	<u>270</u>	<u>17</u>	<u>21</u>
<u>1251</u>	<u>1.0</u>	<u>7.8</u>	<u>170</u> <sup>(h)</sup>	<u>270</u>	<u>13</u>	<u>21</u>
<u>1252</u>	<u>4.0</u>	<u>7.4</u>	<u>68</u> <sup>(f)</sup>	<u>132</u>	<u>20</u>	<u>16</u>
<u>1253</u>	<u>10</u>	<u>7.4</u>	<u>68</u> <sup>(f)</sup>	<u>208</u>	<u>20</u>	<u>14</u>
<u>1254</u>	<u>5.0</u>	<u>7.9</u>	<u>120</u> <sup>(a)</sup>	<u>228</u>	<u>12</u>	<u>54</u>
<u>1255</u>	<u>3.5</u>	<u>7.6</u>	<u>160</u> <sup>(a)</sup>	<u>501</u>	<u>111</u>	<u>44</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1256</u>	<u>5.0</u>	<u>7.7</u>	<u>177</u>	<u>574</u>	<u>219</u>	<u>91</u>
<u>1257</u>	<u>3.7</u>	<u>7.6</u>	<u>251<sup>(l)</sup></u>	<u>780</u>	<u>312</u>	<u>144</u>

(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**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1301</u>	<u>13</u>	<u>7.3</u>	<u>135<sup>(a)</sup></u>	<u>2300</u>	<u>2745</u>	<u>215</u>
<u>1302</u>	<u>19</u>	<u>7.0</u>	<u>96<sup>(a)</sup></u>	<u>267</u>	<u>48</u>	<u>16</u>
<u>1304</u>	<u>13</u>	<u>7.4</u>	<u>135<sup>(a)</sup></u>	<u>1080</u>	<u>190</u>	<u>62</u>
<u>1305</u>	<u>13</u>	<u>7.3</u>	<u>96<sup>(a)</sup></u>	<u>329</u>	<u>41</u>	<u>12</u>

**Table D-14 Segment-Specific Values for Basin 14, Colorado River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1401</u>	<u>12</u>	<u>7.7</u>	<u>232<sup>(c)</sup></u>	<u>7584</u>	<u>473</u>	<u>110</u>
<u>1402</u>	<u>12</u>	<u>7.8</u>	<u>200</u>	<u>336</u>	<u>51</u>	<u>41</u>
<u>1403</u>	<u>1.0</u>	<u>7.7</u>	<u>180<sup>(d)</sup></u>	<u>298</u>	<u>55</u>	<u>36</u>
<u>1404</u>	<u>1.0</u>	<u>8.0</u>	<u>180<sup>(d)</sup></u>	<u>300</u>	<u>57</u>	<u>36</u>
<u>1405</u>	<u>2.0</u>	<u>7.8</u>	<u>180<sup>(d)</sup></u>	<u>332</u>	<u>66</u>	<u>40</u>
<u>1406</u>	<u>3.0</u>	<u>7.9</u>	<u>180<sup>(d)</sup></u>	<u>332</u>	<u>67</u>	<u>41</u>
<u>1407</u>	<u>2.0</u>	<u>7.8</u>	<u>180<sup>(d)</sup></u>	<u>418</u>	<u>100</u>	<u>67</u>
<u>1408</u>	<u>2.0</u>	<u>8.1</u>	<u>180<sup>(d)</sup></u>	<u>422</u>	<u>100</u>	<u>64</u>
<u>1409</u>	<u>15</u>	<u>7.8</u>	<u>237<sup>(e)</sup></u>	<u>434</u>	<u>84</u>	<u>56</u>
<u>1410</u>	<u>14</u>	<u>7.7</u>	<u>320<sup>(f)</sup></u>	<u>788<sup>(g)</sup></u>	<u>260<sup>(g)</sup></u>	<u>177<sup>(g)</sup></u>
<u>1411</u>	<u>5.0</u>	<u>7.9</u>	<u>318<sup>(h)</sup></u>	<u>2473</u>	<u>740</u>	<u>465</u>
<u>1412</u>	<u>16</u>	<u>7.6</u>	<u>310</u>	<u>4600</u>	<u>1635</u>	<u>961</u>
<u>1413</u>	<u>7.0</u>	<u>7.8</u>	<u>188<sup>(a)</sup></u>	<u>367<sup>(b)</sup></u>	<u>47</u>	<u>63</u>
<u>1414</u>	<u>5.0</u>	<u>8.0</u>	<u>188</u>	<u>362</u>	<u>52</u>	<u>32</u>
<u>1415</u>	<u>2.0</u>	<u>7.9</u>	<u>163<sup>(i)</sup></u>	<u>222</u>	<u>21</u>	<u>13</u>
<u>1416</u>	<u>8.0</u>	<u>7.8</u>	<u>163<sup>(i)</sup></u>	<u>307</u>	<u>24</u>	<u>17</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1417</u>	<u>13</u>	<u>7.8</u>	<u>190</u> <sup>(a)</sup>	<u>524</u> <sup>(b)</sup>	<u>109</u>	<u>68</u>
<u>1418</u>	<u>5.0</u>	<u>7.9</u>	<u>188</u> <sup>(a)</sup>	<u>296</u>	<u>71</u>	<u>38</u>
<u>1419</u>	<u>2.8</u>	<u>8.0</u>	<u>188</u> <sup>(a)</sup>	<u>317</u>	<u>72</u>	<u>47</u>
<u>1420</u>	<u>9.4</u>	<u>7.6</u>	<u>190</u> <sup>(a)</sup>	<u>462</u>	<u>91</u>	<u>81</u>
<u>1421</u>	<u>12</u>	<u>7.7</u>	<u>317</u>	<u>1080</u>	<u>447</u>	<u>243</u>
<u>1422</u>	<u>10</u>	<u>8.0</u>	<u>312</u>	<u>896</u>	<u>290</u>	<u>103</u>
<u>1423</u>	<u>5.0</u>	<u>8.0</u>	<u>188</u> <sup>(a)</sup>	<u>434</u>	<u>102</u>	<u>47</u>
<u>1424</u>	<u>2.5</u>	<u>7.6</u>	<u>240</u>	<u>362</u>	<u>48</u>	<u>15</u>
<u>1425</u>	<u>5.0</u>	<u>8.0</u>	<u>217</u> <sup>(i)</sup>	<u>474</u> <sup>(b)</sup>	<u>120</u>	<u>54</u>
<u>1426</u>	<u>14</u>	<u>7.8</u>	<u>315</u> <sup>(k)</sup>	<u>2190</u> <sup>(g)</sup>	<u>776</u> <sup>(g)</sup>	<u>720</u> <sup>(g)</sup>
<u>1427</u>	<u>1.0</u>	<u>7.4</u>	<u>163</u> <sup>(i)</sup>	<u>300</u>	<u>24</u>	<u>37</u>
<u>1428</u>	<u>3.0</u>	<u>7.4</u>	<u>190</u> <sup>(l)</sup>	<u>334</u>	<u>55</u>	<u>41</u>
<u>1429</u>	<u>1.2</u>	<u>7.4</u>	<u>188</u> <sup>(a)</sup>	<u>315</u>	<u>49</u>	<u>37</u>
<u>1430</u>	<u>0.5</u>	<u>7.2</u>	<u>194</u>	<u>306</u>	<u>23</u>	<u>30</u>
<u>1431</u>	<u>5.0</u>	<u>7.3</u>	<u>190</u> <sup>(a)</sup>	<u>652</u>	<u>186</u>	<u>88</u>
<u>1432</u>	<u>5.0</u>	<u>7.6</u>	<u>190</u> <sup>(a)</sup>	<u>464</u>	<u>96</u>	<u>68</u>
<u>1433</u>	<u>3.0</u>	<u>8.1</u>	<u>321</u> <sup>(m)</sup>	<u>1165</u>	<u>371</u>	<u>287</u>
<u>1434</u>	<u>5.0</u>	<u>7.8</u>	<u>190</u> <sup>(l)</sup>	<u>340</u>	<u>56</u>	<u>44</u>

<sup>(c)</sup> Data from Segments 1201 and 1401

<sup>(d)</sup> Data from Segments 1403, 1404, 1405, 1406, 1407, and 1408

<sup>(e)</sup> Data from Segments 1409, 1410, and 1417

<sup>(f)</sup> Data from Segments 1410, 1426, and 1433

<sup>(g)</sup> Data from 1995 to present to reflect changes in the watershed

<sup>(h)</sup> Data from Segments 1411 and 1412

<sup>(i)</sup> Data from Segments 1415, 1416, and 1427

<sup>(j)</sup> Data from Segment 1425 and its tributaries

<sup>(k)</sup> Data from Segments 1411, 1412, and 1426

<sup>(l)</sup> Data from Segments 1428 and 1434

<sup>(m)</sup> Data from Segments 1421, 1426, and 1433

**Table D-15 Segment-Specific Values for Basin 15, Colorado-Lavaca Coastal**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1501</u>	<u>15</u>	<u>7.3</u>	<u>85</u> <sup>(c)</sup>	<u>706</u>	<u>384</u>	<u>65</u>
<u>1502</u>	<u>16</u>	<u>7.3</u>	<u>95</u> <sup>(c)</sup>	<u>495</u>	<u>114</u>	<u>22</u>

<sup>(c)</sup> Data from Basins 15 and 16

**Table D-16 Segment-Specific Values for Basin 16, Lavaca River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
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<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1601</u>	<u>10</u>	<u>7.8</u>	<u>85</u> <sup>(a)</sup>	<u>1108</u> <sup>(b)</sup>	<u>123</u>	<u>29</u>
<u>1602</u>	<u>6.0</u>	<u>7.7</u>	<u>177</u>	<u>441</u>	<u>68</u>	<u>23</u>
<u>1603</u>	<u>8.0</u>	<u>7.9</u>	<u>82</u>	<u>454</u> <sup>(b)</sup>	<u>69</u>	<u>16</u>
<u>1604</u>	<u>7.4</u>	<u>7.4</u>	<u>57</u>	<u>148</u> <sup>(b)</sup>	<u>19</u>	<u>7.4</u>
<u>1605</u>	<u>5.3</u>	<u>7.6</u>	<u>141</u>	<u>480</u>	<u>72</u>	<u>15</u>

**Table D-17 Segment-Specific Values for Basin 17, Lavaca-Guadalupe Coastal**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1701</u>	<u>27</u>	<u>7.8</u>	<u>85</u> <sup>(c)</sup>	<u>3700</u>	<u>974</u>	<u>164</u>

<sup>(c)</sup> Data from Basin 16

**Table D-18 Segment-Specific Values for Basin 18, Guadalupe River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1801</u>	<u>44</u>	<u>7.6</u>	<u>167</u> <sup>(a)</sup>	<u>434</u>	<u>70</u>	<u>52</u>
<u>1802</u>	<u>40</u>	<u>7.7</u>	<u>212</u>	<u>460</u> <sup>(b)</sup>	<u>63</u>	<u>52</u>
<u>1803</u>	<u>12</u>	<u>7.7</u>	<u>206</u>	<u>325</u>	<u>33</u>	<u>30</u>
<u>1804</u>	<u>4.8</u>	<u>7.7</u>	<u>213</u>	<u>297</u>	<u>18</u>	<u>24</u>
<u>1805</u>	<u>2.0</u>	<u>8.0</u>	<u>161</u>	<u>217</u>	<u>15</u>	<u>19</u>
<u>1806</u>	<u>3.0</u>	<u>7.7</u>	<u>204</u>	<u>290</u>	<u>18</u>	<u>16</u>
<u>1807</u>	<u>3.9</u>	<u>7.7</u>	<u>100</u>	<u>456</u>	<u>78</u>	<u>22</u>
<u>1808</u>	<u>8.0</u>	<u>7.7</u>	<u>225</u>	<u>332</u>	<u>25</u>	<u>28</u>
<u>1809</u>	<u>2.0</u>	<u>7.6</u>	<u>189</u> <sup>(c)</sup>	<u>247</u>	<u>13</u>	<u>23</u>
<u>1810</u>	<u>12</u>	<u>7.6</u>	<u>215</u>	<u>673</u>	<u>135</u>	<u>85</u>
<u>1811</u>	<u>1.0</u>	<u>7.4</u>	<u>254</u>	<u>311</u>	<u>17</u>	<u>24</u>
<u>1812</u>	<u>2.0</u>	<u>7.7</u>	<u>184</u>	<u>248</u>	<u>14</u>	<u>19</u>
<u>1813</u>	<u>0.5</u>	<u>7.7</u>	<u>189</u>	<u>266</u>	<u>12</u>	<u>26</u>
<u>1814</u>	<u>2.0</u>	<u>7.5</u>	<u>265</u>	<u>388</u> <sup>(b)</sup>	<u>19</u>	<u>24</u>
<u>1815</u>	<u>0.5</u>	<u>7.1</u>	<u>228</u>	<u>299</u>	<u>13</u>	<u>16</u>
<u>1816</u>	<u>2.8</u>	<u>7.7</u>	<u>185</u> <sup>(d)</sup>	<u>292</u> <sup>(b)</sup>	<u>23</u>	<u>12</u>
<u>1817</u>	<u>0.5</u>	<u>7.4</u>	<u>185</u> <sup>(d)</sup>	<u>259</u> <sup>(b)</sup>	<u>10</u>	<u>5.0</u>
<u>1818</u>	<u>0.5</u>	<u>7.6</u>	<u>185</u> <sup>(d)</sup>	<u>266</u> <sup>(b)</sup>	<u>10</u>	<u>5.0</u>

<sup>(c)</sup> Data from Segment 1813

<sup>(d)</sup> Data from Segments 1816, 1817, and 1818

**Table D-19 Segment-Specific Values for Basin 19, San Antonio River**



<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>1901</u>	<u>30</u>	<u>7.7</u>	<u>312</u>	<u>616</u>	<u>100</u>	<u>97</u>
<u>1902</u>	<u>8.8</u>	<u>7.6</u>	<u>257</u>	<u>606</u>	<u>100</u>	<u>149</u>
<u>1903</u>	<u>6.0</u>	<u>7.4</u>	<u>240</u>	<u>372</u>	<u>41</u>	<u>60</u>
<u>1904</u>	<u>2.7</u>	<u>7.9</u>	<u>204<sup>(a)</sup></u>	<u>262</u>	<u>13</u>	<u>45</u>
<u>1905</u>	<u>2.0</u>	<u>7.6</u>	<u>240</u>	<u>339</u>	<u>13</u>	<u>76</u>
<u>1906</u>	<u>5.0</u>	<u>7.3</u>	<u>253</u>	<u>465</u>	<u>63</u>	<u>68</u>
<u>1907</u>	<u>0.5</u>	<u>7.4</u>	<u>204<sup>(a)</sup></u>	<u>402<sup>(b)</sup></u>	<u>21</u>	<u>43</u>
<u>1908</u>	<u>1.0</u>	<u>7.4</u>	<u>204<sup>(a)</sup></u>	<u>302</u>	<u>18</u>	<u>27</u>
<u>1909</u>	<u>1.2</u>	<u>7.3</u>	<u>204<sup>(a)</sup></u>	<u>258</u>	<u>14</u>	<u>44</u>
<u>1910</u>	<u>2.2</u>	<u>7.2</u>	<u>204</u>	<u>374</u>	<u>45</u>	<u>53</u>
<u>1911</u>	<u>5.0</u>	<u>7.4</u>	<u>202</u>	<u>477</u>	<u>54</u>	<u>54</u>
<u>1912</u>	<u>12</u>	<u>7.9</u>	<u>204<sup>(a)</sup></u>	<u>420</u>	<u>68</u>	<u>66</u>
<u>1913</u>	<u>5.0</u>	<u>7.2</u>	<u>256</u>	<u>500</u>	<u>60</u>	<u>45</u>

**Table D-20 Segment-Specific Values for Basin 20, San Antonio-Nueces Coastal**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2001</u>	<u>14</u>	<u>7.6</u>	<u>241<sup>(a)</sup></u>	<u>1780</u>	<u>1080</u>	<u>82</u>
<u>2002</u>	<u>10</u>	<u>7.5</u>	<u>243</u>	<u>1060</u>	<u>530</u>	<u>40</u>
<u>2003</u>	<u>12</u>	<u>7.6</u>	<u>241<sup>(a)</sup></u>	<u>810</u>	<u>193</u>	<u>40</u>
<u>2004</u>	<u>8.1</u>	<u>7.4</u>	<u>240<sup>(a)</sup></u>	<u>889</u>	<u>279</u>	<u>54</u>

**Table D-21 Segment-Specific Values for Basin 21, Nueces River**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2101</u>	<u>23</u>	<u>7.9</u>	<u>160<sup>(a)</sup></u>	<u>12150</u>	<u>2250</u>	<u>350</u>
<u>2102</u>	<u>10</u>	<u>7.8</u>	<u>164</u>	<u>431</u>	<u>132</u>	<u>49</u>
<u>2103</u>	<u>6.0</u>	<u>7.8</u>	<u>149</u>	<u>568</u>	<u>111</u>	<u>53</u>
<u>2104</u>	<u>8.0</u>	<u>7.6</u>	<u>137</u>	<u>452</u>	<u>105</u>	<u>42</u>
<u>2105</u>	<u>5.0</u>	<u>7.6</u>	<u>160<sup>(a)</sup></u>	<u>316</u>	<u>49</u>	<u>40</u>
<u>2106</u>	<u>15</u>	<u>7.6</u>	<u>158</u>	<u>498</u>	<u>128</u>	<u>75</u>
<u>2107</u>	<u>13</u>	<u>7.5</u>	<u>130</u>	<u>1080</u>	<u>242</u>	<u>225</u>
<u>2108</u>	<u>11</u>	<u>7.4</u>	<u>201</u>	<u>840</u>	<u>218</u>	<u>277</u>
<u>2109</u>	<u>10</u>	<u>7.5</u>	<u>226<sup>(c)</sup></u>	<u>508</u>	<u>73</u>	<u>128</u>
<u>2110</u>	<u>2.0</u>	<u>7.2</u>	<u>226<sup>(c)</sup></u>	<u>560</u>	<u>100</u>	<u>40</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2111</u>	<u>0.5</u>	<u>7.6</u>	<u>226</u> <sup>(c)</sup>	<u>276</u>	<u>12</u>	<u>27</u>
<u>2112</u>	<u>0.5</u>	<u>7.6</u>	<u>190</u>	<u>242</u>	<u>16</u>	<u>15</u>
<u>2113</u>	<u>0.5</u>	<u>7.7</u>	<u>160</u> <sup>(a)</sup>	<u>238</u>	<u>11</u>	<u>14</u>
<u>2114</u>	<u>0.5</u>	<u>7.7</u>	<u>160</u> <sup>(a)</sup>	<u>252</u>	<u>12</u>	<u>34</u>
<u>2115</u>	<u>0.5</u>	<u>7.7</u>	<u>160</u> <sup>(a)</sup>	<u>248</u>	<u>12</u>	<u>41</u>
<u>2116</u>	<u>4.0</u>	<u>7.8</u>	<u>167</u>	<u>494</u>	<u>146</u>	<u>73</u>
<u>2117</u>	<u>7.0</u>	<u>7.5</u>	<u>185</u>	<u>935</u>	<u>259</u>	<u>167</u>

<sup>(c)</sup> Data from Segments 2109, 2110, and 2111

**Table D-22 Segment-Specific Values for Basin 22, Nueces-Rio Grande Coastal**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2201</u>	<u>12</u>	<u>7.7</u>	<u>675</u> <sup>(a)</sup>	<u>7950</u>	<u>3778</u>	<u>1150</u>
<u>2202</u>	<u>72</u>	<u>7.4</u>	<u>713</u>	<u>2780</u>	<u>860</u>	<u>770</u>
<u>2203</u>	<u>36</u>	<u>7.9</u>	<u>675</u> <sup>(a)</sup>	<u>14200</u>	<u>10605</u>	<u>984</u>
<u>2204</u>	<u>15</u>	<u>7.3</u>	<u>653</u> <sup>(a)</sup>	<u>13900</u> <sup>(c)</sup>	<u>3300</u> <sup>(c)</sup>	<u>598</u> <sup>(c)</sup>

<sup>(c)</sup> Data from 1995 to present to reflect changes in the watershed

**Table D-23 Segment-Specific Values for Basin 23, Rio Grande**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2301</u>	<u>15</u>	<u>7.7</u>	<u>255</u>	<u>880</u>	<u>210</u>	<u>283</u>
<u>2302</u>	<u>5.9</u>	<u>7.6</u>	<u>240</u>	<u>712</u>	<u>146</u>	<u>247</u>
<u>2303</u>	<u>5.0</u>	<u>7.9</u>	<u>230</u> <sup>(a)</sup>	<u>561</u>	<u>114</u>	<u>221</u>
<u>2304</u>	<u>5.0</u>	<u>7.7</u>	<u>237</u>	<u>650</u>	<u>117</u>	<u>212</u>
<u>2305</u>	<u>2.0</u>	<u>7.9</u>	<u>230</u> <sup>(a)</sup>	<u>650</u>	<u>115</u>	<u>215</u>
<u>2306</u>	<u>47</u>	<u>7.4</u>	<u>251</u>	<u>1125</u>	<u>142</u>	<u>403</u>
<u>2307</u>	<u>39</u>	<u>7.5</u>	<u>229</u>	<u>1453</u>	<u>411</u>	<u>460</u>
<u>2308</u>	<u>20</u>	<u>7.7</u>	<u>224</u>	<u>775</u>	<u>126</u>	<u>223</u>
<u>2309</u>	<u>1.0</u>	<u>7.7</u>	<u>230</u> <sup>(a)</sup>	<u>224</u>	<u>14</u>	<u>9.0</u>
<u>2310</u>	<u>4.0</u>	<u>7.7</u>	<u>510</u>	<u>2236</u>	<u>853</u>	<u>494</u>
<u>2311</u>	<u>6.0</u>	<u>7.6</u>	<u>2203</u>	<u>9840</u>	<u>4030</u>	<u>2381</u>
<u>2312</u>	<u>6.0</u>	<u>7.8</u>	<u>1973</u> <sup>(c)</sup>	<u>5455</u>	<u>1954</u>	<u>1550</u>
<u>2313</u>	<u>4.0</u>	<u>7.5</u>	<u>230</u> <sup>(a)</sup>	<u>285</u>	<u>18</u>	<u>20</u>
<u>2314</u>	<u>24</u>	<u>7.8</u>	<u>240</u>	<u>718</u>	<u>110</u>	<u>224</u>

(c) Data from Segment 2312 and from station 13265 in Segment 2311

**Table D-24 Segment-Specific Values for Basin 24, Bays and Estuaries**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2411</u>	<u>11</u>	<u>6.8</u>	<u>950<sup>(a)</sup></u>	<u>12800</u>	<u>7150</u>	<u>1010</u>
<u>2412</u>	<u>8.3</u>	<u>6.8</u>	<u>950<sup>(a)</sup></u>	<u>6790</u>	<u>3598</u>	<u>496</u>
<u>2421</u>	<u>11</u>	<u>7.8</u>	<u>787</u>	<u>13400</u>	<u>7842</u>	<u>1060</u>
<u>2422</u>	<u>8.0</u>	<u>7.8</u>	<u>148</u>	<u>7785</u>	<u>3290</u>	<u>460</u>
<u>2423</u>	<u>13</u>	<u>7.8</u>	<u>950<sup>(a)</sup></u>	<u>12800</u>	<u>7170</u>	<u>960</u>
<u>2424</u>	<u>13</u>	<u>7.8</u>	<u>3112</u>	<u>26099</u>	<u>13100</u>	<u>1789</u>
<u>2425</u>	<u>16</u>	<u>7.9</u>	<u>700</u>	<u>12846</u>	<u>6000</u>	<u>778</u>
<u>2426</u>	<u>16</u>	<u>7.6</u>	<u>930</u>	<u>12459</u>	<u>5970</u>	<u>814</u>
<u>2427</u>	<u>12</u>	<u>7.6</u>	<u>730</u>	<u>11915</u>	<u>5675</u>	<u>810</u>
<u>2428</u>	<u>16</u>	<u>7.9</u>	<u>1037</u>	<u>12870</u>	<u>6400</u>	<u>838</u>
<u>2429</u>	<u>9.0</u>	<u>7.5</u>	<u>644</u>	<u>10501</u>	<u>5625</u>	<u>815</u>
<u>2430</u>	<u>9.0</u>	<u>7.6</u>	<u>603</u>	<u>9670</u>	<u>4979</u>	<u>712</u>
<u>2431</u>	<u>15</u>	<u>7.7</u>	<u>1727<sup>(c)</sup></u>	<u>19412</u>	<u>8350</u>	<u>1171</u>
<u>2432</u>	<u>13</u>	<u>7.7</u>	<u>3163<sup>(d)</sup></u>	<u>21600</u>	<u>9759</u>	<u>1378</u>
<u>2433</u>	<u>10</u>	<u>7.8</u>	<u>3163<sup>(d)</sup></u>	<u>24862<sup>(b)</sup></u>	<u>13200</u>	<u>1860</u>
<u>2434</u>	<u>14</u>	<u>7.9</u>	<u>3163<sup>(d)</sup></u>	<u>27100</u>	<u>14240</u>	<u>1940</u>
<u>2435</u>	<u>27</u>	<u>7.8</u>	<u>3163<sup>(d)</sup></u>	<u>25415<sup>(b)</sup></u>	<u>13825</u>	<u>1880</u>
<u>2436</u>	<u>11</u>	<u>7.7</u>	<u>1002</u>	<u>13960</u>	<u>6545</u>	<u>900</u>
<u>2437</u>	<u>11</u>	<u>7.9</u>	<u>2867</u>	<u>24250</u>	<u>12200</u>	<u>1670</u>
<u>2438</u>	<u>10</u>	<u>7.7</u>	<u>1466<sup>(e)</sup></u>	<u>14000</u>	<u>6980</u>	<u>1025</u>
<u>2439</u>	<u>12</u>	<u>7.9</u>	<u>1606</u>	<u>19300</u>	<u>10500</u>	<u>1430</u>
<u>2441</u>	<u>25</u>	<u>7.8</u>	<u>1185<sup>(f)</sup></u>	<u>23600</u>	<u>11150</u>	<u>1465</u>
<u>2442</u>	<u>20</u>	<u>7.7</u>	<u>1185<sup>(f)</sup></u>	<u>20215<sup>(b)</sup></u>	<u>11800</u>	<u>1295</u>
<u>2451</u>	<u>11</u>	<u>7.9</u>	<u>1185<sup>(f)</sup></u>	<u>26000</u>	<u>13400</u>	<u>1850</u>
<u>2452</u>	<u>12</u>	<u>7.8</u>	<u>1185<sup>(f)</sup></u>	<u>22150</u>	<u>11500</u>	<u>1600</u>
<u>2453</u>	<u>11</u>	<u>7.9</u>	<u>980</u>	<u>19200</u>	<u>9860</u>	<u>1340</u>
<u>2454</u>	<u>12</u>	<u>7.9</u>	<u>1185<sup>(f)</sup></u>	<u>22700</u>	<u>11780</u>	<u>1630</u>
<u>2455</u>	<u>11</u>	<u>8.0</u>	<u>1185<sup>(f)</sup></u>	<u>24450</u>	<u>12025</u>	<u>1597</u>
<u>2456</u>	<u>28</u>	<u>7.9</u>	<u>950<sup>(a)</sup></u>	<u>4260</u>	<u>2518</u>	<u>393</u>
<u>2461</u>	<u>10</u>	<u>7.9</u>	<u>950<sup>(a)</sup></u>	<u>26200</u>	<u>14100</u>	<u>1950</u>
<u>2462</u>	<u>16</u>	<u>8.0</u>	<u>950<sup>(a)</sup></u>	<u>10450</u>	<u>6970</u>	<u>960</u>
<u>2463</u>	<u>17</u>	<u>7.9</u>	<u>950<sup>(a)</sup></u>	<u>19800</u>	<u>10200</u>	<u>1365</u>

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2471</u>	<u>9.0</u>	<u>7.9</u>	<u>950</u> <sup>(a)</sup>	<u>28600</u>	<u>14500</u>	<u>2000</u>
<u>2472</u>	<u>15</u>	<u>7.9</u>	<u>950</u> <sup>(a)</sup>	<u>15500</u>	<u>7500</u>	<u>1012</u>
<u>2473</u>	<u>16</u>	<u>7.8</u>	<u>950</u> <sup>(a)</sup>	<u>19725</u>	<u>10000</u>	<u>1400</u>
<u>2481</u>	<u>10</u>	<u>7.9</u>	<u>5011</u> <sup>(g)</sup>	<u>34850</u>	<u>17100</u>	<u>2400</u>
<u>2482</u>	<u>17</u>	<u>7.8</u>	<u>5011</u> <sup>(g)</sup>	<u>30900</u>	<u>15800</u>	<u>2150</u>
<u>2483</u>	<u>13</u>	<u>7.9</u>	<u>5011</u> <sup>(g)</sup>	<u>29650</u>	<u>15873</u>	<u>2220</u>
<u>2484</u>	<u>10</u>	<u>7.9</u>	<u>5011</u> <sup>(g)</sup>	<u>33800</u>	<u>16800</u>	<u>2380</u>
<u>2485</u>	<u>33</u>	<u>7.7</u>	<u>5011</u> <sup>(g)</sup>	<u>30850</u>	<u>17400</u>	<u>2400</u>
<u>2491</u>	<u>12</u>	<u>8.0</u>	<u>5011</u> <sup>(g)</sup>	<u>36925</u>	<u>18700</u>	<u>2666</u>
<u>2492</u>	<u>17</u>	<u>7.9</u>	<u>5011</u> <sup>(g)</sup>	<u>40050</u>	<u>21100</u>	<u>3095</u>
<u>2493</u>	<u>13</u>	<u>7.9</u>	<u>5011</u> <sup>(g)</sup>	<u>37350</u>	<u>19250</u>	<u>2650</u>
<u>2494</u>	<u>10</u>	<u>7.9</u>	<u>5011</u> <sup>(g)</sup>	<u>35950</u>	<u>18335</u>	<u>2565</u>

<sup>(c)</sup> Data from Segments 2431 and 2439

<sup>(d)</sup> Data from Segments 2424, 2432, 2433, 2434, and 2435

<sup>(e)</sup> Data from Segment 2438 and from stations 13303 and 13304 in Segment 2421

<sup>(f)</sup> Data from Segments 2441, 2442, 2451, 2452, 2453, 2454, and 2455

<sup>(g)</sup> 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**

<u>Segment Number</u>	<u>TSS (mg/L)</u>	<u>pH (s.u.)</u>	<u>Total Hardness (mg/L as CaCO<sub>3</sub>)</u>	<u>TDS (mg/L)</u>	<u>Chloride (mg/L)</u>	<u>Sulfate (mg/L)</u>
<u>2501</u>	<u>12</u>	<u>7.0</u>	<u>4613</u>	<u>28700</u>	<u>15500</u>	<u>2170</u>

# **Appendix E. Minimum Analytical Levels and Suggested Analytical Methods.**

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**Table E-18. 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 section 307.6 of the Standards, all 126 priority pollutants, and those pollutants listed in 40 CFR 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. If the EPA amends 40 CFR Part 136 with more sensitive analytical methods or replaces any method in this table, then the permittee is required to use the more sensitive methods published in 40 CFR Part 136.

<b>Pollutant</b>	<b>CASRN <sup>1</sup></b>	<b>MAL (µg/L)</b>	<b>Screening Level <sup>2</sup> (µg/L)</b>	<b>Suggested Method</b>
<u>Acenaphthene</u>	<u>83-32-9</u>	<u>10</u>		<u>625</u>
<u>Acenaphthylene</u>	<u>208-96-8</u>	<u>10</u>		<u>625</u>
<u>Acetaldehyde</u>	<u>75-07-0</u>	<u>50</u>		<u>1667</u>
<u>Acrolein</u>	<u>107-02-8</u>	<u>50</u>		<u>624</u>
Acrylonitrile	107-13-1	50		<u>1624B</u> <u>624</u>
Aldrin	309-00-2	<u>0.01</u> <del>0.05</del>		608
<u>Allyl alcohol</u>	<u>107-18-6</u>	<u>50</u>		<u>1624</u>
<u>Allyl chloride</u>	<u>107-05-1</u>	<u>10</u>		<u>1624</u>
Aluminum, <u>total</u> <sup>3</sup>	7429-90-5	<u>2.5</u> <u>30</u>		<u>200.8</u> <sup>3</sup> <u>202.2</u>
<u>Amyl acetate</u>	<u>628-63-7</u>	<u>5</u>		<u>1666</u>
<u>Aniline</u>	<u>62-53-3</u>	<u>10</u>		<u>625</u> <sup>10</sup>
<u>Anthracene</u>	<u>120-12-7</u>	<u>10</u>		<u>625</u>
Antimony, <u>total</u> <sup>3,4</sup>	7440-36-0	<u>5</u> <del>60</del>		<u>200.8</u> <sup>3</sup> <u>200.7</u>
Arsenic, <u>total</u> <sup>3</sup>	7440-38-2	<u>0.5</u> <u>10</u>		<u>200.8</u> <sup>3</sup> <u>206.2</u>
<u>Asbestos</u>	<u>1332-21-4</u>	<u>Not Specified</u> <sup>11</sup>		<u>100.1 and 100.2</u> <sup>12</sup>
Barium, <u>total</u> <sup>3</sup>	7440-39-3	<u>310</u>		<u>200.8</u> <sup>3</sup> <u>208.2</u>
Benzene	71-43-2	10		624
Benzidine	92-87-5	50		625
Benzo(a)anthracene	56-55-3	<u>5</u> <u>10</u>		625
Benzo(a)pyrene	50-32-8	<u>5</u> <u>10</u>		625
<u>Benzo(b)fluoranthene</u>	<u>205-99-2</u>	<u>10</u>		<u>625</u>

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
<u>Benzo(g,h,i)perylene</u>	<u>191-24-2</u>	<u>20</u>		<u>625</u>
<u>Benzo(k)fluoranthene</u>	<u>207-08-9</u>	<u>5</u>		<u>625</u>
<u>Benzonitrile</u>	<u>100-47-0</u>	<u>1 mg/L</u>		<u>ASTM D3371</u>
<u>Benzyl chloride</u>	<u>100-44-7</u>	<u>Not Specified <sup>11</sup></u>		<u>TBD<sup>4</sup></u>
<u>Beryllium, total<sup>3</sup></u>	7440-41-7	<u>0.5</u> <del>5</del>		<u>200.8<sup>3</sup></u> <del>200.7</del>
<u>Bis(2-chloroethoxy)methane</u>	<u>111-91-1</u>	<u>10</u>		<u>625</u>
<u>Bis(2-chloroethyl)ether</u>	<u>111-44-4</u>	<u>10</u>		<u>625</u>
<u>Bis(2-chloroisopropyl)ether</u>	<u>108-60-1</u>	<u>10</u>		<u>625</u>
<u>Bis(chloromethyl)ether<sup>5</sup></u>	542-88-1	<u>—<sup>5</sup></u>		<u>—<sup>5</sup></u>
<u>Bis(2-ethylhexyl)phthalate</u> <u>[Di(2-ethylhexyl)phthalate]</u>	<u>117-81-7</u>	<u>10</u>		<u>625</u>
<u>Boron, total</u>	7440-42-8	20	100	200.7
<u>Bromide</u>	—	<u>400</u> <del>2000</del>		<u>300.0, Rev. 2.1</u> <u>300.1, Rev. 1.0</u> <del>320.1</del>
<u>Bromodichloromethane</u> <u>[Dichlorobromomethane]</u>	<u>75-27-4</u>	<u>10</u>		<u>624</u>
<u>Bromoform</u>	<u>75-25-2</u>	<u>10</u>		<u>624</u>
<u>4-Bromophenyl phenyl ether</u>	<u>101-55-3</u>	<u>10</u>		<u>625</u>
<u>Butyl acetate</u>	<u>540-88-5</u>	<u>5</u>		<u>1666</u>
<u>n-Butylamine</u>	<u>109-73-9</u>	<u>Not Specified <sup>11</sup></u>		<u>TBD <sup>11</sup></u>
<u>sec-Butylamine</u>	<u>13952-84-6</u>	<u>Not Specified <sup>11</sup></u>		<u>TBD <sup>11</sup></u>
<u>tert-Butylamine</u>	<u>75-64-9</u>	<u>Not Specified <sup>11</sup></u>		<u>TBD <sup>11</sup></u>
<u>Butylbenzyl phthalate</u>	<u>85-68-7</u>	<u>10</u>		<u>625</u>
<u>Cadmium, total<sup>3,4</sup></u>	7440-43-9	1		<u>200.8<sup>3</sup></u> <del>213.2</del>
<u>Captan</u>	<u>133-06-2</u>	<u>0.330 <sup>13</sup></u>		<u>SM6630B</u>
<u>Carbaryl</u>	63-25-2	5		632
<u>Carbazole</u>	<u>86-74-8</u>	<u>20</u>		<u>1625</u>
<u>Carbofuran</u>	<u>1563-66-2</u>	<u>3</u>		<u>632</u>
<u>Carbon disulfide</u>	<u>75-15-0</u>	<u>10</u>		<u>1624</u>
<u>Carbon tetrachloride</u>	56-23-5	<u>2</u> <del>10</del>		624
<u>Chlordane</u>	57-74-9	<u>0.2</u> <del>0.15</del>		608
<u>Chlorine</u>	<u>7782-50-5</u>	<u>33</u>		<u>4500-C1 E or G</u>
<u>Chlorobenzene</u>	108-90-7	10		624
<u>Chlorodibromomethane</u>	<u>124-48-1</u>	<u>10</u>		<u>624</u>

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
<u>Chloroethane</u>	<u>75-00-3</u>	<u>50</u>		<u>624</u>
<u>2-chloroethylvinyl ether</u>	<u>110-75-8</u>	<u>10</u>		<u>624</u>
Chloroform	67-66-3	10		624
<u>2-Chloronaphthalene</u>	<u>91-58-7</u>	<u>10</u>		<u>625</u>
<u>2-Chlorophenol</u>	<u>95-57-8</u>	<u>10</u>		<u>625</u>
<u>4-Chlorophenyl phenyl ether</u>	<u>7005-72-3</u>	<u>10</u>		<u>625</u>
Chlorpyrifos	2921-88-2	0.05		1657
Chromium, total-Recoverable <sup>3</sup>	7440-47-3	<u>3</u> <del>10</del>		<u>200.8</u> <sup>3</sup> <del>218.2</del>
Chromium, hexavalent	18540-29-9	<u>3</u> <del>10</del>		<u>218.6, rev. 3.3</u> <del>218.4</del>
Chromium, trivalent <sup>6</sup>	16065-83-1	— <sup>6</sup>		— <sup>6</sup>
Chrysene	218-01-9	<u>5</u> <del>10</del>		625
Cobalt, total <sup>3</sup>	7440-48-4	<u>0.3</u> <del>5</del>	1500	<u>200.8</u> <sup>3</sup> <del>219.2</del>
Copper, total <sup>3,4</sup>	7440-50-8	<u>0.5</u> <del>10</del>		<u>200.8</u> <sup>3</sup> <del>220.2</del>
<u>Coumaphos</u>	<u>56-72-4</u>	<u>0.025</u>		<u>1657</u>
<u>Cresols (all isomers)</u>	<u>1319-77-3</u>	<u>10</u>		<u>625</u> <sup>10</sup>
<u>p-Chloro-m-Cresol</u> [ <u>4-Chloro-3-methylphenol</u> ]	108-39-4	10		625 <sup>10</sup>
<u>4,6-Dinitro-o-Cresol</u> [ <u>2-Methyl-4,6-dinitrophenol</u> ]	95-48-7	<u>10</u> <del>50</del>		625 <sup>10</sup>
<u>p-Cresol</u> [ <u>4-Methylphenol</u> ]	106-44-5	10		625 <sup>10</sup>
<u>Crotonaldehyde</u>	<u>4170-30-3</u>	<u>10</u>		<u>1624</u>
Cyanide, total	57-12-5	<u>10</u> <del>20</del>		<u>335.4 or</u> <u>4500-CN D or</u> <u>4500-CN E</u> <del>335.2</del>
Cyanide, available amenable to chlorination	57-12-5	<u>10</u> <del>20</del>		<u>4500-CN G</u> <del>335.4</del>
		<u>2</u>		<u>OIA-1677</u>
Cyanide, weak acid dissociable	57-12-5	<del>20</del>		4500-CN I
<u>Cyclohexane</u>	<u>110-82-7</u>	<u>5</u>		<u>1666</u>
4,4'-DDD	72-54-8	0.1		608
4,4'-DDE	72-55-9	0.1		608
4,4'-DDT	50-29-3	<u>0.02</u> <del>0.1</del>		608
2,4-D <sup>17</sup>	94-75-7	<u>0.7</u> <del>10</del>		615 or <u>SM6640B</u>



Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
Danitol <sup>7</sup> [Fenpropathrin]	39515-41-8	— <sup>7</sup>		— <sup>7</sup>
<i>n</i> -Decane	<u>124-18-5</u>	<u>30</u>		<u>625</u> <sup>10</sup>
Demeton	8065-48-3	0.20		1657 <sup>14,15</sup>
Diazinon	333-41-5	0.5		1657
		<u>0.1</u>		<u>614</u>
Dibenzo( <i>a,h</i> )anthracene	<u>53-70-3</u>	<u>5</u>		<u>625</u>
Dibromochloromethane [see Chlorodibromomethane]	<u>124-48-1</u>	<u>10</u>		<u>624</u>
1,2-Dibromoethane	106-93-4	<u>10</u> <u>2</u>		<u>1624</u> <sup>10</sup> <u>618</u>
Dicamba	<u>1918-00-9</u>	<u>0.110</u>		<u>1658</u> <sup>14</sup>
Dichlobenil	<u>1194-65-6</u>	Not Specified <sup>11</sup>		TBD <sup>11</sup>
Dichlone	<u>117-80-6</u>	Not Specified <sup>11</sup>		<u>1656</u> <sup>12</sup>
<i>m</i> -Dichlorobenzene [1,3-Dichlorobenzene]	<u>541-73-1</u>	<u>10</u>		<u>624</u>
<i>o</i> -Dichlorobenzene [1,2-Dichlorobenzene]	<u>95-50-1</u>	<u>10</u>		<u>624</u>
<i>p</i> -Dichlorobenzene [1,4-Dichlorobenzene]	106-46-7	10		<u>624</u> <u>625</u>
3,3'-Dichlorobenzidine	<u>91-94-1</u>	<u>5</u>		<u>625</u>
1,1-Dichloroethane	<u>75-34-3</u>	<u>10</u>		<u>624</u>
1,2-Dichloroethane	107-06-2	10		624
1,1-Dichloroethene [1,1-Dichloroethylene]	75-35-4	10		624
Dichloromethane [Methylene chloride]	<u>75-09-2</u>	<u>20</u>		<u>624</u>
2,4-Dichlorophenol	<u>120-83-2</u>	<u>10</u>		<u>625</u>
1,2-Dichloropropane	<u>78-87-5</u>	<u>10</u>		<u>624</u>
1,3-Dichloropropene	542-75-6	10		624
2,2-Dichloropropionic acid [Dalapon]	<u>75-99-0</u>	<u>2</u>		<u>615</u>
Dichlorvos	<u>62-73-7</u>	<u>0.004</u>		<u>1657</u>
Dicofol [Kelthane]	115-32-2	<u>0.99020</u>		ASTM D5812- <u>96(02)</u> <u>617</u>
Dieldrin	60-57-1	<u>0.02</u> <u>0.1</u>		608
Diethyl amine	<u>109-89-7</u>	<u>50 mg/L</u>		<u>1671</u>
Diethyl phthalate	<u>84-66-2</u>	<u>10</u>		<u>625</u>
Dimethyl amine	<u>124-40-3</u>	<u>50 mg/L</u>		<u>1671</u>
2,4-Dimethylphenol	<u>105-67-9</u>	<u>10</u>		<u>625</u>

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
<u>Dimethyl phthalate</u>	<u>131-11-3</u>	<u>10</u>		<u>625</u>
<u>Di-n-butyl phthalate</u>	<u>84-74-2</u>	<u>10</u>		<u>625</u>
<u>Dinitrobenzene</u>	<u>25154-54-5</u>	<u>10</u>		<u>1625</u>
<u>2,4-Dinitrophenol</u>	<u>51-28-5</u>	<u>50</u>		<u>625</u>
<u>2,4-Dinitrotoluene</u>	<u>121-14-2</u>	<u>10</u>		<u>625</u>
<u>2,6-Dinitrotoluene</u>	<u>606-20-2</u>	<u>10</u>		<u>625</u>
<u>Di-n-octyl phthalate</u>	<u>117-84-0</u>	<u>10</u>		<u>625</u>
<b><u>Dioxins/Furans [TCDD Equivalents]</u></b>		(ppq)		<u>1613B</u>
2,3,7,8-TCDD	1746-01-6	10		
1,2,3,7,8-PeCDD	40321-76-4	50		
<b><u>2,3,7,8-HxCDDs</u></b>				
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		
<u>1,2,3,4,6,7,8-HpCDD</u>	<u>35822-46-9</u>	<u>50</u>		
<u>OCDD</u>	<u>3268-87-9</u>	<u>100</u>		
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		
<b><u>2,3,7,8-HxCDFs</u></b>				
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		
<b><u>2,3,4,7,8-HpCDFs</u></b>	<u>38998-75-3</u>			
<u>1,2,3,4,6,7,8-HpCDF</u>	<u>67562-39-4</u>	<u>50</u>		
<u>1,2,3,4,7,8,9-HpCDF</u>	<u>55673-89-7</u>	<u>50</u>		
<u>OCDF</u>	<u>39001-02-0</u>	<u>100</u>		
<u>1,2-Diphenylhydrazine (as Azobenzene)</u>	<u>122-66-7</u>	<u>20</u>		<u>1625</u>
<u>Diquat</u>	<u>2764-72-9</u>	<u>1.5</u>		<u>549, 549.1</u>
<u>Disulfoton</u>	<u>298-04-4</u>	<u>0.032</u>		<u>1657</u>
<u>Diuron</u>	330-54-1	0.090		632
<u>Endosulfan I (<i>alpha</i>)</u>	959-98-8	<u>0.01</u> <del>0.1</del>		608
<u>Endosulfan II (<i>beta</i>)</u>	33213-65-9	<u>0.02</u> <del>0.1</del>		608
<u>Endosulfan sulfate</u>	1031-07-8	0.1		608
<u>Endrin</u>	72-20-8	<u>0.02</u> <del>0.1</del>		608
<u>Endrin aldehyde</u>	<u>7421-93-4</u>	<u>0.1</u>		<u>608</u>
<u>Epichlorohydrin</u>	<u>106-89-8</u>	<u>1 mg/L</u>		<u>ASTM D-3695 <sup>14</sup></u>
<u>Ethion</u>	<u>563-12-2</u>	<u>0.015</u>		<u>1657</u>
<u>Ethylbenzene</u>	<u>100-41-4</u>	<u>10</u>		<u>624</u>
<u>Ethylene diamine</u>	<u>107-15-3</u>	<u>Not Specified <sup>11</sup></u>		<u>TBD <sup>11</sup></u>
<u>Ethylene dibromide</u>	<u>106-93-4</u>	<u>10</u>		<u>1624</u>

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
<u>Formaldehyde</u>	<u>50-00-0</u>	<u>50</u>		<u>1667</u>
<u>Fluoranthene</u>	<u>206-44-0</u>	<u>10</u>		<u>625</u>
<u>Fluorene</u>	<u>86-73-7</u>	<u>10</u>		<u>625</u>
Fluoride	16984-48-8	500		<u>300.0_300.1</u> <u>340.3</u>
<u>Furfural</u>	<u>98-01-1</u>	<u>50 mg/L</u>		<u>1667</u>
Guthion [Azinphos Methyl]	86-50-0	0.1		1657
Heptachlor	76-44-8	<u>0.01</u> <del>0.05</del>		608
Heptachlor epoxide	1024-57-3	<u>0.01</u> <del>1.0</del>		608
Hexachlorobenzene	118-74-1	<u>5</u> <del>10</del>		625
Hexachlorobutadiene	87-68-3	10		625
<i>alpha</i> -Hexachlorocyclohexane	319-84-6	0.05		608
<i>beta</i> -Hexachlorocyclohexane	319-85-7	0.05		608
<i>gamma</i> -Hexachlorocyclohexane [Lindane]	58-89-9	0.05		608
<i>delta</i> -Hexachlorocyclohexane	<u>319-86-8</u>	<u>0.05</u>		<u>608</u>
<u>Hexachlorocyclopentadiene</u>	<u>77-47-4</u>	<u>10</u>		<u>625 or 1625B</u> <sup>16</sup>
Hexachloroethane	67-72-1	20		625
Hexachlorophene	70-30-4	10		604.1
<u>Indeno(1,2,3-<i>cd</i>)pyrene</u>	<u>193-39-5</u>	<u>5</u>		<u>625</u>
Iron, <u>total</u>	7439-89-6	<u>7</u> <del>5</del>	300	<u>200.7</u> <u>236.2</u>
<u>Isophorone</u>	<u>78-59-1</u>	<u>10</u>		<u>625</u>
<u>Isopropanolamine dodecylbenzenesulfonate</u>	<u>42504-46-1</u>	<u>Not Specified</u> <sup>11</sup>		<u>TBD</u> <sup>11</sup>
<u>Kepone</u>	<u>143-50-0</u>	<u>0.3</u>		<u>1656</u>
Lead, <u>total</u> <sup>3,4</sup>	7439-92-1	<u>0.5</u> <del>5.0</del>		<u>200.8</u> <sup>3</sup> <u>239.2</u>
Malathion <sup>17</sup>	121-75-5	0.1		1657 <u>or</u> <u>SM6630C</u>
<u>Magnesium, total</u>	<u>7439-95-4</u>	<u>20</u>		<u>200.7</u>
<u>Manganese, total</u> <sup>3</sup>	7439-96-5	<u>0.52</u>	50	<u>200.8</u> <sup>3</sup> <u>243.2</u>
<u>Mercaptodimethur</u> [Methiocarb]	<u>2032-65-7</u>	<u>0.06</u>		<u>632</u> <sup>14</sup>
Mercury, <u>total</u> <sup>3,8,9</sup>	7439-97-6	<u>0.005</u> <del>0.2</del>		<u>245.7, Rev. 2.0</u> <u>245.1</u>
		0.0005		1631E

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
Methoxychlor <sup>17</sup>	72-43-5	2.0		617 or SM6630B and C
Methyl bromide [Bromomethane]	<u>74-83-9</u>	<u>50</u>		<u>624</u>
Methyl chloride [Chloromethane]	<u>74-87-3</u>	<u>50</u>		<u>624</u>
Methyl ethyl ketone	78-93-3	50		624
Methyl mercaptan	<u>74-93-1</u>	<u>Not Specified</u> <sup>11</sup>		<u>TBD</u> <sup>11</sup>
Methyl methacrylate	<u>80-62-6</u>	<u>10</u>		<u>1624</u>
Methyl parathion <sup>17</sup>	<u>298-00-0</u>	<u>0.05</u>		<u>1657 or SM6630C</u>
Mevinphos	<u>7786-34-7</u>	<u>0.2</u>		<u>1657</u>
Mexacarbate	<u>315-18-4</u>	<u>1.5</u>		<u>632</u>
Mirex	2385-85-5	<u>0.015</u> <u>0.2</u>		<u>SM6630B and C</u> <sup>16</sup> <u>617</u>
Molybdenum, total <sup>3</sup>	7439-98-7	<u>1</u> <u>5</u>	500	<u>200.8</u> <sup>3</sup> <u>246.2</u>
Monoethyl amine	<u>75-04-7</u>	<u>Not Specified</u> <sup>11</sup>		<u>TBD</u> <sup>11</sup>
Monomethylamine	<u>74-89-5</u>	<u>50 mg/L</u>		<u>1667</u>
Naled	<u>300-76-5</u>	<u>0.05</u>		<u>1657</u>
Napthalene	<u>91-20-3</u>	<u>10</u>		<u>625</u>
Napthenic acid	<u>1338-24-5</u>	<u>Not Specified</u> <sup>11</sup>		<u>TBD</u> <sup>11</sup>
Nickel, total <sup>3,4</sup>	7440-02-0	<u>0.5</u> <u>10</u>		<u>200.8</u> <sup>3</sup> <u>249.2</u>
Nitrate-nitrogen	14797-55-8	<u>100</u> <u>1000</u>		<u>300.0, Rev. 2.1</u> <u>300.1, Rev. 1.0</u> <u>352.1</u>
Nitrobenzene	98-95-3	10		625
2-Nitrophenol	<u>88-75-5</u>	<u>20</u>		<u>625</u>
4-Nitrophenol	<u>100-02-7</u>	<u>50</u>		<u>625</u>
N-Nitrosodiethylamine	55-18-5	20		625
N-Nitrosodimethylamine	<u>62-75-9</u>	<u>50</u>		<u>625 or 1625B</u>
N-Nitroso-di-n-butylamine	924-16-3	20		625
N-Nitroso-di-n-propylamine	<u>621-64-7</u>	<u>20</u>		<u>625 or 1625B</u>
N-Nitrosodiphenylamine	<u>86-30-6</u>	<u>20</u>		<u>625 or 1625B</u>
Nitrotoluene	<u>1321-12-6</u>	<u>Not Specified</u> <sup>11</sup>		<u>TBD</u> <sup>11</sup>
Nonylphenol	<u>104-40-5</u>	<u>333</u>		<u>1625</u>
para-Nonylphenol	<u>84852-15-3</u>	<u>333</u>		<u>1625</u>
Nonylphenol	<u>25154-52-3</u>	<u>333</u>		<u>1625</u>
n-Octadecane	<u>593-45-3</u>	<u>30</u>		<u>625</u> <sup>10</sup>

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
Parathion (ethyl) <sup>17</sup>	56-38-2	0.1		1657_or SM6630C
Pentachlorobenzene	608-93-5	20		625
Pentachlorophenol	87-86-5	<del>5</del> 50		625
Phenanthrene	85-01-8	10		625
Phenol, total	108-95-2	10		625
<i>p</i> -Phenolsulfonate	127-82-2	Not Specified <sup>11</sup>		TBD <sup>11</sup>
Phosgene	75-44-5	<del>—</del> <sup>7, 11</sup>		Degrades in water <sup>7</sup>
<b>Polychlorinated biphenyls (PCBs)</b>	1336-36-3			<del>608</del>
PCB-77	32598-13-3	0.0005		1668
PCB-81	70362-50-4	0.0005		1668
PCB-126	57465-28-8	0.0005		1668
PCB-169	32774-16-6	0.0005		1668
PCB-1016	12674-11-2	<del>0.2</del> ±0		608
PCB-1221	11104-28-2	<del>0.2</del> ±0		608
PCB-1232	11141-16-5	<del>0.2</del> ±0		608
PCB-1242	53469-21-9	<del>0.2</del> ±0		608
PCB-1248	12672-29-6	<del>0.2</del> ±0		608
PCB-1254	11097-69-1	<del>0.2</del> ±0		608
PCB-1260	11096-82-5	<del>0.2</del> ±0		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 <sup>10</sup>
Quinoline	91-22-5	1 mg/L		ASTM D-4763
Resorcinol	108-46-3	100		1625
Selenium, total <sup>3,4</sup>	7782-49-2	<del>5</del> 10.0		<del>200.8</del> <sup>3</sup> 270.2
Silver, total <sup>3,4</sup>	7440-22-4	<del>0.5</del> 2.0		<del>200.8</del> <sup>3</sup> 272.2
Strontium	7440-24-6	1.0		200.7
Strychnine	57-24-9	40		1625
Styrene	100-42-5	10		1625
1,2,4,5-Tetrachlorobenzene	95-94-3	20		<del>1625</del> 625
1,1,2,2-Tetrachloroethane	79-34-5	10		624
Tetrachloroethene [Tetrachloroethylene]	127-18-4	10		624
Thallium, total <sup>3,4</sup>	7440-28-0	<del>0.5</del> 10		<del>200.8</del> <sup>3</sup> 279.2

Pollutant	CASRN <sup>1</sup>	MAL (µg/L)	Screening Level <sup>2</sup> (µg/L)	Suggested Method
<u>Tin, total</u>	7440-31-5	<u>5</u> <del>20</del>		<u>200.7, 200.9</u> <sup>3</sup> <del>282.2</del>
<u>Titanium, total</u>	7440-32-6	30	40	283.2
<u>Toluene</u>	<u>108-88-3</u>	<u>10</u>		<u>624</u>
Toxaphene	8001-35-2	<u>0.3</u> <del>5.0</del>		608
2,4,5-TP [Silvex]	93-72-1	<u>0.3</u> <del>2.0</del>		<u>SM6640B</u> <del>615</del>
<u>1,2-Trans-dichloroethene</u> <u>1,2-Trans-dichloroethylene</u>	<u>156-60-5</u>	<u>10</u>		<u>624</u>
Tributyltin [TBT]	688-73-3	0.010		TNRCC 1001
<u>1,2,4-Trichlorobenzene</u>	<u>120-82-1</u>	<u>10</u>		<u>625</u>
1,1,1-Trichloroethane	71-55-6	10		624
<u>1,1,2-Trichloroethane</u>	<u>79-00-5</u>	<u>10</u>		<u>624</u>
<u>Trichloroethene</u> [Trichloroethylene]	79-01-6	10		624
<u>Trichlorofon</u>	<u>52-68-6</u>	<u>0.45</u>		<u>1657</u>
2,4,5-Trichlorophenol	95-95-4	50		<u>1625</u> <del>625</del>
<u>2,4,6-Trichlorophenol</u>	<u>88-06-2</u>	<u>10</u>		<u>625</u>
<u>Triethanolmine dodecylbenzenesulfonate</u>	<u>27323-41-7</u>	<u>Not Specified</u> <sup>11</sup>		<u>TBD</u> <sup>11</sup>
<u>Triethylamine</u>	<u>121-44-8</u>	<u>50 mg/L</u>		<u>1667</u>
<b>TTHM (Total Trihalomethanes)</b> Bromodichloromethane Dibromochloromethane Tribromomethane [Bromoform] Trichloromethane [Chloroform]	75-27-4 124-48-1 75-25-2 67-66-3	10 10 10 10		624
<u>Trimethylamine</u>	<u>75-50-3</u>	<u>Not Specified</u> <sup>11</sup>		<u>1666</u> <sup>12</sup>
<u>Uranium, total</u>	<u>7440-61-1</u>	<u>0.5</u>		<u>200.8</u> <sup>3</sup>
<u>Vanadium, total</u>	<u>7440-62-2</u>	<u>5</u>		<u>200.8</u> <sup>3</sup>
<u>Vinyl acetate</u>	<u>108-05-4</u>	<u>50</u>		<u>1624</u>
Vinyl chloride	75-01-4	10		624
<u>Xylenes, total</u>	<u>1330-20-7</u>	<u>10</u>		<u>1624C</u>
<u>Xylenol</u>	<u>1300-71-6</u>	<u>30</u>		<u>625</u>
<u>Zinc, total</u> <sup>3-4</sup>	7440-66-6	5.0		<u>200.8</u> <sup>3</sup> <del>289.2</del>
<u>Zirconium</u>	<u>7440-67-7</u>	<u>100</u>		<u>1620</u>

<sup>1</sup> Chemical Abstracts Service Registry Number.

<sup>2</sup> 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.

- <sup>3</sup> EPA Methods 200.8 and 200.9 are approved for use in the NPDES program (40 CFR Part 136, revised March 12, 2007). EPA Method 200.8 may also be used upon request. Such a request should be made in writing to EPA's Houston Laboratory, 10625 Fallstone Road, Houston, Texas, 77099-4303. Once Method 200.8 is approved for use in the NPDES program, no written request will be necessary.
- <sup>4</sup> 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. EPA Method 1638 may also be used once it is approved for use in the NPDES program.
- <sup>5</sup> Hydrolyzes in water. Will not require applicant to analyze at this time.
- <sup>6</sup> Trivalent chromium (Cr) determined by subtracting hexavalent Cr from total Cr.
- <sup>7</sup> EPA procedure not approved. Will not require applicant to analyze at this time.
- <sup>8</sup> Either method listed for mercury may be used.
- <sup>9</sup> 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.
- <sup>10</sup> 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.
- <sup>11</sup> The TCEQ has requested the EPA to provide MALs and/or suggested methods.
- <sup>12</sup> Method is draft and has not yet been approved by EPA.
- <sup>13</sup> The MAL is 3.3 times the MDL and lowest calibration point for Captan of 0.1 µg/L as given in Method 1656.
- <sup>14</sup> *Methods for Benzene: Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water And Wastewater*. U.S. Environmental Protection Agency, September 1978.
- <sup>15</sup> *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.
- <sup>16</sup> EPA Methods 605, 607, and 612 may also be used.
- <sup>17</sup> Except as provided in 40 CFR Section 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 Section 136.3(a). See 40 CFR Section 455.50.

**Table E-29. Analytical Methods and MALs for the Determination of Pollutants Regulated by 30 TAC §section 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. If the EPA amends 40 CFR Part 136 with more sensitive analytical methods or replaces any method in this table, then the permittee is required to use the more sensitive methods published in 40 CFR Part 136.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Acrylonitrile	<u>1624B</u> <del>624</del>	50	50	The MAL is based on the MDL published in 40 CFR Part 136, Method 1624B. MAL based on the minimum quantitation level (MQL) developed by EPA, Region 6, July 1992. 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	<u>0.01</u> <del>0.05</del>	0.004	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is approximately ten <del>2.5</del> times the detection limit MDL documented in 40 CFR Part 136, Method 608.
Aluminum, total <sup>†</sup>	<u>200.8</u> <del>202.2</del>	<u>2.5</u> <del>30</del>	<u>1.0</u> <del>7.8</del>	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is approximately 2.5 times the MDL four times the detection limit for based on EPA Method 200.8. <sup>1</sup> <del>200.9<sup>2</sup>.</del>
Anthracene	625	10	<del>—</del> <sup>4</sup>	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. <sup>1</sup>
Arsenic, total <sup>†</sup>	<u>200.8</u> <del>206.2</del>	<u>0.5</u> <del>40</del>	<u>0.4</u> <del>0.5</del>	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. <sup>1</sup> MAL is twenty times the detection limit documented in EPA, Method 200.9 <sup>2</sup> and corresponds to the MQL developed by EPA Region 6, July 1992.
Barium, total <sup>†</sup>	<u>200.8</u> <del>208.2</del>	<u>3</u> <del>40</del>	<u>0.8</u> <del>2</del>	The MAL is approximately 3.8 times the MDL based on EPA Method 200.8. <sup>1</sup> MAL is the lowest concentration of the optimum working range given for EPA, Method 208.2 <sup>3</sup> .



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. <del>MAL based on the MQL developed by EPA Region 6, July 1992.</del> The MDL is documented in 40 CFR Part 136, Method 625.
Benzo(a)anthracene	625	<del>5</del> 10	<del>—</del> <sup>11</sup> 7.8	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. <del>MAL based on the MQL developed by EPA, Region 6, July 1992.</del> The MDL is documented in 40 CFR Part 136, Method 625.
Benzo(a)pyrene	625	<del>5</del> 10	2.5	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. <del>MAL based on the MQL developed by EPA, Region 6, July 1992.</del> The MDL is documented in 40 CFR Part 136, Method 625.
Bis(2-chloroethyl)ether	<u>625</u>	<u>10</u>	<u>5.7</u>	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	<del>—</del> <sup>4</sup>	<del>—</del> <sup>4</sup>	<del>—</del> <sup>4</sup>	Analytical method undetermined.
Bis(2-ethylhexyl)phthalate [Di(2-ethylhexyl)phthalate]	<u>625</u>	<u>10</u>	<u>2.5</u>	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]	<u>624</u>	<u>10</u>	<u>2.2</u>	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.
Cadmium, total <sup>1+5</sup>	<del>200.8</del> <del>213.2</del>	1	<del>0.5</del> <del>0.05</del>	The MAL is two times the MDL based on EPA Method 200.8. <sup>1</sup> <del>MAL is twenty times the detection limit given for EPA, Method 200.9<sup>2</sup> and corresponds to the MQL developed by EPA Region 6, July 1992.</del>
Carbaryl	632	5.0	0.02	The MAL is based on laboratory consensus taken October 1992. The MDL is given by EPA Method 632. <sup>6</sup>
Carbon tetrachloride	624	<del>2</del> 10	<del>—</del> <sup>11</sup> 2.8	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. <del>MAL based on the MQL developed by EPA, Region 6, July 1992.</del> The MDL is documented in 40 CFR Part 136, Method 624.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Chlordane	608	<u>0.2</u> <del>0.15</del>	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. MAL is approximately ten times the detection limit documented in 40 CFR Part 136, Method 608.
Chlorine	<u>4500-Cl E</u> <u>4500-Cl G</u>	<u>33</u>	<u>10</u>	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	<u>6.0</u>	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	<u>624</u>	<u>10</u>	<u>3.1</u>	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 approximately ten 12.5 times the MDL detection limit given by EPA, Method 1657. <sup>6</sup>
Chromium, total Recoverable <sup>1</sup> (Dissolved)	<u>200.8</u> <del>218.2</del>	<u>3</u> <del>10.0</del>	<u>0.9</u> <del>0.1</del>	The MAL is 3.3 times the MDL based on EPA Method 200.8. <sup>1</sup> MAL is based on the contract required detection limit (CRDL) published in the EPA Contract Laboratory Program Statement of Work, Doc. No. ILMO2.0, Method 218.2. MDL based on EPA, Method 200.9. <sup>2</sup>
Chromium, hexavalent	<u>218.6</u> <u>Rev. 3.3</u> <del>218.4</del>	<u>3.0</u> <del>10</del>	<u>0.3</u> <del>1</del>	The MAL is ten times the MDL detection limit given by EPA Method 218.6, Revision 3.3. <sup>218.4</sup> <sup>3</sup>
Chromium, trivalent	See documentation note.	—	—	Trivalent chromium is determined by subtracting the concentration of hexavalent chromium (dissolved) from the dissolved total chromium concentration.
Chrysene	625	<u>5</u> <del>10</del>	2.5	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July, 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Copper, total <sup>4,5</sup>	<u>200.8</u> <del>220.2</del>	<u>0.5</u> <del>10</del>	<u>0.5</u> <del>0.7</del>	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MDL is documented in EPA Method 200.8. <sup>1</sup> MAL is approximately ten times the detection limit given by EPA, Method 200.9. <sup>2</sup>

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
<del><i>p</i>-Chloro-<i>m</i>-cresol [4-Chloro-3-methylphenol]</del>	625	10	3	MAL based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625. <sup>2,15</sup>
<del>4,6-Dinitro-<i>o</i>-cresol [2-Methyl-4,6-dinitrophenol]</del>	625	<del>10 50</del>	<del>4.7 24</del>	<del>MAL based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 625.<sup>2,15</sup></del>
<del><i>p</i>-Cresol [4-Methylphenol]</del>	625	10	<del>7.8 —<sup>4</sup></del>	<del>The MDL is documented in 40 CFR Part 136, Method 625.<sup>2,15</sup> MAL based on the contract required quantitation levels (CRQLs) for water from EPA Region 6, Target Compound List acquired January 14, 1993.</del>
Cyanide, total	<del>335.4, 4500-CN D, 4500-CN E, 335.2</del>	<del>10 20</del>	<del>—<sup>4</sup></del>	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL is based on the lowest standard concentration within the applicable range set in EPA, Method 335.2 <sup>3</sup> . The CRDL is 10 µg/L published in the EPA Contract Laboratory Program Statement of Work, Document Number ILMO2.0 using Method 239.2.
Cyanide, available <sup>16</sup> amenable to chlorination	<del>4500-CN G 335.1</del>	<del>10 20</del>	<del>—<sup>54</sup></del>	<del>The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. There is no MDL documented in Standard Methods (20<sup>th</sup> Edition).<sup>5</sup> Both chlorinated and unchlorinated cyanide sample concentrations are determined using EPA, Method 335.2<sup>3</sup>.</del>
	OIA-1677	2	0.5	The MAL and MDL are documented in EPA Method OIA-1677 dated August 1999.
Cyanide, weak acid dissociable	4500-CN I	20	1.4	MAL based on the MDL developed by the TNRCC Laboratory on 12/09/94.
4,4'-DDD	608	0.1	0.011	The MAL is approximately <del>ten</del> 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	<del>0.02 0.1</del>	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. MAL is approximately ten times the detection limit documented in 40 CFR Part 136, Method 608.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
2,4-D	615 or SM6640B	<del>10</del> 0.7	<del>1.2</del> 0.07	The MAL is approximately ten times the detection limit given by SM6640B. <sup>5</sup> EPA Method 615. <sup>6</sup>
Danitrol [Fenpropathrin]	No published EPA method available. Method under development	— <sup>4</sup>	— <sup>4</sup>	No published EPA method available. Method, MAL and MDL developed by the Texas Natural Resource Conservation Commission Laboratory. May be reviewed by EPA, Region 6 for use in Texas.
Demeton	1657 <sup>12, 13</sup>	0.20	0.020	The MAL is ten times the detection limit given by EPA Method 1657. <sup>6</sup>
Diazinon	1657	0.5	0.038	The MAL is approximately ten <del>13.2</del> times the detection limit given by EPA Method 1657. <sup>6</sup>
	614	0.1	0.01	The MAL is 10 times the detection limit given by EPA Method 614. <sup>6</sup>
Dibenzo(a,h)anthracene	625	5	— <sup>4</sup>	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008.
Dibromochloromethane [see Chlorodibromomethane]	624	10	3.1	MAL based on the MQL developed by EPA Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 624.
1,2-Dibromoethane	<del>618</del> 1624	<del>2</del> 10	<del>0.2</del> — <sup>4</sup>	The MAL is based on the baseline value documented in Attachment 15-1, page 5-17 of the EPA <i>Development Document for Effluent Limitations Guidelines and Standards for the Centralized Waste Treatment Industry - Final</i> , August 2000. MAL is ten times the detection limit given in EPA Method 618. <sup>6</sup>
<i>m</i> -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.
<i>o</i> -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.
<i>p</i> -Dichlorobenzene [1,4-Dichlorobenzene]	<del>625</del> 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 <del>624</del> 625.
3,3'-Dichlorobenzidine	625	5	— <sup>11</sup>	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.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
<u>1,1-Dichloroethene</u> [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.
<u>Dichloromethane</u> [Methylene chloride]	<u>624</u>	<u>20</u>	<u>2.8</u>	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.
<u>1,2-Dichloropropane</u>	<u>624</u>	<u>10</u>	<u>6.0</u>	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.
Dicofol [Kelthane]	<u>ASTM</u> <u>D5812-</u> <u>96(02)617</u>	<u>0.990</u> <u>20</u>	— <sup>4</sup>	The MAL is 3.3 times the lowest calibration point for Dicofol of 0.3 µg/L given in Method 1656. MAL based on laboratory consensus taken October 1992 and Method 617. <sup>6</sup>
Dieldrin	608	<u>0.02</u> <del>0.1</del>	0.002	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 608.
<u>2,4-Dimethylphenol</u>	<u>625</u>	<u>10</u>	<u>2.7</u>	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.
<u>Di-n-butyl phthalate</u>	<u>625</u>	<u>10</u>	— <sup>4</sup>	The MAL is based on the MQL developed by EPA Region 6, July 1992.
<b><u>Dioxins/Furans (TCDD Equivalents)</u></b> 2,3,7,8-TCDD 1,2,3,7,8-PeCDD <b><u>2,3,7,8-HxCDDs</u></b> 1,2,3,4,7,8-HxCDD 1,2,3,6,7,8-HxCDD 1,2,3,7,8,9-HxCDD <b><u>1,2,3,4,6,7,8-HpCDD</u></b> <b><u>OCDD</u></b> 2,3,7,8-TCDF 1,2,3,7,8-PeCDF <sup>10</sup> 2,3,4,7,8-PeCDF <b><u>2,3,7,8-HxCDFs</u></b> 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 <b><u>2,3,4,7,8-HpCDFs</u></b> <b><u>1,2,3,4,6,7,8-HpCDF</u></b> <b><u>1,2,3,4,7,8,9-HpCDF</u></b> <b><u>OCDF</u></b>	1613B	(ppq) 10 50 50 50 50 50 100 10 50 50 50 50 50 50 50 50 50 50 50 50 100	(ppq) See documen- tation note 40	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. MAL based on the MQL developed by the Dioxin National Strategy as reported by EPA Region 6, July 1992 Minimum Quantification Report and the minimum levels at which the analytical system will give acceptable selected ion current profile and calibration as published in EPA Method 1613.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Diuron	632	0.090	0.009	The MAL is approximately ten times the detection limit given by EPA Method 632. <sup>6</sup>
Endosulfan I ( <i>alpha</i> )	608	$\frac{0.01}{0.1}$	$\frac{11}{0.014}$	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 608.
Endosulfan II ( <i>beta</i> )	608	$\frac{0.02}{0.1}$	0.004	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July 1992. 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	$\frac{0.02}{0.1}$	0.006	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July 1992. 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	$\frac{300.0 \text{ or } 300.1}{340.3}$	500	50	The MAL is ten times the lowest concentration of the applicable working range given by EPA Method 300.0/340.3. <sup>3</sup>
Guthion [Azinphos Methyl]	1657	0.1	0.009	The MAL is approximately ten times the detection limit given by EPA Method 1657. <sup>6</sup>
Heptachlor	608	$\frac{0.01}{0.05}$	0.003	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is approximately ten times the detection limit documented in 40 CFR Part 136, Method 608.
Heptachlor epoxide	608	$\frac{0.01}{1.0}$	$\frac{11}{0.083}$	The MAL is based on the CERCLA National Contract Laboratory Program's CROL referred to by EPA Region 6 MQL guidance dated February 8, 2008. MAL is approximately ten times the detection limit documented in 40 CFR Part 136, Method 608.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Hexachlorobenzene	625	<del>10</del> <u>5</u>	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. MAL based on the MQL developed by EPA, Region 6, July, 1992. The MDL is documented in 40 CFR Part 136, Method 625.
Hexachlorobutadiene	625	10	0.9	The MAL is approximately ten 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.
<i>alpha</i> -Hexachlorocyclohexane	608	0.05	0.003	The MAL is approximately ten 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.
<i>beta</i> -Hexachlorocyclohexane	608	0.05	0.006	The MAL is approximately ten 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.
<i>gamma</i> -Hexachlorocyclohexane [Lindane]	608	0.05	0.004	The MAL is approximately ten 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.
<u>Hexachlorocyclopentadiene</u>	<u>625 or 1625B</u> <sup>14</sup>	<u>10</u>	<u>—</u> <sup>4</sup>	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 approximately ten 8.3 times the detection limit given in EPA Method 604.1. <sup>6</sup>
Lead, total <sup>1-5</sup>	<del>239.2</del> <u>200.8</u>	<del>5.0</del> <u>0.5</u>	<del>0.7</del> <u>0.05</u>	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. <sup>1</sup> MAL is based on the MQL developed by EPA, Region 6, July, 1992 and is greater than the CRDL of 3 µg/L published in the EPA Contract Laboratory Program Statement of Work, Doc. Number ILMO2.0 using Method 239.2. MDL based on EPA, Method 200.9. <sup>2</sup>
Malathion	1657 or <u>SM6630C</u>	0.1	0.011	The MAL is approximately ten 9.1 times the detection limit given in EPA Method 1657. <sup>6</sup>

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Mercury <sup>1,7,8,9</sup>	<u>245.7</u> , Rev. 2.0 <del>245.1</del>	<u>0.005</u> <del>0.2</del>	<u>0.0018</u> <del>—</del> <sup>4</sup>	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. MAL is based on the CRDL published in the EPA Contract Laboratory Program Statement of Work, Document Number ILMO2.0 using Method 245.1 and corresponds with the MQL developed by EPA, Region 6, July 1992.
Mercury <sup>1,7,8,9</sup>	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. MAL is based on the minimum level published in Method 1631, Revision B. <sup>8</sup>
Methoxychlor	617 or SM6630B and C	2.0	0.176	The MAL is approximately ten <sup>11.4</sup> times the detection limit given in EPA Method 617. <sup>6</sup>
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 617	<u>0.015</u> <del>0.2</del>	<u>0.004</u> <del>0.015</del>	The MAL is approximately ten <sup>3.75</sup> times the MDL and lowest calibration point for Mirex of 0.004 µg/L as given in Method 1656. detection limit given in EPA Method 617. <sup>6</sup>
Nickel, total <sup>1,5</sup>	<u>200.8</u> <del>249.2</del>	<u>0.5</u> <del>10</del>	<u>0.5</u> <del>0.6</del>	The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. The MAL is equal to the MDL given for EPA Method 200.8. <sup>1</sup> MAL is approximately ten times the detection limit given for EPA, Method 200.9. <sup>2</sup>
Nitrate-nitrogen	<u>300.1</u> <del>352.1</del>	<u>100</u> <del>1000</del>	<u>10</u> <del>100</del>	The MAL is ten times the lowest concentration of the applicable range given by EPA 1979, Method 300.1, Rev. 1.0, 352.1. <sup>3</sup>
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.



Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
<u>para-Nonylphenol (CASRN 84852-15-3)</u>	<u>1625</u>	<u>333</u>	<u>111</u>	<u>The MAL is three times the MDL published in Method 1625.</u>
<u>Nonylphenol (CASRN 25154-52-3)</u>	<u>1625</u>	<u>333</u>	<u>111</u>	<u>The MAL is three times the MDL published in Method 1625.</u>
Parathion (ethyl)	<u>1657 or SM6630C</u>	0.1	0.010	<u>The MAL is ten times the detection limit given in EPA Method 1657.<sup>6</sup></u>
Pentachlorobenzene	625	20	5	<u>The suggested method, MAL and MDL are based on laboratory consensus taken October 1992.</u>
Pentachlorophenol	625	<u>5</u> <del>50</del>	3.6	<u>The MAL is based on the MQL approved by EPA Region 6 on February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July 1992. MAL is based on the CRQL for water analysis using Method 625 from the EPA Region 6, Target Compound List acquired January 14, 1993.</u>
Phenanthrene	625	10	5.4	<u>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.</u>
<b>Polychlorinated biphenyls (PCBs)</b>	<b>608</b>			
<u>PCB-77</u>	<u>1668</u>	<u>0.0005</u>	<u>0.000169</u>	<u>The MALs are based on estimated minimum levels as published in Method 1668.</u>
<u>PCB-81</u>	<u>1668</u>	<u>0.0005</u>	<u>0.000177</u>	
<u>PCB-126</u>	<u>1668</u>	<u>0.0005</u>	<u>0.000136</u>	<u>The MALs are based on the MQLs approved by EPA Region 6 on February 8, 2008. MAL based on the MQLs developed by EPA, Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 608.</u>
<u>PCB-169</u>	<u>1668</u>	<u>0.0005</u>	<u>0.000161</u>	
PCB-1016	<u>608</u>	<u>0.2 ±0</u>	ND <sup>4</sup>	
PCB-1221	<u>608</u>	<u>0.2 ±0</u>	ND <sup>4</sup>	
PCB-1232	<u>608</u>	<u>0.2 ±0</u>	ND <sup>4</sup>	
PCB-1242	<u>608</u>	<u>0.2 ±0</u>	0.065	
PCB-1248	<u>608</u>	<u>0.2 ±0</u>	ND <sup>4</sup>	
PCB-1254	<u>608</u>	<u>0.2 ±0</u>	ND <sup>4</sup>	
PCB-1260	<u>608</u>	<u>0.2 ±0</u>	ND <sup>4</sup>	
Pyridine	<u>625<sup>2</sup></u>	20	<u>10</u> <del>5</del>	
Selenium, total <sup>1,5</sup>	<u>200.8</u> <u>270.2</u>	<u>5</u> <u>±0.0</u>	<u>2.1</u> <u>2.0</u>	<u>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.<sup>1</sup> MAL is five times the detection limit for Method 270.2.</u>

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
Silver, total <sup>1,5</sup>	<del>272.2</del> 200.8	<del>2.0</del> 0.5	<del>0.5</del> 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. <sup>1</sup> MAL is based on the MQL developed by EPA Region 6, July 1992. MDL based on EPA, Method 200.9. <sup>2</sup>
1,2,4,5-Tetrachlorobenzene	<del>625</del> 1625	20	<del>105</del>	The MAL is 2 times the MDL published in the <i>List of Lists: A Catalog of Analytes and Methods</i> , U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Industrial Technology Division, September 1990. Method, MAL and MDL based on laboratory consensus taken October, 1992.
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	0.5	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. <sup>1</sup>
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	<del>5.0</del> 0.3	0.24	The MAL is based on the MQL approved by EPA Region 6 in February 8, 2008. MAL based on the MQL developed by EPA, Region 6, July 1992. The MDL is documented in 40 CFR Part 136, Method 608.
2,4,5-TP [Silvex]	<del>615</del> SM6640B	<del>2.0</del> 0.3	<del>0.17</del> 0.03	The MAL is approximately ten times the detection limit given by SM6640B. <sup>5</sup> EPA Method 615. <sup>6</sup>
Tributyltin [TBT]	TNRCC 1001	0.010	3.2 × 10 <sup>-6</sup>	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.

Pollutant	Suggested Method	MAL (µg/L)	MDL (µg/L)	MAL Source Documentation
<u>1,1,2-Trichloroethane</u>	<u>624</u>	<u>10</u>	<u>5.0</u>	<u>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.</u>
<u>Trichloroethene</u> [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	<u>1625</u> <u>625</u>	50	10	<u>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. MAL is based on the CRQL for water analysis using Method 625 from the EPA Region 6, Target Compound List acquired January 14, 1993.</u>
<b>TTHM (Total Trihalomethanes)</b> 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	— <sup>4</sup>	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, <u>total</u> <sup>1-5</sup>	<u>200.8</u> <u>289.2</u>	5.0	<u>1.8</u> <u>0.3</u>	<u>The MAL is approximately 2.8ten times the MDL based on detection limit given by EPA Method 200.8.<sup>1</sup>200.9<sup>2</sup></u>

<sup>1</sup> 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. EPA Method 200.8 may also be used upon request. Such a request should be made in writing to EPA’s Houston Laboratory, 10625 Fallstone Road, Houston, Texas, 77099-4303. Once Method 200.8 is approved for use in the NPDES program, no written request will be necessary.

<sup>2</sup> 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.

<sup>2</sup> Methods for the Determination of Metals in Environmental Samples, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati, EPA-600/4-91-010, June 1991. Method 200.9 contains accuracy and precision data generated using graphite furnace atomic absorbance spectrophotometer techniques for the following metals: aluminum, arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver and zinc. This accuracy and precision data supports the working ranges and detection limits for each corresponding method found in 40 CFR Part 136.

<sup>3</sup> Methods for the Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.

<sup>4</sup> Not determined or not published by the EPA.

- <sup>5</sup> 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=EPA Method 1638](http://www.standardmethods.org/applications/Login/index.cfm?test=no&forwardto=EPA%20Method%201638) may also be used once it is approved for use in the NPDES program. Method 1638. Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma-mass Spectrometry, U.S. Environmental Protection Agency, Office of Water, EPA 821-R-96-005, January 1996.
- <sup>6</sup> 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.
- <sup>7</sup> Either method listed for mercury may be used.
- <sup>8</sup> Method 1631, Revision EB. 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 2002/21-R-99-005, May 1999.
- <sup>9</sup> 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.
- <sup>10</sup> The ML is not published in 40 CFR Part 136, Method 1613B.
- <sup>11</sup> The MDL is published in 40 CFR Part 136.
- <sup>12</sup> Methods for Benzene: Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water And Wastewater. U.S. Environmental Protection Agency, September 1978.
- <sup>13</sup> 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.
- <sup>14</sup> EPA Methods 605, 607, and 612 may also be used.
- <sup>15</sup> Product and Product Group Discharges Subject to Effluent Limitations and Standards for the Organic Chemicals, Plastics, and Synthetic Fibers Point Source Category – 40 CFR 414. U.S. Environmental Protection Agency, Office of Water, April 2005.
- <sup>16</sup> 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.**

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**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.

<b><u>Seg- ment No.</u></b>	<b><u>Lake/Reservoir Name</u></b>	<b><u>Site ID</u></b>	<b><u>TP Mean (mg/L)</u></b>	<b><u>Chlorophyll <i>a</i> Mean (µg/L)</u></b>	<b><u>Secchi Mean (m)</u></b>
(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

<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Site ID</u>	<u>TP Mean (mg/L)</u>	<u>Chlorophyll <i>a</i> Mean (µg/L)</u>	<u>Secchi Mean (m)</u>
0803	Lake Livingston	10899	0.136	15.15	0.79
0807	Lake Worth	10942	0.073	23.51	0.79
0809	Eagle Mountain Reservoir	<u>10944</u> <u>10945</u>	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	<u>10982</u> <u>16749</u>	0.067	21.88	0.86
0823	Lewisville Lake	11027	0.046	11.67	0.76
0826	Grapevine Lake	<u>11035</u> <u>16113</u>	0.063	7.21	1.01
0827	White Rock Lake	11038	0.086	20.89	0.51
0828	Lake Arlington	<u>11040</u> <u>13904</u>	0.033	15.99	0.86
0830	Benbrook Lake	<u>11046</u> <u>15151</u>	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

<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Site ID</u>	<u>TP Mean (mg/L)</u>	<u>Chlorophyll <i>a</i> Mean (µg/L)</u>	<u>Secchi Mean (m)</u>
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



<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Site ID</u>	<u>TP Mean (mg/L)</u>	<u>Chlorophyll <i>a</i> Mean (µg/L)</u>	<u>Secchi Mean (m)</u>
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.

<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Surface Area (acres)</u>	<u>Volume (acre-ft.)</u>	<u>Volumetric Survey Year</u>	<u>Retention Time (yrs)</u>	<u>Retention Time Source*</u>
(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 <sup>(a)</sup>	=	=	=	=
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

<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Surface Area (acres)</u>	<u>Volume (acre-ft.)</u>	<u>Volumetric Survey Year</u>	<u>Retention Time (yrs)</u>	<u>Retention Time Source*</u>
0613	Lake Tyler	2,341 <sup>(b)</sup>	43,500 <sup>(c)</sup>	2003	=	=
0613	Lake Tyler East	2,396 <sup>(b)</sup>	36,698 <sup>(d)</sup>	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

<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Surface Area (acres)</u>	<u>Volume (acre-ft.)</u>	<u>Volumetric Survey Year</u>	<u>Retention Time (yrs)</u>	<u>Retention Time Source*</u>
<u>1231</u>	<u>Lake Graham</u>	<u>2,444</u>	<u>45,302</u>	<u>1998</u>	<u>1.9</u>	<u>Ground</u>
<u>1233</u>	<u>Hubbard Creek Reservoir</u>	<u>14,922</u>	<u>324,983</u>	<u>1997</u>	<u>4.1</u>	<u>Ground</u>
<u>1234</u>	<u>Lake Cisco</u>	<u>10,450</u>	<u>26,000</u>	<u>=</u>	<u>=</u>	<u>=</u>
<u>1235</u>	<u>Lake Stamford</u>	<u>5,124</u>	<u>51,573</u>	<u>1999</u>	<u>=</u>	<u>=</u>
<u>1236</u>	<u>Fort Phantom Hill Reservoir</u>	<u>4,213</u>	<u>70,036</u>	<u>1993</u>	<u>=</u>	<u>=</u>
<u>1237</u>	<u>Lake Sweetwater</u>	<u>630</u>	<u>11,900</u>	<u>=</u>	<u>3.8</u>	<u>Ground</u>
<u>1240</u>	<u>White River Lake</u>	<u>2,020</u>	<u>44,300</u>	<u>1993</u>	<u>16.3</u>	<u>Ground</u>
<u>(1241)</u>	<u>Buffalo Springs Lake</u>	<u>200</u>	<u>4,200</u>	<u>=</u>	<u>=</u>	<u>=</u>
<u>1247</u>	<u>Granger Lake</u>	<u>4,064</u>	<u>52,525</u>	<u>2002</u>	<u>0.42</u>	<u>Ground</u>
<u>1249</u>	<u>Lake Georgetown</u>	<u>1,287</u>	<u>36,904</u>	<u>2005</u>	<u>0.76</u>	<u>Ground</u>
<u>1252</u>	<u>Lake Limestone</u>	<u>12,553</u>	<u>208,017</u>	<u>2002</u>	<u>0.93</u>	<u>Ground</u>
<u>1254</u>	<u>Aquilla Reservoir</u>	<u>3,066</u>	<u>44,566</u>	<u>2008</u>	<u>1.3</u>	<u>Ground</u>
<u>1403</u>	<u>Lake Austin</u>	<u>1,599</u>	<u>21,804</u>	<u>1999</u>	<u>0.02</u>	<u>Ground</u>
<u>1404</u>	<u>Lake Travis</u>	<u>19,199</u>	<u>1,134,863</u>	<u>2008</u>	<u>1.1</u>	<u>Ground</u>
<u>1405</u>	<u>Marble Falls Lake</u>	<u>608</u>	<u>7,486</u>	<u>2007</u>	<u>0.01</u>	<u>Ground</u>
<u>1406</u>	<u>Lake Lyndon B. Johnson</u>	<u>6,273</u>	<u>133,090</u>	<u>2007</u>	<u>0.14</u>	<u>Ground</u>
<u>1407</u>	<u>Inks Lake</u>	<u>788</u>	<u>14,074</u>	<u>2007</u>	<u>0.02</u>	<u>Ground</u>
<u>1408</u>	<u>Lake Buchanan</u>	<u>22,019</u>	<u>875,610</u>	<u>2006</u>	<u>1.2</u>	<u>Ground</u>
<u>1411</u>	<u>E. V. Spence Reservoir</u>	<u>14,640</u>	<u>517,272</u>	<u>1999</u>	<u>33.3</u>	<u>Ground</u>
<u>(1412)</u>	<u>Lake Colorado City</u>	<u>1,612</u>	<u>31,805</u>	<u>=</u>	<u>1.3</u>	<u>Ground</u>
<u>(1416)</u>	<u>Brady Reservoir</u>	<u>2,020</u>	<u>30,430</u>	<u>=</u>	<u>2.3</u>	<u>Ground</u>
<u>1418</u>	<u>Lake Brownwood</u>	<u>6,587</u>	<u>131,429</u>	<u>1997</u>	<u>1.2</u>	<u>Ground</u>
<u>1419</u>	<u>Lake Coleman</u>	<u>1,811</u>	<u>38,094</u>	<u>2006</u>	<u>2.1</u>	<u>Ground</u>
<u>1422</u>	<u>Lake Nasworthy</u>	<u>1,380</u>	<u>10,108</u>	<u>1993</u>	<u>1.2</u>	<u>Ground</u>
<u>1423</u>	<u>Twin Buttes Reservoir</u>	<u>9,080</u>	<u>186,200</u>	<u>=</u>	<u>18.7</u>	<u>Ground</u>
<u>1425</u>	<u>O. C. Fisher Lake</u>	<u>5,440</u>	<u>115,743</u>	<u>=</u>	<u>6.2</u>	<u>Ground</u>
<u>(1426)</u>	<u>Oak Creek Reservoir</u>	<u>2,375</u>	<u>39,360</u>	<u>=</u>	<u>2.1</u>	<u>Ground</u>
<u>1429</u>	<u>Lady Bird Lake (formerly Town Lake)</u>	<u>468</u>	<u>6,409</u>	<u>1999</u>	<u>0.01</u>	<u>Ground</u>
<u>1433</u>	<u>O. H. Ivie Reservoir</u>	<u>19,149</u>	<u>554,340</u>	<u>=</u>	<u>11.9</u>	<u>Ground</u>
<u>1805</u>	<u>Canyon Lake</u>	<u>8,308</u>	<u>378,852</u>	<u>2000</u>	<u>1.3</u>	<u>Ground</u>
<u>1904</u>	<u>Medina Lake</u>	<u>6,066</u>	<u>254,823</u>	<u>1995</u>	<u>1.6</u>	<u>Ground</u>
<u>2103</u>	<u>Lake Corpus Christi</u>	<u>18,256</u>	<u>257,260</u>	<u>2002</u>	<u>0.53</u>	<u>Ground</u>
<u>2116</u>	<u>Choke Canyon Reservoir</u>	<u>25,989</u>	<u>695,271</u>	<u>1993</u>	<u>3.7</u>	<u>Ground</u>
<u>2303</u>	<u>International Falcon</u>	<u>85,195</u>	<u>2,646,817</u>	<u>=</u>	<u>1.2</u>	<u>Ground</u>

<u>Segment No.</u>	<u>Lake/Reservoir Name</u>	<u>Surface Area (acres)</u>	<u>Volume (acre-ft.)</u>	<u>Volumetric Survey Year</u>	<u>Retention Time (yrs)</u>	<u>Retention Time Source*</u>
	<u>Reservoir</u>					
<u>2305</u>	<u>International Amistad Reservoir</u>	<u>65,597</u>	<u>3,275,532</u>	<u>1994</u>	<u>2.1</u>	<u>Ground</u>
<u>2312</u>	<u>Red Bluff Reservoir</u>	<u>11,193</u>	<u>289,670</u>	<u>=</u>	<u>2.8</u>	<u>Ground</u>
<u>(2454)</u>	<u>Cox Creek Lake</u>	<u>541</u>	<u>5,034</u>	<u>=</u>	<u>=</u>	<u>=</u>

(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.cityof tyler.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 D. Modeling Memorandum of Agreement (MOA) between the TNRCC and the EPA~~

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[Moved to Chapter "Modeling Dissolved Oxygen."]