Texas StreamTeam

Caring for Our Waters

Core Volunteer Water Quality Monitor Training Packet

This training packet is an official record of Texas Stream Team core volunteer water quality monitor training. If the training is scheduled for more than one day, it is the responsibility of the volunteer to keep this packet and bring it to each training session. Upon completion of phase III, the volunteer should sign the front page of the training packet and leave it with the trainer for submission to Texas Stream Team or partner agency. **Please print legibly!**

The trainee must successfully complete a three-phase training program:

- ★ **Phase I** – Introduction to program, watersheds, nonpoint source pollution, and monitoring procedures
- ★ **Phase II** – Introduction to field observations, water clarity and total depth monitoring procedures, sample collection methodology, and conducting monitoring with the assistance of trainer(s)
- ★ **Phase III** – Conducting monitoring without the assistance of trainer(s).

Name: _____

Street Address: _____

City: _____ **State:** _____ **Zip Code:** _____

Phone -- Primary: _____ **Alternate:** _____

E-mail Address: _____

Affiliation *(if applicable)*: _____

Texas Stream Team Group *(if applicable)*: _____

Texas Stream Team Partner *(if applicable)*: _____

Trainer(s): _____

Date(s):
Phases I-III: _____ Phase I: _____ Phase II: _____ Phase III: _____

If you are a teacher, do you want a 9-hr TEEAC credit sticker for completing all three phases of training? ☐ **YES** ☐ **NO**

Texas Stream Team, River Systems Institute, Texas State University – San Marcos
Riverside Apartments – Unit C4, 601 University Drive, San Marcos, Texas 78666
Phone: 877-506-1401 E-mail: txstreamteam@txstate.edu
Online: http://txstreamteam.rivers.txstate.edu/ http://www.facebook.com/TexasStreamTeam

The Volunteer Commitment Statement, Liability Release, and Equipment Loan Agreement should be read and signed following the completion of phase III of the core water quality monitor training. These must be read and signed by all volunteer in order to participate in the Texas Stream Team program.

Volunteer Commitment Statement

As a volunteer monitor working with Texas Stream Team, I commit to the collection of accurate, objective environmental information at one or more approved site(s) at least once a month for at least one year. The environmental information that I collect will be provided to Texas Stream Team as soon as possible after I collect it. I commit to following the procedures demonstrating during the Texas Stream Team volunteer water quality monitor training. I agree that I will conduct my environmental monitoring in a safe way that will protect me and those people working with or near me. I also agree that I will obey all laws and not trespass on private property unless written permission is granted by the owner, and this document is provided to Texas Stream Team before monitoring.

Liability Release

I understand and agree that as a volunteer participating in this program that I am not acting on behalf of Texas State University - San Marcos, the Texas State University System, the Texas Commission on Environmental Quality (TCEQ) or any Texas Stream Team partner in any official capacity. I understand and agree that as a volunteer participating in this program that I am not an employee, agent, servant, or representative of Texas State University - San Marcos, Texas State University System, TCEQ or any partner for any purpose.

I understand and am aware of the risks and hazards connected with the various activities to be performed by volunteers participating in this program. I understand and am aware that the risks and hazards connected with my participation in this program can result in personal injuries, including death, to myself or others as well as damage to real or personal property belonging to myself or others.

I elect to participate voluntarily and engage in the various activities to be performed by volunteers participating in this program knowing that my participation in this program may be hazardous to my person and my property. I voluntarily assume full responsibility for my property loss and personal injury, including death that I may sustain as a result of my participation as a volunteer for this program, whether or not such property loss, personal injury, death or property damage is caused by the negligence of Texas State University - San Marcos, Texas State University, TCEQ and any partner.

I also agree to indemnify and hold harmless Texas State University - San Marcos, Texas State University, TCEQ and any Partner from any loss, liability, damage, or costs, including court costs and attorney's fees, that they may incur due to my participation as a volunteer in this Program whether caused by the negligence of Texas State University - San Marcos, Texas State University, TCEQ and any partner or otherwise. For example, I specifically agree to indemnify and hold harmless Texas State University - San Marcos, Texas State University, TCEQ and any partner from losses they may incur as a result of my injuring another person or damaging another person's property while participating as a volunteer in this program.

Equipment Loan Agreement

I, for myself, by heirs, and executors do hereby assume responsibility for the safety and care of all equipment, materials, and supplies loaned or entrusted to me, and agree to transport, store and use such equipment, materials and/or supplies in a prudent and reasonable manner; to take such action as necessary to reduce the possibility of damage to, of or from such equipment. I agree upon verbal or written demand of Texas State University or their authorized delegate to return said equipment within five days of such demand to Texas Stream Team.

Signature

I, _____,have completed the Texas Stream Team core water quality
(Volunteer's Signature)
monitor training, have read the Volunteer Commitment Statement, Liability Release, and Equipment Loan Agreement, and agree to the terms therein.

Prepared in cooperation with the Texas Commission on Environmental Quality and the United States Environmental Protection Agency.

PHASE I
Texas Stream Team
ENVIRONMENTAL MONITORING FORM
PLEASE PRINT (Black Ink or #2 Pencil)

Send to:
Texas Stream Team
Texas State University
Riverside Apts - Unit C4
601 University Drive
San Marcos, TX 78666-4616
Toll Free: (877) 506-1401
Email: *txstreamteam@txstate.edu*

Group ID # ____ Monitor's Name _____

Station ID # _____ Site Description _____

Sample Date ____ (M M D D Y Y) Sample Time (military) ____ (H H M M) Sample Depth (meters) ____ (not total depth)

Meter Calibration: (Within 24 hours of sampling.) Store and calibrate standard at room temperature.

Calibration	Date	Time	Standard Value	Standard Temp (°C)	Initial Meter Reading	Meter Adjusted To	Post Test
Conductivity							
pH (7.0)							

Core Tests and Measurements:

- ____ CONDUCTIVITY (µS/cm) ❑ TDS Tester 3 (Low) ❑ TDS Tester 4 (High) ❑ Other
- ____ AIR TEMPERATURE (°C)
- ____ WATER TEMPERATURE (°C)
- ____ Average DISSOLVED OXYGEN (mg/L) 1st titration _____ 2nd titration _____
- ____ pH (standard units)
- ____ SECCHI DISK TRANSPARENCY (meters)
- ____ TOTAL DEPTH (meters)
- ____ TRANSPARENCY TUBE (meters)

Field Observations:

- ____ FLOW SEVERITY: 1-no flow 2-low 3-normal 4-flood 5-high 6-dry
- ____ ALGAE COVER: 1-absent 2-rare (<25%) 3-common (26-50%) 4-abundant (51-75%) 5-dominant (>75%)
- ____ WATER COLOR: 1-no color 2-light green 3-dark green 4-tan 5-red 6-green/brown 7-black
- ____ WATER CLARITY: 1-clear 2-cloudy 3-turbid
- ____ WATER SURFACE: 1-clear 2-scum 3-foam 4-debris 5-sheen
- ____ WATER CONDITIONS: 1-calm 2-ripples 3-waves 4-white caps
- ____ WATER ODOR: 1-none 2-oil 3-acrid (pungent) 4-sewage 5-rotten egg 6-fishy 7-musky
- ____ PRESENT WEATHER: 1-clear 2-cloudy 3-overcast 4-rain
- ____ DAYS SINCE LAST SIGNIFICANT PRECIPITATION (runoff)
- ____ RAINFALL ACCUMULATION (inches, last 3 days)

Reagents/Media: Are any reagents (or media) expired? ❑Yes ❑No
List any expired:

Bacteria Test:

____ Average *E. COLI* (cfu/100 mL) Sample 1 _____ Sample 2 _____

INCUBATION: Period (hrs) _____ (28-31 hrs) Temp. (°C) _____ (33+/-3°C)

SAMPLE 1: Sample size _____ mL Dilution factor (100/sample size) _____

Colonies counted _____ x dilution factor _____ = _____ cfu/100 mL

SAMPLE 2: Sample size _____ mL Dilution factor (100/sample size) _____

Colonies counted _____ x dilution factor _____ = _____ cfu/100 mL

FIELD BLANK: *E. coli* colony growth (circle one) YES / NO

DATA QUALITY REVIEW: Checklist completed (circle one) YES / NO

Additional Tests Conducted (nutrients, etc.):

- ____ TYPE: _____
- ____ FECAL COLIFORM (colonies/100 mL) Source of readings: ❑ Certified Lab ❑ Monitor

Coastal Area Salinity Tests and Observations:

- ____ SALINITY (ppt) ____ SAMPLE TEMP (°C)
- ____ TIDE STAGE: 1-low 2-falling 3-slack 4-rising 5-high

Measurement Comments and Field Observations:

_____

_____

_____

_____

____ minutes TOTAL TIME SPENT SAMPLING AND TRAVELING

____ miles TOTAL ROUNDTRIP DISTANCE TRAVELED

____ TOTAL NUMBER OF PARTICIPANTS

I CERTIFY THAT ALL PROCEDURES HAVE BEEN FOLLOWED AND THIS INFORMATION IS ACCURATE TO THE BEST OF MY ABILITY.

_____ CERTIFIED MONITOR'S SIGNATURE _____ DATE _____ DATA MANAGER'S SIGNATURE _____ DATE

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PHASE II
Texas Stream Team
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Texas State University
Riverside Apts - Unit C4
601 University Drive
San Marcos, TX 78666-4616
Toll Free: (877) 506-1401
Email: *txstreamteam@txstate.edu*

Group ID # ____ Monitor's Name _____

Station ID # _____ Site Description _____

Sample Date ____ (M M D D Y Y) Sample Time (military) ____ (H H M M) Sample Depth (meters) ____ (not total depth)

Meter Calibration: (Within 24 hours of sampling.) Store and calibrate standard at room temperature.

Calibration	Date	Time	Standard Value	Standard Temp (°C)	Initial Meter Reading	Meter Adjusted To	Post Test
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pH (7.0)							

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- ____ DISSOLVED OXYGEN (mg/L) Average — 1st titration _____ 2nd titration _____
- ____ pH (standard units)
- ____ SECCHI DISK TRANSPARENCY (meters)
- ____ TOTAL DEPTH (meters)
- ____ TRANSPARENCY TUBE (meters)

Field Observations:

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____ *E. COLI* (cfu/100 mL) Average Sample 1 _____ Sample 2 _____

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____ TOTAL NUMBER OF PARTICIPANTS

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_____ CERTIFIED MONITOR'S SIGNATURE _____ DATE _____ DATA MANAGER'S SIGNATURE _____ DATE

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PHASE III
Texas Stream Team
ENVIRONMENTAL MONITORING FORM
PLEASE PRINT (Black Ink or #2 Pencil)

Send to:
Texas Stream Team
Texas State University
Riverside Apts - Unit C4
601 University Drive
San Marcos, TX 78666-4616
Toll Free: (877) 506-1401
Email: *txstreamteam@txstate.edu*

Group ID # ____ Monitor's Name _____

Station ID # _____ Site Description _____

Sample Date ____ (M M D D Y Y) Sample Time (military) ____ (H H M M) Sample Depth (meters) ____ (not total depth)

Meter Calibration: (Within 24 hours of sampling.) Store and calibrate standard at room temperature.

Calibration	Date	Time	Standard Value	Standard Temp (°C)	Initial Meter Reading	Meter Adjusted To	Post Test
Conductivity							
pH (7.0)							

Core Tests and Measurements:

- ____ CONDUCTIVITY (µS/cm) ❑ TDS Tester 3 (Low) ❑ TDS Tester 4 (High) ❑ Other
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- ____ WATER TEMPERATURE (°C)
- ____ Average DISSOLVED OXYGEN (mg/L) 1st titration _____ 2nd titration _____
- ____ pH (standard units)
- ____ SECCHI DISK TRANSPARENCY (meters)
- ____ TOTAL DEPTH (meters)
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Colonies counted _____ x dilution factor _____ = _____ cfu/100 mL

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____ TIDE STAGE: 1-low 2-falling 3-slack 4-rising 5-high

Measurement Comments and Field Observations:

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____ minutes TOTAL TIME SPENT SAMPLING AND TRAVELING

____ miles TOTAL ROUNDTRIP DISTANCE TRAVELED

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I CERTIFY THAT ALL PROCEDURES HAVE BEEN FOLLOWED AND THIS INFORMATION IS ACCURATE TO THE BEST OF MY ABILITY.

_____ CERTIFIED MONITOR'S SIGNATURE _____ DATE _____ DATA MANAGER'S SIGNATURE _____ DATE

What is Texas Stream Team?

Texas Stream Team is a network of trained volunteers and supportive partners working together to gather information about the natural resources of Texas and to ensure the information is available to all Texans. Volunteers are trained to collect quality-assured information that can be used to make environmentally sound decisions. Established in 1991, Texas Stream Team is funded by the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (EPA). Currently, over 400 Texas Stream Team volunteers collect water quality data on lakes, rivers, streams, wetlands, bays, bayous and estuaries in Texas.

Texas Stream Team supports a wide range of monitoring activities, including a rigorous certified water quality monitoring program, environmental education programs, community action projects including storm drain stenciling, and statewide and regional conferences and workshops.

Effective collection and management of water quality data provides volunteers the opportunity to recognize changes in water quality and empowers them to take appropriate action. The Texas Stream Team program promotes the use of volunteer data at the local level, by partners, volunteers, schools, government agencies, business, industry, and others, for education and use in natural resource management decisions.

Our Goals and Philosophy

Texas Stream Team is guided by these goals:

- To produce quality-assured, usable information that government agencies, waste generators, and the public need to make environmentally sound decisions.
- To improve communication and facilitate education about the natural resources in Texas.
- To resolve conflicts over environmental impacts through positive cooperation.

These goals are founded on the premise that water issues are inextricably linked with air, biological, land, and human issues, and that the protection of all natural resources requires the active, positive cooperation of all Texans.

Who Can be Involved?

Anyone with a desire to monitor water quality or learn more about the natural resources in Texas can be involved. Volunteers monitor a wide variety of habitats from rivers, creeks, ponds, and lakes to bays, bayous, and estuaries. Over 300 groups have been trained in Texas Stream Team to date. These groups range in size from one person monitoring a single site to groups whose members monitor more than 5o sites. Volunteers range from third-graders to senior citizens, from individuals to groups like the Girl Scouts and the Sierra Club. Many of the groups are science teachers and their students.

Levels of Volunteer Participation and Certification

Texas Stream Team volunteers participate at various levels depending on their environmental monitoring activity.

Texas Stream Team Certified Water Quality Monitors are volunteers that complete a monitoring plan and complete three phases of training using a test kit that measures physical and chemical parameters in water. Participation in the program includes these commitments:

- *While not a requirement for participation, volunteers are asked for a one-year commitment to monitor their site.* The information collected with a Texas Stream Team kit can be considered baseline data that provide an overall picture of water quality. The physical chemical properties of water can vary dramatically over a year and from year to year. Two years of data is considered the minimum needed to capture baseline conditions and the natural variability at a site.

- *Volunteers are asked to monitor their site (s) monthly at the same time of day each month.* For example, a possible monitoring schedule would be the first Saturday of the month at 10:00 am. The adherence to a consistent monitoring time is crucial because the physical and chemical parameters fluctuate over a 24-hour period. Monitoring takes approximately one to two hours.

- *In order to collect quality-assured data, volunteers are asked to attend tow quality-control sessions I the first year and one session per year thereafter.* The Texas Stream Team protocols were developed under a Quality Assurance Project Plan approved by the TCEQ. The QAPP ensures volunteers collect information of the highest quality and that volunteers are collecting data that can augment professional data.

Texas Stream Teamers are volunteers participating in Texas Stream Team by performing monitoring activities other than certified water quality monitoring, or are students working under the guidance of a Certified Water Quality Monitor.

Certified Trainers of Water Quality Monitors are Certified Water Quality Monitors who have completed two additional phases of training, which qualifies them to train monitors and perform quality control at the monitoring site.

Certified Quality Assurance Officers are certified Water Quality Monitors who complete two additional phases of training, which qualifies them to conduct quality control sessions that Certified Monitors attend twice per year.

Teacher and Student Participation

About 40% of Texas Stream Team monitoring groups is teachers and their students. Educators find Texas Stream Team to be valuable teaching tool that lends itself to cross-disciplinary instruction. By teaching students how to measure what is happening in the environment around them, Texas Stream Team helps teachers effectively present the abstract concepts of biology, chemistry and ecology. With a broader understanding of water quality issues, students are better prepared to form solutions to environmental concerns.

Teachers who complete the three-phase training and become Certified Water Quality monitors have two options for getting their students involved in Texas Stream Team monitoring Students in grades K-12 can monitor a body of water under a teacher's supervision with activities based on the educational objectives of the class. A teacher who goes a step further and becomes a Certified Trainer can then train students (grades 6-12) to become certified monitors. These students can then go on form groups and monitor their own sites.

Continuing Education Credit for Teachers
Texas Stream Team, in association with the Texas Education Agency, is now offering continuing education credit for all teaches who complete Texas Stream Team Certified Water Quality Monitoring (CWQM) training. The Texas Environmental Education Advisory Committee (TEEAC), an advisor to the Texas Commissioner of Education, offers a recognition program to encourage teachers to learn more about the environment. Texas Stream Team CWQM training qualifies teachers for nine of the 45 hours of environmental awareness workshops and seminars that TEEAC recommends for educators. Upon completion of the TEEAC requirements each educator received an Environmental Education Certificate along with a letter of achievement sent to their principal and superintendent.

Texas Stream Team Partners Program

Texas Stream Team works extensively in forming watershed-based partnerships and networks to help volunteers locate resources needed to collect and report environmental information. The Texas Stream Team Partners Program solicits public and private entities to help train, equip, manage, and offer general support to the growing number of volunteer monitors across the state. Texas Stream Team establishes strong ties between citizens, industries, river authorities, councils of government, water districts, cities, state and federal agencies, students, teachers, and private groups and foundations.

Texas Stream Team partnerships help:

• Support and enhance environmental problem solving in partnership with citizens and public agencies • Develop student interest in math, science, and environmental protection • Establish early problem detection network • Encourage pollution reduction and prevention	• Demonstrate local commitment to environmental protection • Help industries institute the principles of Chemical Manufacturer's Association's "Responsible Care" program • Fulfill requirements of TCEQ's "Clean Industries 2000" and "Clean Cities 2000" Initiatives

Partnership Levels
Partnership Levels allow partners to select the level of commitment appropriate for them. Organizations may become Texas Stream Team Partners by agreeing to support citizens at one of the three levels.

- Lead Partners ensure monitors receive all the resources needed to collect high quality data, and coordinate and manage monitoring activities. Lead Partners supply resources from their budgets or Texas Stream Team can help form a Partner Network in which several Partners pool resources to support the program.
- Patron Partners contribute in-kind services such as trainers, lab services, or data management resources.
- Donor Partners contribute financial resources or equipment such as kits for monitors.

Quality Assurance Program

If volunteers choose to participate in the Quality Assurance Program, they are asked to follow their Texas Stream Team Quality Assurance Project Plan (QAPP). The QAPP is the EPA-approved guidance document that ensures the information volunteers collect is of the highest quality. Data measurement sampling and calibration techniques, quality control, and reporting requirements are all addressed by the plan. The QUAPP provides the framework for volunteers to collect comparable data that can augment professional monitoring. Summaries of a few requirements of the Quality Assurance Program are listed below.

Attendance at Quality Control Session: Monitors are asked to attend two quality control (QC) sessions during the first year of monitoring and one QC session every year thereafter. These sessions are led by a Certified Quality Assurance Officer and are designed to detect and correct flaws in monitoring technique or equipment accuracy. This requirement is necessary to ensure the highest possible level of quality and reliability in the volunteer data.

Duplicate Sampling is performed by volunteers while monitoring and at QC sessions to measure the precision of their monitoring techniques. The duplicate values must fall within a range specified in the QAPP.

Volunteer Accuracy is determined at QC sessions by comparing the volunteer results to those of the quality Assurance Officer. The monitor values must fall within a range specified in the QAPP.

Newsletter and Web Page

Check out the Texas Stream Team newsletter and web page. They contain information about nonpoint source pollution issues, partnership development, regional highlights, and events. Download previous issues in .pdf format from our website, or get on our mailing list and we will send future issues directly to your doorstep.

Data Viewer

All data collected by Texas Stream Team volunteers is available on the Texas Stream Team website data viewer at https://aqua.rivers.txstate.edu/

Texas State University-San Marcos
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Marcos, TX 78666
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Dissolved Oxygen Testing Tips

Oxygen is critical to the survival of aquatic plants and animals, and a shortage of dissolved oxygen is not only a sign of pollution, it is harmful to the fish. Some aquatic species are more sensitive to oxygen depletion than others, but some general guidelines to consider when analyzing test results are:

5-6 ppm: Sufficient for most species

<3 ppm: Stressful to most aquatic species

<2 ppm: Fatal to most species

Because of its importance to the fish's survival, aquaculturists, or "fish farmers," and aquarists use the dissolved oxygen test as a primary indicator of their system's ability to support healthy fish.

Where Does The Oxygen Come From?

The oxygen found in water comes from many sources, but the largest source is oxygen absorbed from the atmosphere. Wave action and splashing allows more oxygen to be absorbed into the water. A second major source of oxygen is aquatic plants, including algae; during photosynthesis plants remove carbon dioxide from the water and replace it with oxygen.

Absorption:

Oxygen is continuously moving between the water and surrounding air. The direction and speed of this movement is dependent upon the amount of contact between the air and water. A tumbling mountain stream or windswept, wave covered lake, where more of the water's surface is exposed to the air, will absorb more oxygen from the atmosphere than a calm, smooth body of water. This is the idea behind aerators; by creating bubbles and waves the surface area is increased and more oxygen can enter the water.

Photosynthesis:

In the leaves of plants one of the most important chemical processes on Earth is constantly occurring-photosynthesis. During daylight, plants constantly take carbon dioxide from the air, and, in the presence of water, convert it to oxygen and carbohydrates, which are used to produce additional plant material. Since photosynthesis requires light, plants do not photosynthesize at night, so no oxygen is produced. Chemically, the photosynthesis reaction can be written as:

Light + nCO_2 + nH_2O ¤ $(CH_2O)n$ + nO_2

Light + Carbon Dioxide + Water ¤ Carbohydrate + Oxygen

Where Does The Oxygen Go?

Once in the water, oxygen is used by the aquatic life. Fish and other aquatic animals need oxygen to breathe or respire. Oxygen is also consumed by bacteria to decay, or decompose, dead plants and animals.

Respiration:

All animals, whether on land or underwater, need oxygen to respire, and grow and survive. Plants and animals respire throughout the night and day, consuming oxygen and producing carbon dioxide, which is then used by plants during photosynthesis.

Decomposition:

All plant and animal waste eventually decomposes, whether it is from living animals or dead plants and animals. In the decomposition process, bacteria use oxygen to oxidize, or chemically alter, the material to break it down to its component parts. Some aquatic systems may undergo extreme amounts of oxidation, leaving no oxygen for the living organisms, which eventually leave or suffocate.

Other Factors:

The oxygen level of a water system is not only dependent on production and consumption. Many other factors work together to determine the potential oxygen level, including:

- Salty vs. fresh water: Fresh water can hold more oxygen than salt water.
- Temperature: Cold water can hold more oxygen than warm water.
- Atmospheric pressure (Altitude): The greater the atmospheric pressure the more oxygen the water will hold.

Testing Dissolved Oxygen:

Dissolved oxygen is often tested using the Azide modification of the Winkler method. When testing dissolved oxygen it is critical not to introduce additional oxygen into the sample. Many people avoid this problem by filling the sample bottle all the way and allowing the water to overflow for one minute before capping.

The first step in a DO titration is the addition of Manganous Sulfate Solution (4167) and Alkaline Potassium Iodide Azide Solution (7166). These reagents react to form a white precipitate, or floc, of manganous hydroxide, $Mn(OH)_2$. Chemically, this reaction can be written as:

Next page...

$MnSO_4 + 2KOH \rightarrow Mn(OH)_2 + K_2SO_4$

Light + Carbon Dioxide + Water ¤ Manganous Hydroxide + Potassium Sulfate

Immediately upon formation of the precipitate, the oxygen in the water oxidizes an equivalent amount of the manganous hydroxide to brown-colored manganic hydroxide. For every molecule of oxygen in the water, four molecules of manganous hydroxide is converted to manganic hydroxide. Chemically, this reaction can be written as:

$4Mn(OH)_2 + O_2 + 2H_2O \rightarrow 4Mn(OH)_3$

Manganous Hydroxide + Oxygen + Water ¤ Manganic Hydroxide

After the brown precipitate is formed, a strong acid, such as Sulfamic Acid Powder (6286) or Sulfuric Acid, 1:1 (6141) is added to the sample. The acid converts the manganic hydroxide to manganic sulfate. At this point the sample is considered "fixed" and concern for additional oxygen being introduced into the sample is reduced. Chemically, this reaction can be written as:

$2Mn(OH)_3 + 3H_2SO_4 \rightarrow Mn2(SO_4)_3 + 6H2O$

Manganic Hydroxide + Sulfuric Acid ¤ Manganic Sulfate + Water

Simultaneously, iodine from the potassium iodide in the Alkaline Potassium Iodide Azide Solution is oxidized by manganic sulfate, releasing free iodine into the water. Since the manganic sulfate for this reaction comes from the reaction between the manganous hydroxide and oxygen, the amount of iodine released is directly proportional to the amount of oxygen present in the original sample. The release of free iodine is indicated by the sample turning a yellow-brown color. Chemically, this reaction can be written as:

$Mn_2(SO_4)_3 + {}_2KI \rightarrow 2MnSO_4 + K_2SO_4 + I_2$

Manganic Sulfate + Potassium Iodide ¤ Manganous Sulfate + Potassium Sulfate + Iodine

The final stage in the Winkler titration is the addition of sodium thiosulfate. The sodium thiosulfate reacts with the free iodine to produce sodium iodide. When all the iodine has been converted the sample changes from yellow-brown to colorless. Often a starch indicator is added to enhance the final endpoint. Chemically, this reaction can be written as:

$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$

Sodium Thiosulfate + Iodine ¤ Sodium Tetrathionate + Sodium Iodide

7414 and 5860 Dissolved Oxygen Kit Testing Tips:

Fixing Dissolved Oxygen Samples:

- "Fix" dissolved oxygen samples in the field as soon as collected. Biological activity in the sample and exposure to air can quickly change the dissolved oxygen level in the sample bottle.
- Fixed samples may be stored for up to 8 hours before titration, if refrigerated and kept in the dark.
- Some of the sample will overflow as chemicals are added during the "fixing" steps, but sufficient amounts of the oxygen-reacting chemicals WILL fall to the bottom of the bottle. The overflow assures that when the sample bottle is closed again, no air will be trapped inside. An air bubble in the sample bottle may introduce additional oxygen during the mixing step, producing false, high readings.

Floc/Precipitate During Fixing of Samples:

- Mix for the full amount of time specified and allow the "floc" to settle according to the instructions. Impatience may result in an incomplete reaction and produce false, low readings. Salt water may take longer to settle.
- After addition of the acid, reagent and precipitate may take up to 20-30 minutes to dissolve. The more dissolved oxygen present, the longer it will take to dissolve. Low readings may result if not enough time is allowed for sample to completely dissolve.

What Is Faint Yellow?:

The titration is actually titrating iodine, from yellow to clear. Since the yellow to clear change is very hard to see we add starch, which turns blue in the presence of iodine. Once all the iodine has been titrated out the starch goes clear. The blue to clear is much easier to see than yellow to clear. The reason that we titrate some of the iodine out (titrate to faint yellow) before adding starch is two-fold:

1. The starch stays dark blue right up until it goes clear, unlike most titrations where the color gradually moves toward the endpoint. Therefore, it is easy to become complacent during the titration and add an excess amount of titrant (overshooting the endpoint), thinking that you are far from the endpoint because the color is not changing.
2. Also starch can be partially decomposed by a large amount of iodine. Therefore, the starch should not be added until the bulk of the iodine has been reduced (titrated out).

So, for both of these reasons, the sample should be titrated to a faint yellow (the exact shade does not matter) before adding the starch.

NOTE: Prior to adding the starch indicator, be sure to carefully remove the titrator and cap. Leave the titrator plunger in it's exact position within the titrator barrel, add the 8 drops of starch and then finish the titration.

Texas Surface Water Quality: What Is It, and How Is It Measured?

In order to protect water quality, we must define and measure it. The state of Texas has established standards that protect the purposes for which the streams, lakes, and estuaries in the state will be used, and defined measurements that determine whether the water quality is good enough to attain those uses.

Based on the standards, the Texas Commission on Environmental Quality (TCEQ), in concert with other federal, regional, and local organizations, carries out a regular program of monitoring and assessment to determine which water bodies are meeting the standards set for their use, and which are not. The state produces a periodic report, the *Texas Water Quality Integrated Report for Clean Water Act Sections 305(b) and 303(d)*, which compares water quality conditions to established standards, as required by the federal Clean Water Act (CWA).

Texas Surface Water Quality Standards

designate the uses, or purposes, for which the state's waterways should be suitable;

establish numerical and narrative criteria for water quality throughout the state;

provide a basis on which TCEQ regulatory programs can establish reasonable methods to implement and attain the state's goals (criteria) for water quality.

Water quality criteria are designed to be protective of uses. Substantial deviations from criteria indicate that related uses might be impaired. For example, the concentration of dissolved oxygen is one criterion for determining the attainment of the aquatic life use. Where oxygen concentrations are low, the use of the water body to support aquatic life might be impaired. However, since other factors affect the health of an aquatic environment, additional data, such as the presence of a high number and variety of species, may show that the use is fully attained, even if oxygen concentrations are lower than the criterion.

Four major categories for water use are defined in the *Texas Surface Water Quality Standards*:

aquatic life use

contact recreation (swimming)

public water supply

fish and shellfish (oyster) consumption

A variety of other general uses are also considered, such as navigation, water supply for agriculture and industry, seagrass propagation, and wetland functions.

Aquatic Life Use

The standards associated with this use are designed to protect aquatic species, and to protect the propagation of both aquatic and terrestrial species. They establish optimal conditions for the support of aquatic life and define indicators used to measure whether these conditions are met. Some pollutants or conditions that may violate this standard include low levels of dissolved oxygen, or high concentrations of toxics such as metals or pesticides dissolved in water.

Contact Recreation

The standard associated with this use measures the level of certain bacteria in water that indicate the relative risk of swimming or other water sports involving direct contact with the water. It is possible to swim in water that does not meet this standard without becoming ill; however, the probability of becoming ill is higher than it would be if bacteria levels were lower.

Public Water Supply

Standards associated with this use indicate whether water from a lake or river is suitable for use as a source for a public water supply system. Source water is treated before it is delivered to the tap. A separate set of standards governs treated drinking water.

Indicators used to measure the safety or usability of surface water bodies as a source for drinking water include the presence or absence of substances such as metals or pesticides. Concentrations of salts, such as sulfate or chloride, are also measured, since treatment to remove high levels of salts from drinking water may be expensive.

Fish Consumption

The standards associated with this use are designed to protect the public from consuming fish or shellfish that may be contaminated by pollutants in the water. The standards identify levels at which there is a significant risk that certain toxic substances dissolved in water may accumulate in the tissue of aquatic species.

Because toxic substances in water may exceed these levels while no accumulation in fish tissue is observable, the state conducts tests on fish and shellfish tissue to determine if there is a risk to the public from consuming fish caught in state waters. The standards also specify bacterial levels in marine waters to assure that oysters or other shellfish subject to commercial harvest and marketing are safe for public sale and consumption.

Indicators of water quality that are not tied to specific uses—such as dissolved solids, nutrients, and toxic substances in sediment—are also described in the standards. Indicators of water quality are discussed in more detail later in this document. A complete copy of the *Texas Surface Water Quality Standards* is available from the TCEQ Publications Library at 512/239-0028, or on the TCEQ website at <www.tceq.texas.gov/permitting/water_quality/wq_assessment/standards/>.

Texas Water Quality Integrated Report

The *Texas Water Quality Integrated Report for Clean Water Act Sections 305(b) and 303(d)* is an overview of the status of surface waters of the state, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources. More than 700 water bodies are assessed in Texas.

The 303(d) List, a subset of the report, identifies:

- water bodies that do not attain one or more of the standards set for their use, or are expected not to meet one or more uses in the near future;
- which pollutants or conditions are responsible for the failure of a water body to attain standards;

Common limitations in water quality include:

- bacteria levels that exceed the criterion established to assure the safety of contact recreation
- dissolved oxygen levels that are lower than the criterion established to assure optimum conditions for aquatic life
- total dissolved solids, sulfate, and chloride that exceed the criteria established to safeguard general water quality uses
- contaminants in fish tissue that pose a risk to consumers

Some water bodies also have:

- toxic substances in water that exceed the criterion to protect aquatic life
- conditions of acidity (measured as pH) and high temperature that exceed the criteria to safeguard general water quality uses

The *Integrated Report* is available on the TCEQ website at <www.tceq.texas.gov/compliance/monitoring/water/quality/data/wqm/305_303.html>.

Indicators of Water Quality

Several different parameters are measured to determine whether a water body meets the standards for its use. Some of the most common are listed here, with an explanation of why they are important to the health of a water body.

Bacteria

E. coli and Enterococci bacteria are measured to determine the relative risk of swimming (contact recreation), depending on whether the water body is fresh or marine. These bacteria originate from the wastes of warm-blooded animals. The presence of these bacteria indicates that associated pathogens from these wastes may be reaching a body of water. Sources may include inadequately treated sewage, improperly managed animal waste from livestock, pets in urban areas, aquatic birds and mammals, or failing septic systems.

Dissolved Oxygen

The concentration of dissolved oxygen is a single, easy-to-measure characteristic of water that correlates with the occurrence and diversity of aquatic life in a water body. A water body that can support diverse, abundant aquatic life is a good indication of high water quality. A problem frequently related to dissolved oxygen concentrations is an excess of nutrients in water. Large quantities of nutrients in water can cause excessive growth of vegetation. This excessive vegetation, in turn, can cause low dissolved oxygen.

Dissolved Solids

High levels of dissolved solids such as chloride and sulfate can cause water to be unusable, or simply too costly to treat for drinking water uses. Changes in dissolved solids concentrations also affect the quality of habitat for aquatic life.

Metals

High concentrations of metals such as cadmium, mercury, and lead pose a threat to drinking water supplies and human health. Eating fish contaminated with metals can cause these toxic substances to accumulate in human tissue, posing a long-term, but significant health threat. Metals also pose a threat to livestock and aquatic life. Potentially dangerous levels of metals and other toxic substances are identified through chemical analysis of water, sediment, and fish tissue.

Organics

Toxic substances from pesticides and industrial chemicals, called organics, pose the same concerns as metals. Polychlorinated biphenyls (PCBs), for example, are industrial chemicals that are toxic and probably carcinogenic. Although banned in the United States in 1977, PCBs remain in the environment, and they accumulate in fish and human tissues when consumed.

Fish Consumption Advisories and Closures

The Texas Department of State Health Services (DSHS) conducts chemical testing of fish tissue to determine whether there is a risk to human health from consuming fish or shellfish caught in Texas streams, lakes, and bays. Fish seldom contain levels of contaminants high enough to cause an imminent threat to human health, even to someone who eats fish regularly. However, risk increases for people who regularly consume larger fish and predatory fish from the same area of contaminated water over a long period of time. To reduce health risks in areas of contamination, people should eat smaller fish from a variety of water bodies. When a fish consumption advisory is issued, a person may legally take fish or shellfish from the water body under advisory, but it is not recommended. When a fish consumption closure is issued for a water body, the taking of fish or shellfish is legally prohibited.

Fish Consumption Advisories

Fish advisories may warn against the consumption of particular fish or shellfish species from the affected water body, or may recommend the amount of fish that

may be consumed over certain periods of time by specific segments of the population. For example, an advisory may read:

> "Consumption Advice: The advisory includes all species of fish and recommends limiting consumption to the following:
>
> > Adults should consume no more than one meal, not to exceed 8 ounces of fish per serving, each week.
> > Children seven years of age and older should consume no more than one meal, not to exceed 4 ounces of fish per serving, each week.
> > Children 6 and under, pregnant women, or women who may soon become pregnant should not consume fish from this reservoir.
> > Persons consuming fish from this reservoir should not consume mineral dietary supplements with selenium exceeding 50 micrograms per day."

Fish Consumption Closures

Fish consumption closures identify a specific water body, or portion of a water body, where the taking of fish is prohibited because the human health risk from fish consumption is very high. The closure notice will also identify the contaminant of concern, such as mercury or fecal coliform bacteria, and will list any (or all) species of fish or shellfish which people are prohibited from taking from the area of closure.

Texas Stream Team

Usefulness of Water for Different Ranges of Conductivity

0-800 µS/cm

- Good drinking water for humans (provided there is no organic pollution and not too much suspended clay material)
- Generally good for irrigation, though above 300 µS/cm, some care must be taken, particularly with overhead sprinklers which may cause leaf scorch on some salt sensitive plants
- Suitable for all livestock

800-2,500 µS/cm

- Can be consumed by humans although most would prefer water in the lower half of this range if available
- When used for irrigation, requires special management including suitable soils, good drainage and consideration of salt tolerance of plants
- Suitable for all livestock

2,500-10,000 µS/cm

- Not recommended for human consumption, although water up to 3000 µS/cm could be drunk if nothing else was available
- Not normally suitable for irrigation, though water up to 6000 µS/cm can be used on very salt tolerant crops with special management techniques
    - Over 6000 µS/cm, occasional emergency irrigation may be possible with care, or if sufficient low salinity water is available, this could be mixed with the high salinity water to obtain an acceptable supply.
- When used for drinking water by poultry and pigs, the salinity should be limited to about 6000 µS/cm.
    - Most other stock can use water up to 10,000 µS/cm.
- Water over 4000 µS/cm can cause shell cracking in laying hens.
- High magnesium levels can cause stock health problems in this range.
    - Analysis recommended

Over 10,000 µS/cm

- Not suitable for human consumption or irrigation
- Not suitable for pigs, poultry or any lactating animals
    - Beef cattle can use water up to 17,000 µS/cm and adult dry sheep can tolerate 23,000 µS/cm.
        - It is possible that waters below these EC levels could contain unacceptable concentrations of particular ions. Detailed chemical analysis should therefore be considered before using high salinity water for stock.
- Water up to 50,000 µS/cm (the salinity of the sea), can be used to flush toilets provided corrosion in the cistern can be controlled.

Source: Department of Primary Industries, Victoria, Australia, *Measuring the Salinity of Water,* Available from *http*://www.dpi.vic.gov.au

Texas Stream Team

Color, Odor, and Surface Scum Key

Possible Causes of Discoloration

Muddy Tan to Light Brown

- Suspended sediments
  - Common after rainfall
  - Runoff from construction, roads, agricultural/range land
  - Soil erosion caused by vegetation removal from riparian zone, rangeland/overgrazing, agriculture, and logging

Pea Green, Bright Green, Yellow, Brown, Brown-Green, Brown-Yellow, Blue-Green

- Water with these colors generally indicates a plankton bloom.
  - Key indicator of a plankton bloom: elevated DO and pH
  - Water color dependent on dominant plankton type present

Tea/Coffee

- Dissolved humic matter (organic portion of soil)
  - Usually associated with woodlands or swampy areas

Milky White

- Paint (construction)
- Milk (food processing)

Dark Red, Purple, Blue or Black

- Fabric dyes
- Inks from paper and cardboard manufacturers

Milky Gray/Black

- Raw sewage discharge
- Other oxygen-demanding waste
- A rotten egg or hydrogen sulfide odor may be present

Clear Black

- Turnover of oxygen depleted bottom waters
- Sulfuric acid spill

Orange-Red

- Deposits on stream beds associated with oil production areas but not always
  - Check for petroleum odor.
- Color can be due to iron and an oily sheen or residue may be present which can occur naturally (not oil or petroleum).
  - No petroleum odor

White Crusty Deposits

- Common in dry areas where the evaporation of water leaves behind salt deposits such as chloride or sulfate
- Also found in association with brine water discharge (from oil production areas)
  - A petroleum odor and an oily sheen may be present along the banks.

Possible Causes of Odors

Rotten Eggs/Hydrogen Sulfide (septic)

- Raw sewage
- Produced by decomposing organic matter and the lack of oxygen

Chlorine

- Wastewater treatment plant discharges
- Swimming pool overflow
- Industrial discharges

Sharp, Pungent Odor

- Chemicals or pesticides

Musty Odor

- Presence of raw or partially treated sewage, livestock waste or algae

Possible Causes of Surface Scum

Tan Foam

- Usually associated with high flow or wave action
    - Wind action plus flow churns water containing organic materials (increased with rainfall runoff), creating harmless foam.
    - Produces small patches to very large clumps

White Foam

- Sometimes patchy or covering wide area around wastewater outfall; thin or billowy; mostly due to soap

Yellow, Brown, Black Film

- Pine, cedar and oak pollens form film on surface, especially in ponds, backwater areas or slow moving water of streams

Rainbow Film

- Oil or other fuel type
    - Sheens are common after rain when oil/gas residue wash off streets.
    - Other sources include spills, pipelines, and oil/gas production areas.
    - Check for a petroleum odor which may be present if there is a large sheen because some organisms can cause a sheen.

This information was taken from the Surface Water Quality Data Interpretation Workbook written by Christine Kolbe available at http://txstreamteam.rivers.txstate.edu/Educators/Curriculum/contentParagraph/0/text_files/file16/Surface%20Water%20Quality%20Data%20Interpretation%20Workbook.pdf