THE MEADOWS CENTER
FOR WATER AND THE ENVIRONMENT

TEXAS STATE UNIVERSITY

TEXAS STREAM TEAM

TEXAS STREAM TEAM OPTICAL BRIGHTENER COMMUNITY SCIENTIST MANUAL

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ACKNOWLEDGMENTS

The Texas Stream Team encourages life-long learning about the environment and people's relationship to the environment through its multidisciplinary community science programs. We also provide hands-on opportunities for Texas State University students and inspire future careers and studies in natural resource related fields. Preparation of the Texas Stream Team Optical Brightener Community Scientist Manual has provided Texas Stream Team with the chance to extend additional outreach and educational opportunities to Texans. Texas Stream Team values the staff contributions and recognizes each individual for their role.

The following staff and student workers assisted in the preparation of this report and are acknowledged for their contributions:

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1.0 INTRODUCTION

The Texas Stream Team Optical Brightener Community Scientist Manual (Optical Brightener Manual) presents methods and procedures to become a certified Texas Stream Team Optical Brightener community scientist. Certification enables community scientists to collect water quality data that meet the requirements of the Texas Commission on Environmental Quality-approved Texas Stream Team Quality Assurance Project Plan.

Texas Stream Team has developed this community science program with input from the Environmental Protection Agency and the Texas Commission on Environmental Quality to address the following goals and benefits:

- Standardized training and quality assurance procedures help community scientists collect accurate, consistent information and improve data quality and integrity which can be used to make environmentally sound decisions.
- As recognized by the Environmental Protection Agency and Texas Commission on Environmental Quality, community scientists collect quality assured data that serve to supplement professionally collected data.
- Collection of quality assured data helps improve understanding of environmental issues and promotes communication and positive cooperation between Texans, professional monitors, and the regulated community.

Texas Stream Team expanded its program to include training in optical brightener detection as an extension of the Bacteria Water Quality Community Scientist Training (Bacteria Training). Monitoring optical brighteners complements bacteria monitoring efforts by enabling community scientists to potentially identify pollution sources, such as failing septic systems or illicit discharges, enhancing the understanding of water quality issues. This manual provides detailed information on the optical brightener training process, required materials, certification requirements, and training options. It also highlights the role of optical brighteners in evaluating waterway health and provides step-by-step instructions for combining optical brightener monitoring with bacteria monitoring efforts. For information on Bacteria water quality training and monitoring procedures, consult the Texas Stream Team Bacteria Water Quality Community Scientist Manual, available on the Texas Stream Team website.

Please note that to receive certification in Optical Brightener Training, participants must hold both Core and Bacteria certifications and have six months of bacteria monitoring experience.

The Optical Brightener Manual was developed to provide community scientists with clear instructions on collecting optical brightener water quality data, while also educating them about the importance of the monitoring they conduct. Texas Stream Team encourages new and veteran community scientists to develop a solid understanding of key concepts such as watersheds, stream order, and eutrophication. By raising awareness of nonpoint source pollution and incorporating optical brightener methods to track pollution indicators, Texas Stream Team equips community scientists with more effective strategies for protecting water resources and addressing water quality problems that may originate at the community level.

1.1 WHAT IS TEXAS STREAM TEAM?

Texas Stream Team (formerly known as Texas Watch) is an environmental education and volunteer-based community scientist water quality monitoring program. Community scientists collect environmental and water quality information that may be used to promote and protect a healthy and safe environment for people and aquatic inhabitants. Texas Stream Team emphasizes communication about the environment, which is based on the premises that water issues are inextricably linked with air, biological, land, and human resource issues, and that the protection of the environment requires the active, positive, collaborative participation of all Texans.

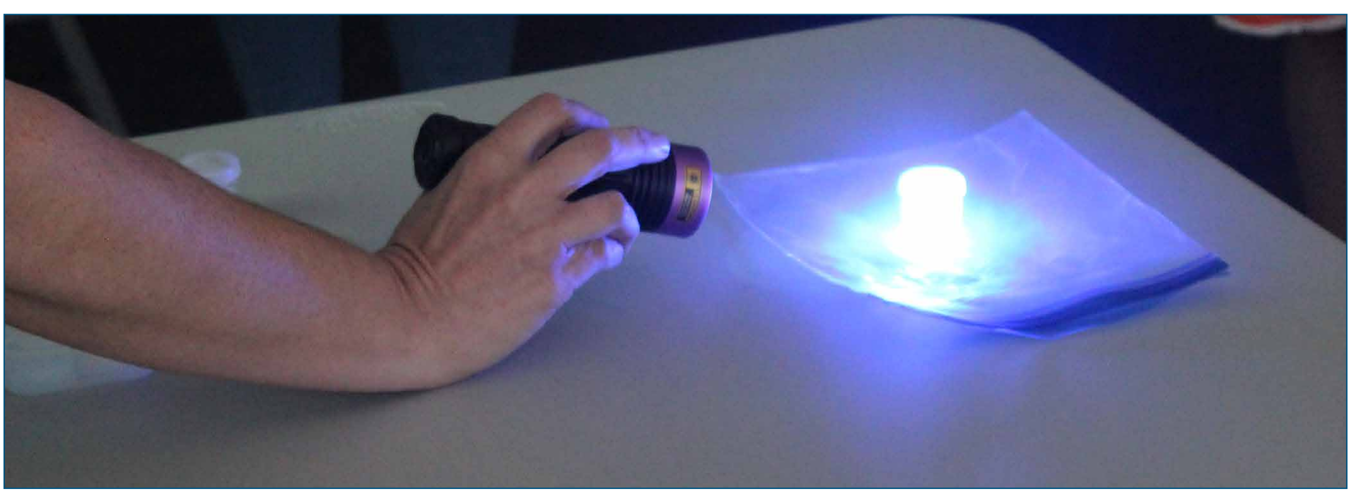
Through Texas Stream Team, community members, students, educators, academic researchers, environmental professionals, and both public and private sector partners are brought together to conduct scientific research and to promote environmental stewardship.

Texas Stream Team encourages everyone to ask:

- What questions do we want to answer about the environment?
- What part of the environment are we most concerned with?
- What can I do to help preserve and protect the environment?

For those whose concerns are centered on water quality, Texas Stream Team helps design water quality monitoring programs to address specific concerns.

Recognizing the size and complexity of the water environment, the time and expense of monitoring water quality, and the significant role each one of us has in protecting Texas waters, the Texas Commission on Environmental Quality, the U.S. Environmental Protection Agency, and Texas State University have formed a cooperative partnership to support Texas Stream Team. Texas Stream Team is partially funded through a Section 319(h) Grant under the Federal Clean Water Act, administered by the Texas Commission on Environmental Quality Nonpoint Source Pollution Program.



1.2 NONPOINT SOURCE POLLUTION

Getting to the Point

To a large extent, water quality within a watershed is linked to the actions of the people who live, work, and play within its boundaries. Water quality issues caused by human activities can be a result of either point source or nonpoint source pollution.

A point source is a single, identifiable source of pollution such as an end-of-pipe discharge from a municipal or industrial wastewater treatment plant. Point sources are regulated under the Federal Clean Water Act and Texas state law and are subject to permit requirements. These permits specify effluent limits, monitoring requirements, and enforcement mechanisms. Even though effluent discharges are permitted and regulated, point sources can still contribute to water quality degradation.

Nonpoint source pollution is pollution from sources which are diffuse and do not often have a single point of origin or are not introduced into a stream from a specific source. The pollutants are generally transported from the land by runoff. Nonpoint sources of pollution are largely unregulated and have not historically been evaluated in the same rigorous manner as point source pollution. Nonpoint source pollution originates from many different locations and sources. We have all seen trash in waterways following a rainfall event. Other contaminants, not so easily seen, enter our waters in much the same way.

Nonpoint source pollution occurs when rainfall runoff transports contaminants on the surface of the land into adjacent water bodies. Contaminated stormwater can cause impairment to the beneficial uses of streams, reservoirs, estuaries, and oceans. Pollutants carried by water percolating through the soil and entering aquifer recharge features can contaminate groundwater. Land management activities associated with agriculture, forestry, and residential and urban development can increase nonpoint source pollutants.

Nonpoint Source Pollution's Effects on Aquatic Ecosystems

Dissolved oxygen is a basic requirement for a healthy aquatic ecosystem. Most fish and insects breathe oxygen dissolved in the water. Some fish and aquatic organisms, such as gar and sludge worms, are adapted to low dissolved oxygen concentrations. However, most desirable fish species, such as largemouth bass and darters, become stressed if dissolved oxygen concentrations are below 4 milligrams per liter (mg/L). Insect larvae and juvenile fish are more sensitive and require even higher concentrations of dissolved oxygen to grow and reproduce.

Oxygen concentrations in the water column fluctuate under natural conditions, but depletion beyond normal fluctuations may be the result of human activities that introduce large quantities of biodegradable organic materials into surface waters. Biodegradable organic materials which include lawn clippings, raw and treated sewage, food processing wastes, rice field drainage, and pulp paper wastes, are some examples of oxygen depleting organic materials that enter surface waters. As these wastes decompose and break down into essential nutrient-enriched building blocks, many chemical and biological processes are directly affected.

Nutrients are fundamental building blocks for healthy aquatic communities, but excess nutrients (especially nitrogen and phosphorus compounds) may over stimulate the growth of aquatic plants and algae. Excessive growth of these plants can clog waterways and interfere with boating and swimming. In addition, these plants will out-compete native submerged aquatic vegetation and, with excessive decomposition, lead to oxygen depletion or a condition called eutrophication. Oxygen concentrations often fluctuate widely, increasing during the day as aquatic plants conduct photosynthesis producing oxygen and falling at night as plants and animals respire, consuming oxygen.

Common Nonpoint Source Pollutants

Sediment from croplands, forestry activities, construction sites, and streambank erosion.

Nutrients from croplands, lawn and gardens, livestock operations, septic systems, and land waste application; sediments from erosion can reduce clarity and sun penetration in bodies of water, harming aquatic plant life and fish. Nutrients can also be carried by runoff from over-fertilized areas or decaying leaves and lawn clippings. Excessive nutrients in waterways can cause excess plant and bacteria growth, resulting in eutrophication (oxygen depletion) and fish kills.

Bacteria from livestock, seepage from improperly maintained septic systems, leaking sewer lines, wildlife, and urban runoff.

Man-made chemicals, including pesticides from roadways, croplands, lawns, gardens, and forestry operations. Toxic materials, such as improperly applied pesticides or automotive products such as motor oil, engine degreasers, and antifreeze. These toxins can wash from city streets and other areas or can result from illegal dumping.

Surface trash, such as plastic containers or cigarette butts; this trash is not only aesthetically unappealing, but residue from discarded containers can be washed into water bodies.

Fertilizers, malfunctioning septic systems, detergents, pharmaceuticals, and organic materials in treated sewage and manure in agricultural runoff are examples of nutrient sources often responsible for water quality degradation. Rural areas are susceptible to groundwater contamination from nitrates found in fertilizer and manure. Nutrients are difficult to control because they typically recycle among the water column, algae, and bottom sediments. For example, algae may temporarily but significantly reduce phosphorus from the water column, but the nutrients will return to the water column and bottom sediments when the algae die and are decomposed by bacteria. Gradual inputs of nutrients tend to accumulate over time rather than leave the system.






Detecting and Tracking Nonpoint Source Pollution

Nonpoint source pollution is episodic. This means it typically enters our rivers and lakes during episodes of rainfall resulting in runoff, during isolated events such as incidences of illegal dumping, or in a random fashion, as when a sewer line overflows or breaks. It is difficult and expensive to monitor nonpoint source pollution using a fixed monitoring schedule and employing tests for only a few chemical variables. Analyzing data for trends and correlations over space and time provides an effective strategy to investigate nonpoint source pollution.

Conducting chemical and biological tests on water quality is like taking a snapshot of the river or lake at that moment in time. Trend analysis on water parameters measured provides clues to assess nonpoint source pollution. Analysis of chemical and biological test results over an extended period provides a foundation of background levels of dissolved oxygen values (oxygen concentrations will correspond to plant production and decomposition), rainfall contributions (streamflow values will change with runoff), and nutrient fluctuations (Secchi measurements can be used to determine the productivity status of a system, which is influenced by nutrient loading).

Living organisms in a stream or lake can provide information about what happened there over time. For example, monitoring a stream with healthy habitat and chemical water quality that meets local water quality standards, but no living organisms, indicates something may have happened there prior to sampling to account for the lack of living organisms. Perhaps a heavy rainstorm scoured the site and displaced the organisms. Perhaps some nonpoint source pollution lowered the dissolved oxygen concentration, causing the organisms to die or move downstream. There are many possible explanations, but by assessing the biological community of the stream over time alongside the water chemistry, the community scientist can learn more about the long-term conditions of the stream than if they performed only water chemical tests or field observations.

Water pollution from nonpoint sources is less obvious and more difficult to identify than from point sources and is not as easy to control through traditional management strategies. The variability of rainfall events and the complexity of the landscapes and geologic features lead to nonpoint source pollution phenomena which are highly variable and intricate. The lack of a single identifiable source of pollution makes it difficult to establish specific cause-and-effect relationships but reinforces the importance of analyzing trends and correlations drawn from consistent, long-term monitoring efforts.

Fecal Contamination and Water Quality

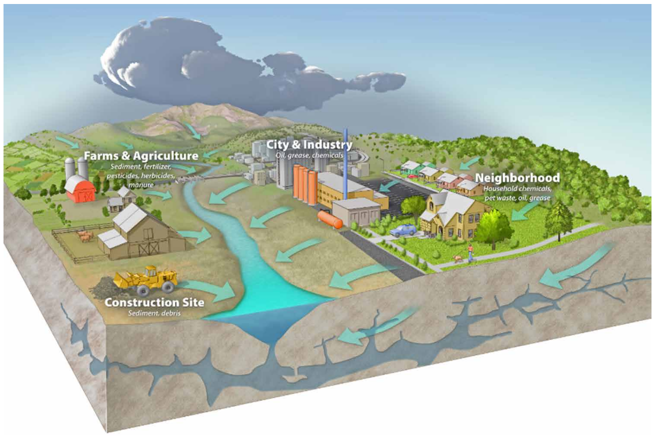
Fecal contamination in a waterbody is primarily measured to assess the potential health risks via primary or secondary contact recreation. Fecal bacteria enter the environment when they are expelled from the gut as fecal matter. Once in the environment, fecal bacteria enter a body of water either as nonpoint source pollution or point source pollution.

Fecal bacteria enter a waterbody in nonpoint source pollution when the source of the contamination comes from diffuse sources of runoff. For example, common nonpoint sources of fecal bacteria can include runoff from agricultural products (such as improperly managed manure), livestock and wildlife waste, and/or urban runoff containing pet waste or sewage. Fecal bacteria can also enter a waterbody in point source pollution, such as broken or malfunctioning sanitary sewer overflows (see Sanitary Sewer Overflows (SSOs) | National Pollutant Elimination System (NPDES) | US EPA) an illicit discharge from a specific source, or seepage from a broken or malfunctioning septic tank.

1.3 TEXAS STREAM TEAM OPTICAL BRIGHTENER MONITORING

Incorporating optical brightener detection into bacteria monitoring adds an essential preliminary screening tool for identifying potential wastewater contamination. This method enhances standardized bacteria monitoring by providing insights into pollution sources that may go undetected through bacterial data alone. These parameters are documented in a Group Monitoring Plan prepared by groups or organizations engaged in Texas Stream Team monitoring. A monitoring plan identifies the monitoring objectives and specifies the sites and parameters monitored and procedures to be implemented. A monitoring plan is unique to the conditions and needs of a site.

Routine collection of both bacterial and optical brightener water quality data is crucial for establishing baseline conditions and identifying abnormal environmental events as they occur. Baseline conditions reflect the normal environmental conditions of a waterbody, including expected variability in water quality results due to factors like temperature, weather, and season. This understanding is built over time through routine observations, allowing for trend analyses that offer critical insights into nonpoint source pollution. These analyses play a key role in assessing and managing water quality, ultimately helping to protect the health of Texans. While six months of bacteria monitoring experience qualifies participants for Optical Brightener Training, it is recommended that community scientists monitor bacteria consistently for at least one year to establish a solid data baseline before attempting to identify pollution sources through optical brightener monitoring.



1.4 INTRODUCTION TO OPTICAL BRIGHTENERS

Optical brighteners, also known as optical brightening agents or fluorescent whitening agents, are synthetic chemicals added to products such as detergents, fabric softeners, fabric refreshers, stain removers, multi-purpose cleaners, toilet cleaners, toilet paper, shampoos and conditioners, and toothpaste to enhance their appearance (Meghmani Global 2020). Anthropogenically introduced to the environment, they absorb ultraviolet light and emit blue light, making materials appear whiter and brighter. These compounds are not biodegradable and can persist in the environment (Klavins & Zucel 2004).

Optical brighteners can enter water bodies through wastewater from household and industrial sources. As these products are washed down the drain, they can flow into a wastewater treatment plant or a septic system. In areas served by septic systems, failing systems can release untreated wastewater, allowing optical brighteners to seep directly into nearby water bodies. Septic systems, which rely on soil filtration, may only partially filter out contaminants like optical brighteners. In contrast, wastewater treatment plants, which are not required to remove optical brighteners,may lack the treatment stages necessary to completely remove them. In both cases, these chemicals are often not fully eliminated during treatment, leading to their accumulation in rivers, lakes, and other aquatic environments (Salas et al. 2019). The long-term effects of optical brighteners on water bodies remain largely unknown.

Detecting optical brighteners in surface waters can serve as a valuable tool for community scientists, indicating potential sources of bacterial contamination. Specifically, the presence of optical brighteners in water can indicate pollution from the following potential sources:

1. Effluent from wastewater treatment plants
2. Ilicit discharges (failing or malfunctioning septic systems)
3. Industrial effluents (commercial laundries, textile manufacturing, carpet cleaning services, and paper mills)
4. Stormwater runoff (urban areas)
5. Agricultural runoff (rural areas with septic systems)
6. Swimming pools

While optical brighteners in water bodies are often used as indicators of potential contamination from wastewater (Wilke & Fisher 2003), their presence alone does not provide a direct measure of pollution. Research on the toxicity of optical brighteners to aquatic and human life is still limited, and their environmental impact is not fully understood. Although they are generally considered to have low toxicity at low concentrations, high levels can potentially disrupt aquatic life, affecting growth and reproduction (Castro-Sierra 2024) and altering natural conditions in water bodies (Buehler & Buehler 2007). Their persistence in the environment also raises concerns about long-term pollution. Optical brighteners are not currently listed as a contaminant of concern by the Environmental Protection Agency, similar to other emerging contaminants like per- and polyfluoroalkyl (PFAS). Although these agents are primarily assessed as indicators of potential wastewater contamination, ongoing research continues to uncover more concerning effects of their presence in waterways.

Currently, the Texas Commission on Environmental Quality does not have specific screening criteria for optical brighteners. However, environmental regulations may indirectly address issues related to these chemicals through broader wastewater management and water quality standards. Their presence is still commonly monitored by environmental scientists, such as water authorities and municipalities, as a proxy for wastewater contamination. The primary purpose of monitoring optical brighteners is to identify human fecal contamination in waterbodies when combined with counts of fecal bacteria. However, this practice holds broader significance for several key reasons. For instance, it contributes to environmental research initiatives and, as a lower-cost and simpler method for sampling - serves as an educational tool for the community by raising awareness of water quality issues. Finally, comprehensive data on the distribution of optical brighteners is necessary in order to establish effective water quality standards, add to the limited understanding of these chemicals and their behavior in surface waters, and aid governments and regulatory bodies in developing and enforcing relevant regulations.

The use of absorbent materials, such as tampons or pads, to detect optical brighteners started gaining traction in community science programs in the early 2010s (The Civil Engineer n.d.). Researchers discovered that absorbent materials in these products could efficiently capture residues of optical brighteners, making it a practical and cost-effective tool for monitoring these contaminants. This approach has been implemented in various locations around the world, including community science projects in Europe and North America (The Civil Engineer n.d.). Local environmental groups and universities often collaborate to facilitate these studies, focusing on regions with significant water quality concerns. Now more widespread, this monitoring technique has evolved into a method that combines grassroots involvement with scientific inquiry to address environmental and health concerns.

Understanding the role of optical brighteners is closely linked to bacteria monitoring, as both can provide critical insights into water pollution. By combining bacteria monitoring with optical brightener detection, environmental professionals can gain a more comprehensive view of contaminants impairing water quality, allowing for more accurate pollution assessments and better-informed management or remediation strategies.

The Texas Stream Team program integrates optical brightener training as an extension of the Bacteria Training. Community scientists actively monitoring and collecting bacterial data are encouraged to sample for optical brighteners concurrently with their bacteria monitoring routine to help identify pollution sources and their implications for aquatic life and water quality. The Texas Stream Team program recommends that community scientists implement the following actions upon detecting optical brighteners at their monitoring site:

1. Accurately document all observations, including photographs of the monitoring site and any relevant nearby environmental factors such as residential properties, commercial establishments, and agricultural activities. Additionally, it is crucial to record the presence of any nearby septic tank systems, stormwater drains, sewer pipelines, or industrial discharge points on the Texas Stream Team Optical Brightener Monitoring Form.
2. Conduct upstream bacteria monitoring from the site where optical brighteners were detected. This approach aids in bacterial source tracking.
3. If the monitoring site is situated in proximity to a septic tank system, community scientists are encouraged to notify their county

authorities and engage local initiatives to facilitate a septic tank inspection.

4. It may be beneficial to conduct monitoring during both dry conditions, to eliminate the potential influence of stormwater runoff that can dilute bacterial concentrations, and after storm events, which may strain septic tank systems or wastewater infrastructure, potentially leading to leaks or malfunctions.

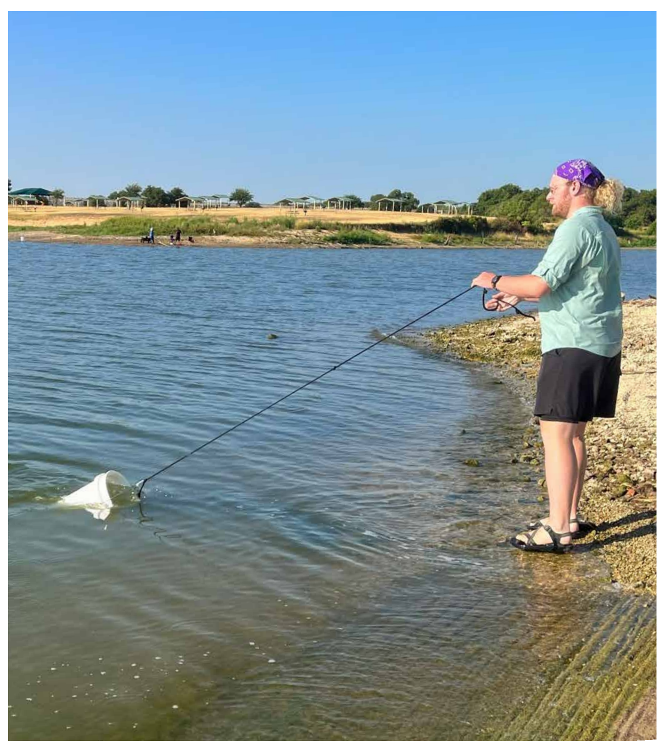
Community scientists are encouraged to utilize their optical brightener data to advance scientific research, identify pollution sources, and take action to mitigate their impact on water quality. The results of optical brightener monitoring may reveal illegal discharge pipes or failing septic systems requiring immediate attention. Conversely, if no optical brighteners are detected despite consistently high levels of bacteria, this may indicate that the bacterial contamination is not linked to human wastewater, allowing for a more focused investigation elsewhere.

By leveraging optical brightener data, community scientists can make informed decisions and target their efforts effectively, ultimately leading to improved water quality outcomes. To ensure the accurate collection and interpretation of this data, the Texas Stream Team offers comprehensive and accessible training in optical brightener detection.

1.5 GETTING STARTED WITH TEXAS STREAM TEAM

Please follow these steps to begin a monitoring project:

1. Schedule a training session(s) with a Texas Stream Team trainer in your area or Contact Texas Stream Team to request a training session. All three training phases can be completed in one training session. If training phases are split up into multiple sessions, Training Phases I and II are generally scheduled with a group. After completing Phases I and II, Phase III can be scheduled later to complete the training. Phase III will typ¬ically take place at the community scientist's monitoring site.
2. Select a monitoring site and request a site identification number based on the guidelines included in this manual under Section 2.1 - Choosing a Monitoring Location. Generally, you should not need to select a new site, as you can add optical brightener monitoring to your existing bacteria monitoring site(s).
3. When establishing a monitoring group, complete a Texas Stream Team Group Monitoring Plan. The monitoring plan identifies the objectives of monitoring and specifies the sites and monitoring procedures. A copy of the Group Monitoring Plan and instructions can be obtained on the Texas Stream Team website. Alternatively, if your group is already operating with a Group Monitoring Plan, please revise your current form to ensure the latest monitoring activities are documented.
4. Acquire monitoring supplies. Community scientists acquire supplies in a variety of ways. They may purchase supplies at their own expense or raise money from other sources such as a civic organization. Some Texas Stream Team partners provide supplies, and the Texas Stream Team office in San Marcos periodically has supplies to loan community scientists.



5. Begin monitoring for optical brighteners alongside bacteria monitoring. Record data on the Optical Brightener Monitoring Form and send the data to your group Data Coordinator or to Texas Stream Team directly.

6. Contact Texas Stream Team for information on scheduling a training, completing a Group Monitoring Plan, acquiring monitoring supplies, or for any other questions.

Phone: 512.245.1346
Email: TxStreamTeam@txstate.edu
Web: TexasStreamTeam.org

1.6 TRAININGS

Information describing the various levels of certifications and trainings offered by Texas Stream Team is provided on the Trainings and Programs page.

The longevity of the program is dependent upon the participation of our dedicated community scientists, and we encourage you to continue increasing your level of involvement by completing the required training to detect optical brighteners, becoming a certified Texas Stream Team Bacteria Trainer/Quality Assurance Officer, or progressing to a Texas Stream Team Advanced Water Quality Community Scientist.

Texas Stream Team Community Scientist Trainings

Texas Stream Team offers additional water quality and environmental monitoring trainings, including:

- Standard Core Water Quality Community Scientist Training
- Probe Core Water Quality Community Scientist Training
- Bacteria Water Quality Community Scientist Training
- **Optical Brightener Community Scientist Training**
- Advanced Water Quality Community Scientist Training
- Macroinvertebrate Bioassessment Community Scientist Training
- Riparian Evaluation Community Scientist Training

This manual includes information for the Optical Brightener Community Scientist Training. Visit the Texas Stream Team Trainings and Programs page to learn more about other trainings offered by Texas Stream Team.

Optical Brightener Community Scientist Training

The optical brightener training extension is available to eligible community scientists who meet the prerequisites outlined below. This training is distinct from other Texas Stream Team programs as it is offered primarily online. To receive certification as a Texas Stream Team optical brightener community scientist, the training program described on the following pages must be completed.

Each trainee is required to fill out the online Training Enrollment Form to become a certified Texas Stream Team optical brightener community scientist and begin monitoring activities.

TRAINING OPTIONS:

- **Remote Training:** The optical brightener training is available primarily online, allowing trainees to complete it at their own pace without requiring in-person instruction. To access the training module, the trainee must contact Texas Stream Team to verify their eligibility and request module access. After verifying eligibility, trainees can complete the online module, answering questions to test their understanding of the materials. After completing the module and answering knowledge-check questions, Texas Stream Team will process the certification, and the trainee will receive their certificate via email. Trainees are encouraged to follow the sampling sequence outlined in the manual to incorporate optical brightener detection into their bacteria monitoring.
- **In-Person Training:** In-person training is available by request and must be scheduled with a certified Texas Stream Team Optical Brightener Trainer. There are no regular scheduled trainings on the Texas Stream Team calendar, as this training is conducted on an as-needed basis only.

Depending on the route taken, community scientists will either complete the training independently using the module or in-person with a trainer, following a three-phase training structure. Regardless of the route, community scientists are required to fill out and submit the Training Enrollment Form and must meet the following prerequisites:

PREREQUISITE

Prior to receiving certification for optical brightener monitoring, participants must:

- Have completed and received certification in the Standard Core Water Quality Community Scientist and Bacteria Water Quality Community Scientist Trainings, and
- Have completed at least six months of bacteria monitoring and submitted the corresponding data to Texas Stream Team.

PHASE I

Phase I begins with an instructional classroom session, recapping background information on the Texas Stream Team program, introducing what optical brighteners are, their significance, and how they are used as indicators of pollution.

Phase I training transitions to a demonstration of optical brightener monitoring procedures. A Texas Stream Team certified trainer explains how optical brightener monitoring supplies are used. The trainer demonstrates optical brightener monitoring procedures while trainees follow along with the demonstration. The trainees perform the procedures simultaneously with the trainer. Trainees record their results on the Phase I Monitoring Form.

After the trainees are comfortable with the optical brightener monitoring procedures, the Phase I Monitoring Form is reviewed. This form signifies the trainee's successful completion of Phase I for the parameters specified and indicates their understanding of the monitoring procedures and commitment to following all procedures.

PHASE II TRAINING

During Phase II, trainees demonstrate the monitoring procedures learned during Phase I. The structure of this phase varies slightly based on the format:

1. In-Person Training:

Trainees perform the optical brightener monitoring procedures in the field under the direct supervision of a trainer. Whenever possible, the selected waterbody should resemble the sites the trainees will monitor regularly. The trainer observes the trainees' procedures, provides real-time feedback, answers questions, and ensures data quality assurance. After the trainees complete the Phase II Monitoring Form, the trainer reviews the trainees' strengths and areas for improvement through a direct discussion. The completed form is retained by the trainee as a reference for Phase III.

2. Remote Training:

   Trainees conduct their field demonstration independently, recording and submitting their procedures and completed Phase II Monitoring Form via the appropriate submission form within the online module. The trainer can provide support via virtual platforms (e.g., Teams, Zoom) during the field demonstration if pre-arranged. After the submission, the trainer reviews the materials and offers detailed feedback via email, video call, or other agreed-upon formats. The feedback addresses strengths, areas for improvement, and next steps for Phase III.

Regardless of the format, all trainees are encouraged to ask questions and seek clarification as needed to ensure confidence in the procedures.

PHASE III TRAINING

Phase III training can take place either at the same time and location as Phases I and II or at the trainee's approved monitoring site within three months of completing Phase II.

1. In-Person Training:

   At the trainee's approved monitoring site, the trainer observes the trainee as they independently conduct the monitoring procedures. The trainee is expected to complete the monitoring process and the Phase III Monitoring Form without assistance from the trainer. Once the trainee has completed the monitoring, the trainer provides feedback and discusses next steps, including how to establish a monitoring site.

2. Remote Training:

   If conducted remotely, trainees independently perform monitoring at their approved site and complete the Phase III Monitoring Form. Trainees document their procedures (e.g., via notes, pictures, or video) and submit the form and supporting documentation via the appropriate submission form within the online module. Feedback and guidance on next steps are provided following submission of the module, including detailed support on setting up a monitoring site.

Regardless of the format, trainees are encouraged to complete the online Measures of Success Survey after finishing Phase III.

FIELD AUDIT AND QUALITY CONTROL REQUIREMENTS

Upon completing Phase III, all community scientists are required to attend a quality control field audit session every two years to comply with the Texas Stream Team Quality Assurance Project Plan. The initial training serves as the first field audit session for trainees.

The field audit session involves a detailed observation of the trainee's techniques to ensure monitoring is conducted according to Texas Stream Team protocols. Trainees are expected to follow protocols as described in this manual without trainer assistance. The Field Audit Session Checklist, included with the monitoring form, will be used to document the session and ensure compliance with monitoring standards.

Certification

Upon completion of training phases I, II, and III, the trainee must complete the online Training Enrollment Form before a certificate of completion can be issued. The trainer will submit completed forms to the Texas Stream Team to create and distribute the certificates. If the training is conducted via the online module, the trainee will submit the completed forms via the module system to Texas Stream Team directly.

The certification process serves as the record to document completion of the training and the first field audit session; therefore, it is critical that a legible form is submitted. If the trainer does not receive the completed form, a certificate of completion will not be generated and sent to the trainee. Texas Stream Team distributes certificates at the beginning of each month.

Texas Stream Team Trainer

Optical brightener community scientists may receive additional certification as a Texas Stream Team Optical Brightener Trainer after completing the requirements described below.

- **Phase I** – Trainer trainee must be a certified Texas Stream Team Optical Brightener community scientist who has been actively monitoring for at least one year.
- **Phase II** – Trainee assists a certified trainer in planning, coordinating, and presenting at one community scientist training session.
- **Phase III** – Trainer trainee plans, coordinates, and presents all phases of one community scientist training assisted by a certified Texas Stream Team trainer.
- **Phase IV** – Trainer trainee submits the completed Trainer Enrollment Form to Texas Stream Team. If approved, the newly certified trainer will receive a certificate as a certified Texas Stream Team trainer.

A certified trainer may ask the trainer trainee to repeat any of the above phases if the trainer feels the trainer trainee is not ready to become a certified trainer. Certified trainers have authority to override prerequisites if the trainer trainee successfully completes all phases up to the certified trainer(s) standards.

The following are requirements to maintain ***active*** trainer status through the Texas Stream Team program:

- The Trainer must participate in and/or lead at least one community scientist training session per year.
- The Trainer must attend the Annual Texas Stream Team Trainer meeting or have an alternate attend in their place.
- The Trainer should submit scheduled trainings to the Texas Steam Team online calendar.
- A Training Sign-In Sheet should be submitted to TxStreamTeam@txstate.edu after each training.
- The Trainer must complete a field audit session every two years. The field audit is designed to detect and correct discrepancies in monitoring techniques. This requirement is necessary to ensure data quality and comparability among community scientists statewide.

Note that if the requirements described above are not met, and the trainer is not actively monitoring within the Texas Stream Team program, they will be required to complete a field audit session to reactivate and will not be able to certify any individuals until then. If the individual has not been monitoring, they will be asked to repeat Phase III and conduct a field audit session to reactivate and be able to certify trainees.

Texas Stream Team Quality Assurance Officer Training

TO PERFORM FIELD AUDIT SESSIONS:

Certified trainers concurrently become certified Quality Assurance Officers upon completion of the trainer certification. Community scientists can be certified to perform field audit sessions as a Texas Stream Team Quality Assurance Officer. Community scientists must observe a field audit session performed by a certified Quality Assurance Officer, then lead a field audit session with a Quality Assurance Officer present. Quality Assurance Officers must undergo field audit sessions every two years to maintain certification.

1.7 QUALITY ASSURANCE

Texas Stream Team data is collected under a Texas Commission on Environmental Quality approved Quality Assurance Project Plan. Quality assurance consists of community scientist activities that involve planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that Texas Stream Team community scientist data are of the type and quality needed and expected by the agencies, including the Texas Commission on Environmental Quality and Environmental Protection Agency, that provide financial support for the program.

The approved Quality Assurance Project Plan documents the procedures Texas Stream Team community scientists implement to ensure that the resulting data are of high quality and meet project data quality objectives. The Quality Assurance Project Plan also ensures community scientists statewide use the same methods for all parameters measured, including optical brighteners, to ensure comparable results. For these reasons, it is critical all community scientists are aware of the Quality Assurance Project Plan requirements and implement the procedures as stated in the approved document.

Quality Control

Quality Control consists of the overall system of community scientist activities to verify that they meet the stated requirements approved by the Texas Commission on Environmental Quality and accepted by the Environmental Protection Agency.

Quality control measures implemented by Texas Stream Team optical brightener community scientists include:

- **Buddy system:** We strongly recommend community scientists always monitor with another person for safety purposes, but also to confirm observations by conducting duplicate visual evaluations of measurements collected.
- **Field Audit Sessions:** Once trained, community scientists must attend one field audit session every two years. A field audit session includes observation of a community scientist conducting a monitoring event by either a Texas Stream Team Trainer, Quality Assurance Officer, or Texas Stream Team staff member. Observations are documented on a Field Audit Session Checklist and all discrepancies are discussed with the community scientist upon completion of the session. A training video describing the field audit procedure can be found on the Texas Stream Team YouTube page.
- **Optical Brightener Contamination**: Ensure that the tampons used are free from any pre-existing fluorescent substances that could affect the results. Texas Stream Team requires sterile, untreated/organic cotton tampons with no applicators for this reason (e.g. Natracare brand). Before beginning a monitoring event, community scientists must check all monitoring equipment for optical brightener contamination using a UV LED black light flashlight.
- **UV Light Contamination**: Optical brighteners are sensitive to photo decay and degrade at an exponential rate. Therefore, samples should always be stored in a dark or shaded place during transportation and analysis to prevent UV light contamination and potential degradation of the sample.
- **Cross Contamination:** Community scientists are trained to avoid contaminating sample containers, hands, tabletops, or any other surface or object. Always wear clean and sterile gloves throughout the procedure to prevent contamination. To avoid cross-contamination when handling tampons, after putting on uncontaminated gloves carefully open the packaging by unwrapping the first half of the wrapper, then pull down the bottom portion to access the string. When possible, only touch the string to place in the sample container.
- **Data Management:** Community scientists implement quality assurance procedures and checklists before entering data to

the Dataviewer. See Section 3.1 - Data Management for additional information.

- **Document Sample Deployment:** It is recommended to photograph samples upon deployment to help locate them later and improve data quality. Submitting a photo with your Optical Brightener Monitoring Form is also recommended (if possible) for documenting sample results.
- **Standardized Submersion Time:** When deploying multiple tampons, ensure they are submerged for the same length of time (at least 24 hours) to prevent variations in exposure that could affect the results. Additionally, community scientists will maintain consistency in the exposure period, particularly for the bottle method, for each monitoring event.
- **Sampling Location:** Tampons, particularly when using the bottle method, should be placed in a sampling location that is shaded, in the centroid of the flow, and where there is sufficient water movement to prevent stagnation, as this can affect the absorption of optical brighteners. It's also best to position samples in a hidden location to avoid interference or place a sign to prevent tampering.
- **Accurate Analysis of Samples:** When examining tampons for optical brighteners, only count blue spots present within the cotton fibers as positive. Other colors, or blue flecks on the surface (that can be easily removed), are not indicative of optical brighteners. While you must record "Absent" in samples where optical brighteners are not detected, you may still note any other types of fluorescence observed in the comments section. This information remains valuable for understanding the conditions at your monitoring site.
- **Tidally Influenced Streams:** Community scientists monitoring tidally influenced streams should exclusively use the Whirl-Pak® bag method because wave activity can interfere with sample integrity. Additionally, monitoring in tidally influenced streams can be challenging, as tidal flow may dilute the concentration of optical brighteners at different times of the day, which can impact detection accuracy.
- **Flashlight Consistency:** Shine the UV LED black light flashlight at the same distance each time to ensure consistent optical brightener detection. Note that in some samples, optical brighteners may not fluoresce if the flashlight is held too far away. Additionally, a 365 nm UV LED black light flashlight is used to ensure detection of optical brighteners within the appropriate nanometer range.

2.0 SAFETY CONSIDERATIONS

General Precautions

1. Read all instructions to familiarize yourself with the monitoring procedures before you begin. Note any precautions in the instructions.
2. Always wear gloves prior to collecting water sample(s) or deploying a tampon.
3. Never monitor in unsafe, hazardous weather conditions. If you suspect hazardous weather conditions, do not attempt to travel to your monitoring location. Reschedule for a later time.
4. Follow the advice of all local, regional, state, and national weather agencies when it comes to your safety.
5. Follow all local, regional, state, and national laws while conducting your optical brightener monitoring.
6. If you need to access private property to conduct optical brightener monitoring, the Private Property Access Form must be submitted to Texas Stream Team PRIOR to accessing private property.
7. Keep all equipment and supplies out of the reach of young children.

8. In the event of an accident or suspected poisoning, immediately call the Poison Control Center at (800) 222-1222. Be prepared to provide information about the supplies ingested or exposed to.
9. Texas Stream Team strongly suggests that you always implement the buddy system and monitor with another person for safety purposes.
10. Always wash hands and clean all surfaces before and after each sampling event.

Protecting Yourself and Your Equipment

1. Avoid contact with skin, eyes, nose, mouth, and clothes while optical brightener monitoring.
2. Always wear gloves.
3. Store supplies and equipment indoors at room temperature or as directed by the manufacturer. Do not expose supplies and equipment to direct sunlight and protect them from extremely high or low temperatures. Avoid storing equipment in an automobile.
4. After completing the monitoring process, dispose of used tampons and any other disposable materials in household compost (if available) or the landfill.
5. Hold scalpels by the handle, never the blade. Always cut away from yourself with the bottle held upside down and on a stable surface. Be mindful of your surroundings while handling scalpels and keep out of reach when not in use.
6. Use UV-blocking safety glasses to protect your eyes from harmful UV radiation when handling a UV LED black light flashlight. Do not point the UV flashlight directly at your skin or eyes.

Site Safety

1. Park your vehicle safely away from roads and out of the way of traffic. Be cautious of traffic when unloading or loading monitoring equipment and accessing your site.
2. If necessary, sample your site from bridges with pedestrian walkways, from docks, or from stream banks. If you must enter the water, always have a buddy or partner on the shore nearby and always wear a life jacket or U.S. Coast Guard approved personal floatation device if wading is necessary.
3. Approach your site carefully! Look out for traffic on bridges and when crossing roads. Be on the lookout for snakes, fire ants, wasps, poison ivy, Africanized honeybees, wild animals, broken bottles, or debris.
4. If using a boat or kayak to sample your site, learn and observe all U.S. Coast Guard and State of Texas regulations.

2.1 CHOOSING A MONITORING LOCATION

Optical brightener monitoring should be conducted at locations where active bacteria monitoring has been ongoing for at least six months. Keep in mind that this is most effective when at sites away from large golf courses, car washes, or areas where laundry detergents or turf care products are commonly used. These sources can introduce optical brighteners unrelated to sewage, leading to false positives that do not indicate wastewater contamination. To ensure accurate results, choose sites with minimal influence from these external sources.

2.2 CHOOSING A MONITORING TIME

Texas Stream Team optical brightener monitoring should be conducted alongside routine bacteria monitoring. However, community scientists are not required to collect optical brightener data as part of their bacterial sampling. Instead, they can choose to sample for optical brighteners if bacterial results suggest possible contamination, indicating a potential need for further investigation into the pollution source. That said, collecting optical brightener data more frequently is not harmful, and community scientists are welcome to monitor more often if time and equipment allow.

As a reminder, bacteria sampling should occur once a month and at regular intervals. For example, if sampling is conducted monthly, try to sample every 30 days. If necessary, sampling can take place as early as 26 days after the last sampling event or as late as 34 days after the last sampling event. Water quality and environmental conditions can change throughout the day, therefore monitoring at the same time and location helps to ensure the data collected on different sampling days using the same protocols are comparable.

If you have questions about whether to cancel, postpone, sample early, or change your sampling location, call, or email your Training Coordinator or Texas Stream Team staff.

For more information about bacteria monitoring times, reference Section 2.2 – Choosing a Monitoring Time in the E. coli Bacteria Water Quality Community Scientist Manual.

2.3 EQUIPMENT AND SUPPLY LIST

Optical Brightener Monitoring Equipment

Optical Brightener monitoring involves using absorbent materials to detect optical brightener compounds in water samples. The Texas Stream Team program employs organic, untreated cotton tampons to achieve this. Two distinct methods are used to collect water samples and allow the tampons to absorb optical brighteners. These methods are detailed in the following sections.

Optical Brightener Monitoring Supplies

The supplies listed below are necessary for starting an optical brightener monitoring program.

- Organic, untreated cotton tampons (e.g., Natracare brand)
- Gloves
- 365 nm UV LED black light flashlight (AAA batteries, if needed)
- DI water bottle
- Fine tip sharpie
- Tweezers (optional)
- Waste bottle
- Whirl-Pak® black photo-sensitive bags

Additional supplies, depending on the method used to conduct optical brightener monitoring:

- Modified Bottle Method
- Clear plastic bottle modified with slits (Figure 1)
- Scissors or a scalpel
- Monofilament fishing line or strong rope
- Weighted kettlebell or similar object*
- Whirl-Pak® Bag Method
- Sample bucket or extension Pole*

*Not required but useful

Vendor and pricing information for ordering supplies and equipment can be found on the Monitoring Equipment Directory page. All items must be inspected upon receipt from the manufacturer and prior to each sampling event to ensure items have not exceeded expiration dates. Items should be checked for completeness, breakage, optical brightener contamination, and to ensure they are operating properly.

2.4 SAMPLING SEQUENCE

A typical monitoring sequence for a certified community scientist includes the following steps:

Note: Community scientists must perform optical brightener procedures before bacteria procedures to accommodate the required hold times for bacteria samples.

1. Print the Monitoring Form or enter your data directly into the Dataviewer using your groups account credentials (if applicable).
2. Before sampling, review the field audit checklist on the second page of the Monitoring Form. Use this list as a guideline throughout the sampling event to ensure all protocols are adhered to.
3. Check all equipment for contamination with a UV LED black light flashlight before

the monitoring event. Optical brighteners rapidly photo decay when exposed to UV light. Protect the sample from UV light upon retrieval and transport before analysis.

4. At the monitoring site, document field observations on the Monitoring Form about the condition of the water, weather, and other pertinent facts. The following can be included in the Comments section:
    - Number of recreational swimmers, fishers, boaters, etc.
    - Any unusual water conditions, such as color or smell
    - The presence or evidence of wildlife
    - The presence of litter or trash
5. Deploy a modified bottle or collect a water sample in a Whirl-Pak® bag, depending on the method used, before bacteria monitoring.
6. Capture a photo of the site before departure to document the placement of your modified bottle, if using the modified bottle method.
7. Let the tampon soak in a Whirl-Pak® bag or modified bottle for 24-72 hours. 24 hours if using the Whirl-Pak® bag and 24-72 hours if using the modified bottle.
8. If using the bottle method, retrieve the sample from your site after the designated time period, ensuring that the time between deployment and retrieval is consistent with the previous optical brightener monitoring event.
9. Once you have finished optical brightener monitoring procedures, begin collecting your bacteria sample(s). For instructions on collecting bacteriological samples, refer to Section 2.4 – Sampling Sequence in the E. *coli* Bacteria Water Quality Community Scientist Manual.
10. For sample analysis, remove the tampon from its container and place it on a clean surface to begin observing for distinctive blue fluorescence. Keep in mind that the tampon can be wet or dry during analysis, as long as any excess water and sediment have been squeezed out beforehand. Record the presence/absence of fluorescence on the Optical Brightener Monitoring Form.
11. Clean and store equipment according to the procedures discussed in section 3.0 - Follow-Up and Clean-Up.
12. Legibly record all applicable data on the Monitoring Form. Remember to double-check for accuracy and readability.
13. Review and check-off the field quality control checklist on the second page of the Monitoring Form.
14. Make sure the Optical Brightener Monitoring Form is completed, then sign and date.
15. Submit the electronic monitoring form or send the hard copy form to your local Texas Stream Team Data Coordinator. Alternatively, you can email a PDF or high-quality image of the form to TxStreamTeam@txstate.edu

2.5 MONITORING PROCEDURES

Texas Stream Team community scientists perform optical brightener monitoring on lakes, rivers, streams, bays, and estuaries. The primary reason for optical brightener monitoring is to investigate bacterial sources.

Using absorbent materials like tampons for preliminary water quality testing is a practical approach, especially for individuals without access to sophisticated laboratory equipment (Discover Magazine 2015). This method involves detecting fluorescence using a UV LED black light flashlight on the absorbent material, similar to chromatography or spectrophotometry, but it is more accessible and cost-effective for community science applications. In chromatography, substances are separated based on their interaction with a medium, while spectrophotometry measures the absorbance or reflectance of light at specific wavelengths to identify chemical components.

While these methods provide high precision in laboratory settings, they often require specialized instruments and expertise. The tampon-based approach, however, simplifies this process.

Studies conducted by Texas Stream Team staff have validated this method, leading to its approval by the Texas Commission on Environmental Quality for use in the Texas Stream Team community science monitoring. This validation has proven the method to be effective for both training and monitoring purposes. There has been a growing emphasis on accessible and community-driven environmental monitoring approaches, exemplified by the Texas Stream Team's optical brightener monitoring methods. This approach utilizes the known properties of optical brighteners and the absorbent nature of products like tampons, making it a useful tool for preliminary screening.

Previously, Dr. Kelly Albus, a fellow with The Meadows Center for Water and the Environment, pioneered the development of the "Tampling" method. Dr. Albus, with the Texas A&M AgriLife and the Texas Water Resources Institute, played a key role in designing this innovative technique for community scientists as well as University and public-school classrooms. An optical brightener data hub was created and launched on the web-based citizen science platform SciStarter.org for data beyond the state level (Albus 2022). Working directly with Dr. Albus, Texas Stream Team built on those efforts to fully develop a comprehensive training program for community scientists. This collaboration helped to integrate the Tampling method into the Texas Stream Team program, providing volunteers with the skills and tools necessary to collect and analyze optical brightener data effectively. Through joint efforts, the scope of the program was expanded, making it accessible to community scientists statewide and establishing a broader data hub that supports both local and regional water quality monitoring.

The accuracy of optical brightener data collected by community scientists depends on proper storage and handling of the materials, including preventing UV light contamination and ensuring accurate analysis of the blue fluorescence of optical brighteners. It is crucial for community scientists to adhere to the procedures outlined in the manual, including the appropriate duration and exposure time for tampons, to ensure reliable test results.

Field Observations

Conducting field observations adds important background information to your optical brightener water quality monitoring results. This background information allows watershed managers and users of the data to better understand and predict trends in bacteria water quality data. For this reason, it is important to adhere to the procedures described in the Core Water Quality Community Scientist Manual to collect and report field observation data on the Monitoring Form.

If you have any questions regarding field observation procedures, please contact a Texas Stream Team Trainer and/or Data Coordinator, or reference Section 2.6 – Monitoring Procedures of the Core Water Quality Community Scientist Manual.

Comments Measurement

Record any explanatory information about the bacteria and/or optical brightener tests in the Comments section. For example, if you needed to transfer the sample you can document it here. This is also the best place to describe:

- The biological conditions such as a plankton bloom, fish kill, presence or abundance of fish, aquatic insects, aquatic plants, and wildlife.
- The lake and stream use(s) like swimming, wading, boating, fishing, irrigation pumps, or navigation.
- In stream or drainage basin activities and events that are impacting water quality – bridge construction, soil washouts, herbicide or pesticide use, livestock watering, dredging, or changes in stream bottom.
- Type of floating debris found at the site.

- Record any potential source points of pollution, such as outfalls pipes, or agricultural runoff channels. Community scientists can use resources such as the Texas Commission on Environmental Quality's Wastewater Outfalls Viewer or Resource Watch to locate nearby wastewater treatment plants.
- Record potential sources of false positives, such as car washes, golf courses or other non- wastewater sources of optical brightener inputs.
- Record potential reasons for false negatives, such as sampling in stagnant waters where optical brighteners may not be adequately distributed, or in public water features where the water is often treated.

Describe your analysis and note the types of fluorescence observed in the sample. Even if no optical brightener fluorescence is detected and the sample is marked as "Absent," you should still record any other types of fluorescence, such as red or purple.

Sample Collection

There are two primary methods for conducting optical brightener monitoring:

1. **Modified Bottle Method** involves submerging a tampon inside a modified, clear plastic bottle and leaving it to saturate at the monitoring site. This method should be used whenever possible and is ideal for streams with consistent flow. Ensure you can access the centroid of flow and return to the site 24-72 hours later when using this method.
2. **Whirl-Pak® Bag Method** involves collecting a water sample in a black photosensitive Whirl-Pak® bag (see Section 2.3 -Equipment and Supply List). The method must be used for tidally influenced streams, where wave activity can compromise sample integrity, and/or when accessing the centroid of flow and returning to the site 24-72 hours later is not feasible.

Both methods require proper sample handling and analysis using a 365 nm UV LED black light flashlight. When selecting a method, consider the safety and accessibility of your site, and follow the appropriate procedures for the chosen approach.

Sequential steps were developed for the optical brightener method, tailored for both freshwater and tidally influenced monitoring sites, with an emphasis on minimizing contamination potential. The step-by-step protocols are outlined below.

> **Note:** Check all equipment for optical brightener contamination with a 365 nm UV LED black light flashlight prior to the monitoring event. Optical brighteners rapidly photo decay when exposed to UV light. Protect the sample from UV light upon retrieval and transport prior to analysis.

METHOD 1: MODIFIED BOTTLE METHOD

Record Field Observations and Comments on the Monitoring Form.

Sample Deployment

Step 1: Before deployment, label a black photosensitive Whirl-Pak® bag with the site ID, date, and time of deployment and retrieval (repeat for each site).

Step 2: Rinse the bottle twice with DI water and check for optical brightener contamination using a UV LED black light flashlight. Tie monofilament line or rope around the bottle neck, ensuring it's long enough for full submersion. Using gloves, rinse the scalpel with DI water and cut up to 5 evenly spaced 4–6-inch slits along the bottle to allow water flow while protecting the tampon (Figure 1).

Step 3: At the sampling site, rinse the bottle 2X with sample water, including the gloves and monofilament line in the process, discarding waste downstream each time.

Step 4: Using gloves, unscrew the cap, carefully remove the tampon from its packaging without touching it, and hold it by the string. Place it halfway inside the bottle and secure the string by tightening the cap. Add pebbles if needed for weight (through the slits). Secure the bottle a tree branch, rock, or weighted kettlebell via the monofilament line/rope.

Step 5: Deploy the bottle at the site, ensuring it is fully submerged in the centroid of flow and shaded. Take a photo to document the location for retrieval and record the date and time of deployment on the Monitoring Form. If centroid deployment is not possible, see Method 2.

Sample Retrieval

Step 1: Allow 24-72 hours between deployment and retrieval of modified bottle. Record the date and time of bottle retrieval on the Monitoring Form.

Step 2: Using gloves, retrieve the bottle and remove the tampon. Quickly rinse with sample water to remove excess sediment. Place the tampon in the labeled Whirl-Pak® bag to prevent UV exposure until sample analysis.

METHOD 2: WHIRL-PAK® BAG METHOD (FOR COASTAL & NON-ACCESSIBLE SITES)

Record Field Observations and Comments on the Monitoring Form.

Sample Collection

Step 1: Before collecting the water sample, label each Whirl-Pak® bag with the site ID, date, and time collected.

Step 2: Using gloves, collect a water sample. There are three ways to do this:

- Bucket Grab Method: rinse the bucket 2X with sample water and discard the water downstream. Grab the sample from the centroid of flow. Pour water from the bucket into the Whirl-Pak® bag - never dip the bag into the bucket.
- Extension Pole Method: rinse the pole twice with ambient water downstream from the monitoring site. Attach the sealed Whirl-Pak® bag to the receiving carriage on the sampling pole using the yellow tabs. Immediately prior to obtaining the sample, remove the seal without touching the bag's interior. Open the bag with the tabs and invert it into the water, keeping the mouth downward to avoid introducing surface scum. Facing the bag upstream, tip it slightly upward to allow air to exit and the bag to fill. Avoid sediment contact.
- Whirl-Pak® Bag Directly: if the site is accessible, submerge the bag 0.3 m (1 ft), or roughly one-third of the depth, in very shallow streams. With the open end facing upstream, push the opened mouth of the bag upstream until full. Avoid sediment contact.

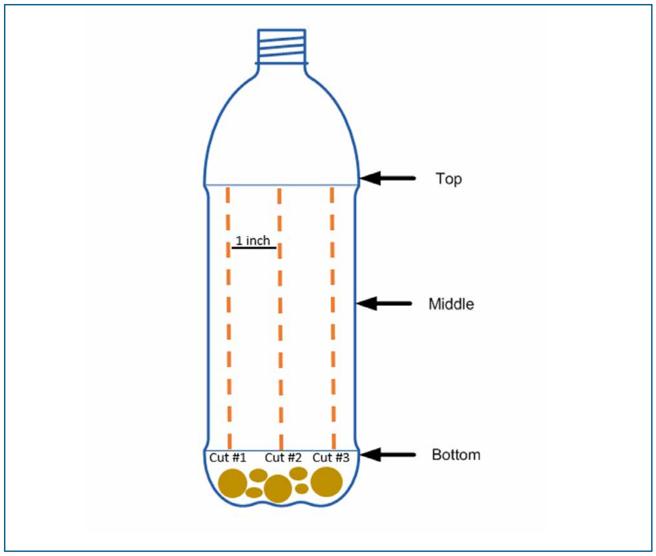


Figure 1. Modified Bottle

Step 3: After collecting the water sample, using gloves, remove the tampon from its packaging and place it in the Whirl-Pak® bag (Figure 2). Close the bag and invert 25 times.

Step 4: Allow the tampon to soak in the Whirl-Pak® bag, positioned upright, in a dark environment for 24 hours.

Sample Analysis (Both Methods)

Step 1: After the designated exposure period, in a dark setting with minimal light, use gloves to squeeze out as much water as possible. Place the tampon on a clean surface to prevent cross-contamination.

Step 2: Gently unravel the tampon and expose as much surface area as possible for analysis.

Step 3: While exposing the tampon with the 365 nm UV LED black light flashlight, observe the tampon for distinctive blue fluorescence (Figure 3). Notes for Presence/Absence:

- If distinctive blue spots are present within the cotton fibers of the tampon (gently pull apart fibers to confirm), even if small amount, mark as "Positive".
- Blue flecks on the surface of the tampon (Figure 4) are likely from contamination after retrieval. This does NOT count as a positive result. (When in doubt, use uncontaminated tweezers to see if blue flecks are easily removed from surface).
- Other colors may be visible with a UV LED black light flashlight but do not reflect optical brighteners (red = photosynthetic material, purple = decaying organic material, etc). A positive result refers ONLY to the blue fluorescence.

Step 4: Document the presence and types of fluorescence, along with any questions or comments, on the Monitoring Form. If unsure about your markings or information, include your reasoning in the comments section and be consistent. Optionally, take photos of the exposed tampon and submit them with the Monitoring Form

Step 5: Dispose of the tampon in household waste. If using the modified bottle method, rinse the bottle twice with DI water for reuse. Reuse the bottle and monofilament line for each sampling event. Replace the bottle every 6 months.

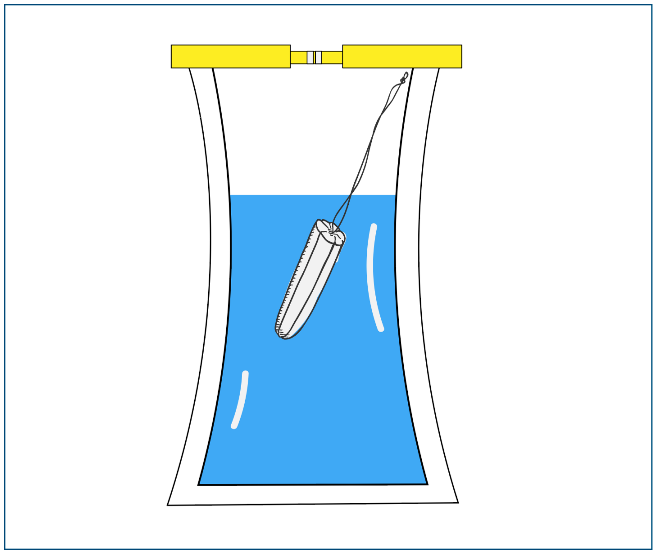


Figure 2. Whirl-Pak® Bag

DATA REPORTING

Only blue fluorescence within the cotton fibers of the tampon should be counted as optical brighteners. Blue flecks on the surface of the tampon are likely from contamination after retrieval. If distinctive blue fluorescence is observed, record "present" under the Sample Result section of the Texas Stream Team Optical Brightener Environmental Monitoring Form. If no distinctive blue fluorescence is observed on the sample, record "Absent" under Sample Result. You may still document other types of fluorescence (red, purple, or brown) in the comments section of the Texas Stream Team Optical Brightener Environmental Monitoring Form.

If it is unclear whether the fluorescence is from optical brighteners, document your observations and concerns in the Comments section of the form. You may record a positive result and note your concerns in the comments, or you can contact Texas Stream Team for further assistance. Community scientists must follow all instructions outlined in the procedures to record the date and time of sample retrieval, analysis, and deployment.

3.0 FOLLOW-UP AND CLEAN-UP

Clean-Up

WASTE DISPOSAL

Step 1: Cotton tampons can be disposed of in a household compost (if available) or in the landfill after sample analysis.

Step 2: Dispose of used gloves and Whirl-Pak® bags by placing them in normal household trash. We encourage the reuse of your bottle and monofilament fishing line if conducting the Modified Bottle Method. Modified bottles should be replaced once every 6 months.

Step 3: After all supplies have been properly disposed, disinfectant should be used to clean tabletops or other work areas, and community scientists should wash hands thoroughly.

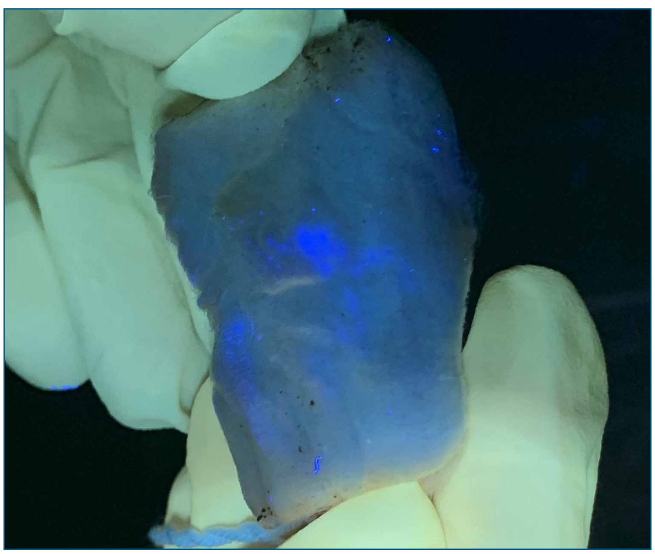


Figure 3. Tampon With Optical Brightener Fluorescence

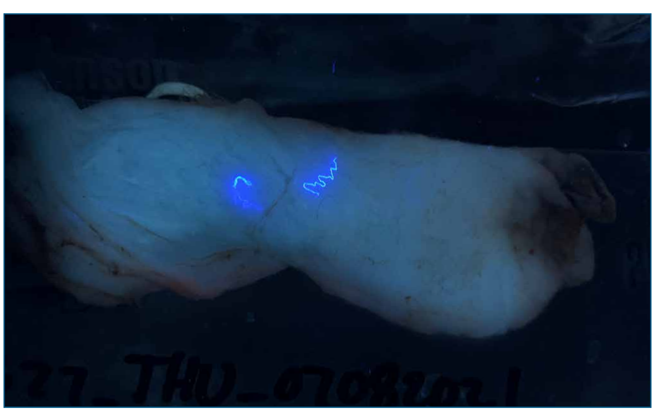


Figure 4. Contaminated tampon with blue flecks on surface

Follow-Up

SUBMITTING A TRAINING ENROLLMENT FORM

The Training Enrollment Form must be submitted to participate in the Texas Stream Team program. Note that the Texas Stream Team cannot certify individuals who do not submit the Training Enrollment Form.

The trainer will send training documentation to Texas Stream Team to be processed by staff. If the module training was used, all documentation will be submitted to Texas Stream Team staff upon module completion. Certificates will be emailed to community scientists the month following the training.

Once trainees have successfully completed all phases of the training and received their certification via email, they can begin monitoring as certified Texas Stream Team Optical Brightener community scientists.

To get started, certified community scientists should:

- Obtain the necessary monitoring supplies.
- Select an approved monitoring site with bacteria data.
- Create a monitoring schedule to ensure consistent data collection.

Community scientists are encouraged to review their training materials and use their Phase III Monitoring Form as a reference to ensure protocols are followed correctly during their monitoring activities.

MONITORING EQUIPMENT

To obtain equipment and supplies for optical brightener monitoring, go to the Texas Stream Team Monitoring Equipment Directory. **Please note**, Texas Stream Team is a federally recognized statewide community science monitoring program with an approved Quality Assurance Project Plan, therefore all monitoring must be conducted using approved methods and with the equipment listed, unless prior approval has been granted by Texas Stream Team staff. The Texas Stream Team is entirely grant funded, and, therefore, unable to provide extensive funding assistance to all community scientists and partners across the state. Texas Stream Team highly encourages community scientists and partners to seek alternate funding sources. Please refer to the Funding Sources Document for assistance.

MONITORING SITE

To select a site, community scientists can begin by referencing the Datamap. The Datamap includes all historic and current water quality monitoring sites. Community scientists can choose to reactivate an inactive site, or they can create a new site using the New Monitoring Site Request Form. Optical brightener monitoring is most effective when occurring at the site of your bacteria monitoring. For more information on site selection, go to Section 2.1- Choosing A Monitoring Location.

MONITORING SCHEDULE

Community scientists should strategically monitor optical brighteners in conjunction with bacteria monitoring to effectively trace potential sources of bacterial contamination (to ensure data quality, the Texas Stream Team requests community scientists conduct bacteria water quality monitoring at least once a month, at the same time each month). Optical brightener monitoring can be conducted on a regular bacteria monitoring schedule, but it may also be triggered as needed following positive bacteria results. As previously mentioned, while six months of bacteria monitoring qualifies participants for optical brightener training, Texas Stream Team strongly recommends monitoring bacteria for at least one year to establish a reliable baseline and account for seasonal variations. For more information on scheduling your sampling time, see Section 2.2 - Choosing a Monitoring Time.

3.1 DATA MANAGEMENT

Community scientists are required to use the Optical Brightener Monitoring Form to record measurements at their optical brightener monitoring site(s). Optical brightener results should be recorded on a separate Optical Brightener Monitoring Form, distinct from the Bacteria Monitoring Form. Test results are always recorded on the form as they are completed in the field. All applicable sections of the Monitoring

Form should be completed. For example, if information is not collected for a parameter, the space on the form remains blank.

Recording Data

To ensure compliance with the approved Quality Assurance Project Plan, community scientists should observe the following rules when completing the Monitoring Form:

1. Write legibly in ink or pencil if using the hard copy version of the Monitoring Form.
2. Correct errors with a single line strike-through followed by initials of the individual making the correction and date the correction was made.
3. Complete the Field Quality Control Checklist on the form to confirm protocols were followed.
4. Sign and date the form once complete for validation.

Before monitoring data can be entered into the Dataviewer, it must undergo a quality control check to ensure the data are of the highest quality and meet the following conditions:

1. Data is collected by a certified community scientist that has met all training requirements as described in this manual.
2. Data is collected using the protocols, equipment, and the Field Quality Control Checklist provided on the form described in this manual.
3. All data entries are legible if using the hard copy version of the Monitoring Form.
4. The Monitoring Form is complete and includes a signature by the community scientist that conducted the monitoring event.
5. All quality assurance and quality control protocols described in this manual have been implemented and met to the best of the community scientist's ability. See Section 3.2 - Data Entry Checklist.

Entering Data into Waterways Dataviewer

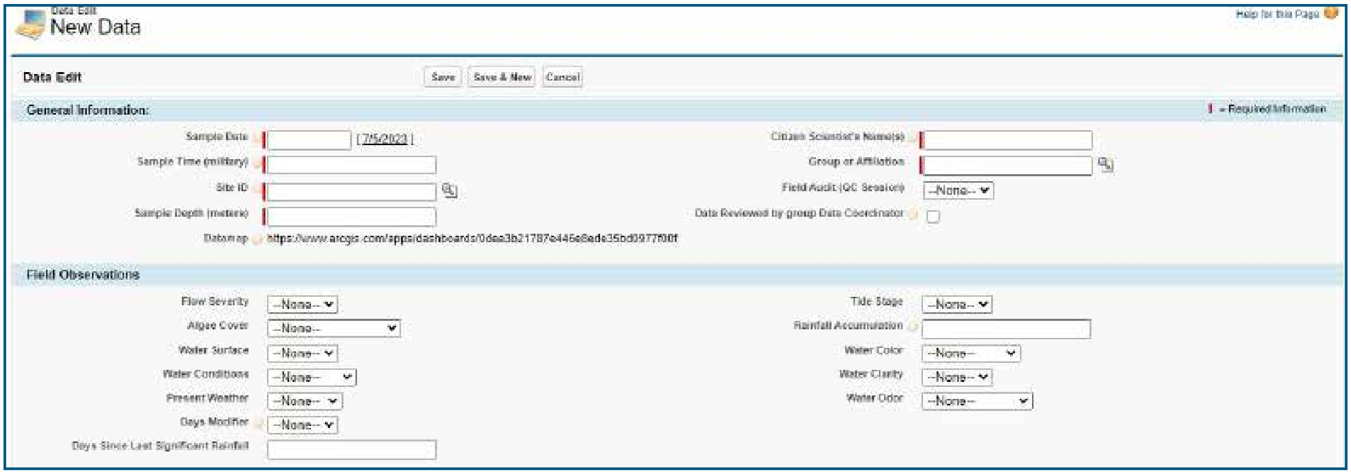
Once the Monitoring Form is complete and meets the quality control checks, the next step is to enter the data into the Dataviewer. There are two ways to enter the data:

1. Monitoring Forms get forwarded to the group Data Coordinator. The group Data Coordinator conducts a quality control check and enters the data into the Dataviewer. If your group does not have a Data Coordinator, skip to the second option.
2. Monitoring Forms are submitted to Texas Stream Team by emailing scanned or high-quality photocopies to TxStreamTeam@txstate.edu for entry by Texas Stream Team staff. Texas Stream Team staff conduct a quality control check and enters the data into the Dataviewer.

Before group Data Coordinators can access the Dataviewer to enter data, they must first request an account and receive assigned login credentials. A request for an account can be made by filling out the Dataviewer Account Request Form.

Once the data from the Monitoring Forms are entered into the Dataviewer, the group Data Coordinator, Texas Stream Team staff, and/or designee verifies the data entry, and the data becomes publicly available.

If the data do not meet the checks described above, the data are flagged upon entry to the Dataviewer for further review by Texas Stream Team staff or designee. The purpose of flagged data is to note inconsistencies or identify data that may have excessive variability. The Dataviewer is designed to recognize and flag data that do not meet requirements in the checklist. Therefore, it is critical for community scientists to comply with the protocols described in this manual to ensure data measurements are of the highest quality and can be used to promote and protect a healthy and safe environment for people and the aquatic life.



3.2 DATA ENTRY CHECKLIST

The data entry checklist is used by the Texas Stream Team community scientist and Data Coordinators to verify that data are collected using approved protocols prior to entering data into the Waterways Dataviewer.

General Procedures

- Sampling should be conducted at approximately the same time/day as previous sampling events at this site, preferably before noon or after 4pm (16:00).
- All relevant measurements must be recorded in appropriate fields on the monitoring form.
- Community scientists should record environmental conditions during sampling, including weather, time of day, tidal influences, and flow rates in the Comments section of their Monitoring Form. Additionally, they should note any unusual events (e.g., heavy rainfall or runoff) that may impact sample integrity or concentration levels.
- Data should be legible if handwritten on a hardcopy form and submitted either via email to your Data Coordinator or Texas Stream Team. When submitting by email, ensure the document is in a PDF or image format. Incomplete forms or missing required information cannot be accepted or published into the Waterways Dataviewer.
- Gloves must be worn throughout the sampling process.
- Community scientists should deploy samples in a location that is shaded, out of public view, and in the centroid of streamflow.
- Be sure to indicate on the Optical Brightener Monitoring Form which method was used to collect the optical brightener sample. Tidally influenced environments should use the Whirl-Pak® bag method instead of the bottle-method, due to the conditions in tidal sites.
- Each form should have a completed Field Quality Control checklist on the back. This helps maintain consistency and ensures that all monitoring criteria are met.
- Community scientists should ensure all samples and bags are clearly labeled with the date, time, and site ID.
- Consistency in format and units should be maintained for all submissions to ensure comparability over time. Record any anomalies or observations at the monitoring site, particularly if there is a positive result. Note any potential nearby sources of human or industrial pollution to aid in further investigations (and false positives, i.e. car washes, golf courses or other sources of optical brightener inputs that don't indicate wastewater).
- Community scientists should be consistent, if possible, in the method used to collect water samples for optical brightener monitoring.
- Community scientists should monitor in conjunction with bacteria monitoring for

comprehensive results.

- Community scientists should check all of their equipment with a UV LED black light flashlight prior to use to ensure it is not contaminated with optical brighteners.

Field Observations

Suggested rainfall resources: Community Rain, Hail & Snow Network, Weather.com and Lower Colorado River Authority's Hydromet page.

- Days since last significant precipitation: Report whole numbers. If it is raining when the sample is collected, or has rained within the past 24 hours, report a value of <1. Otherwise, report the actual number, if known, or a 'greater than' value.
- Rainfall accumulation: Report inches of rain within the last 3 days.
- Algae: Recorded algae observed on the water surface and below the water surface.
- Water Color: Observed water color in a plastic cup or bucket with a white background.
- Water Clarity: Observed the relative cloudiness of the water from bridge or banks.
- Water Odor: Tested by wafting from plastic cup or bucket.
- Present Weather: Marked cloudy if there is at least one cloud in the sky.

Optical Brightener Measurements

- Follow Texas Stream Team protocols for exposure time. Samples should remain exposed to the water for approximately 24 hours (Whirl-Pak® bag method) or 24-72 hours (bottle method) prior to analysis. This ensures consistency and reduces variability in results.
- Always collect samples from the same location and depth to ensure reliable comparisons over time.
- Capture photos of the tampon deployment location and the tampons when analyzed. This visual evidence helps validate data and provides context for your monitoring efforts.
- Document the time the sample was deployed and collected, and how long the tampon soaked prior to analysis. This information is crucial to evaluating your optical brightener sample, as exposure to light or excessive soaking time can lead to UV light contamination or sample degradation.
- Only report optical brightener presence if distinctive blue fluorescence is visible on the tampon's cotton fibers. If no fluorescence is observed, do not record the sample as "present." Be sure to follow all guidelines on sample analysis as stated in the procedures section of this manual.

3.3 EQUIPMENT MAINTENACE AND STORAGE

The importance of proper maintenance and storage of all monitoring equipment cannot be overstated. The accuracy of the measurements depends on proper maintenance and storage. The time, effort, and expense that goes into conducting Texas Stream Team water quality monitoring is highly valued, therefore, do not dismiss this very important step that will add value to the quality of data produced and increase the longevity of the equipment.

WASTE BOTTLES

Dispose of all waste chemicals by slowly flushing them down the drain of a sanitary sewer with plenty of water. Allow the tap to run while flushing the waste. Do not dispose of chemicals into a septic waste system, waterbody, or onto the ground. Once emptied, rinse waste bottles twice with tap or deionized water. Allow them to dry before storing them in a secure area.

SAMPLE COLLECTION EQUIPMENT

Ensure all containers (Whirl-Pak® bags, bottles) are intact and free of optical brightener contamination before each sampling event. Store all equipment in a clean, dry area away from sunlight to prevent degradation.

3.4 REPORTING UNUSUAL ACTIVITY AND UNLAWFUL EVENTS

Illicit discharge

An illicit discharge can have different meanings across different regulatory agencies. For the purposes of Texas Stream Team monitoring activities, an illicit discharge is defined as any event wherein a storm drain has a measurable flow during dry weather conditions (Center for Watershed Protection 2004). Illicit discharges are usually produced from a singular source or operation and can be further broken down into categories based on their frequency, flow-type, and mode of entry (Center for Watershed Protection 2004). Illicit discharges can be either direct or indirect. An illicit discharge has a direct mode of entry when the discharge is directly connected to a storm drain through a sewage pipe, shop drain, or other kind of pipe (Center for Watershed Protection 2004). An indirect discharge occurs when flows generated outside of the storm drain enter the system, either through inlets, or by infiltrating the joints of a pipe (Center for Watershed Protection 2004). Illicit discharges include any instances wherein chemicals or waste are discarded into a sanitary sewer drain. Examples of illicit discharges include improperly discarded oil and grease, runoff from excessive fertilizers and pesticides, and illegal dumping of hazardous chemicals (Center for Watershed Protection 2004). Other examples include septic tank seepage, laundry wastewater, or illegal sanitary sewer connections (Center for Watershed Protection 2004). For information about illicit discharge, and additional examples of illicit discharges that might be expected corresponding to land use, visit the Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments.

HOW TO REPORT AN ILLICIT DISCHARGE

To report an illicit discharge, please contact your city office. Many cities allow community members to anonymously report illicit discharges online. Check your city's Department of Water or Department of Public Works for an online form, or, alternatively, you can contact your city office at their main office phone line. For assistance with reporting illicit discharges, you can also contact Texas Stream Team at TxStreamTeam@txstate.edu or by calling (512) 245-1346.

Wildlife Kills and Pollution Events

The Texas Parks and Wildlife Department's Kills and Spills Team (KAST) is comprised of a group of biologists who investigate fish and wildlife kills. KAST biologists evaluate both unnatural and natural events to assess the impacts to fish and wildlife resources and to determine the causes of the events. KAST biologists work to:

1. Determine the causes of wildlife kills and/or pollution events.
2. Attempt to minimize environmental damage resulting from wildlife kills and/or pollution events.
3. Obtain compensation for environmental damage and restore the affected environment resulting in Kill or Spill. (Kills and Spills Team n.d.)

REPORTING A KILL OR SPILL

Prompt notification is essential to a successful investigation, and the sooner that KAST biologists are notified of a potential wildlife kill or pollution event, the better the chances are that useful evidence can be collected, and conclusive actions can be taken. When reporting a Kill or Spill, make a note of the:

1. Location, date, and time
2. Water color, clarity, and odor
3. Number, size, and species of affected organisms
4. Recent weather
5. Condition and behavior of animals or organisms
6. Condition of plants/other organisms (Kills and Spills Team n.d.)

To contact KAST, call (512) 389-4848 or contact your regional KAST biologist. You can find your regional KAST biologist at the Kills and Spills Team Contacts page.

Texas Commission on Environmental Quality Compliance and Enforcement

The Texas Commission on Environmental Quality Office of Compliance and Enforcement is responsible for enforcing compliance with state environmental law, responding to emergencies and natural disasters, overseeing dam safety, and monitoring air quality (Office of Compliance and Enforcement 2023). The Texas Commission on Environmental Quality divides the state of Texas into four areas, with further regional divisions. Within their defined administrative region, each regional office is responsible for:

- Investigating compliance at permitted air, water and waste facilities
- Investigating complaints at facilities and operations- permitted or not- from community members, businesses, and other concerned parties
- Developing enforcement actions and referrals for violations
- Environmental education and technical assistance for communities
- Monitoring the quality of ambient air, surface water, and public drinking water (Office of Compliance and Enforcement 2023)

Reporting an Environmental Problem

Concerned community members can file an Environmental Complaint with the Texas Commission on Environmental Quality. In general, the Texas Commission on Environmental Quality can assist with any complaint, provided that you have:

- Seen water that may be polluted.
- Seen or smelled something unpleasant in the air.
- Seen land that may be contaminated.
- Are having problems with your drinking water.
- Have information or evidence about an environmental problem.
- Are having problems with an individual or company licensed or registered by the Texas Commission on Environmental Quality.
- Need assistance or information regarding environmental laws, possible pollution sources, or other questions relating to Texas Commission on Environmental Quality Compliance and Enforcement. (Office of Compliance and Enforcement 2023)

For more information on what Texas Commission on Environmental Quality can and cannot help you with, please visit the Texas Commission on Environmental Quality website.

To report an Environmental Problem, contact the Texas Commission on Environmental Quality Office of Compliance and Enforcement at their 24-hour line 888-777-3186 or fill out their online form.

If you would prefer to contact your regional Texas Commission on Environmental Quality Field Office, you can find applicable contact information on the Texas Commission on Environmental Quality website.

4.0 REFERENCES, ONLINE RESOURCES, AND GLOSSARY

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Wilke, B. I., & Fisher, C. (2003). "Stilbene-Based Optical Brighteners in Environmental Waters: A Review." Environmental Science & Technology.

Online Resources

Equipment Checkout Form

Dataviewer Account Request Form

Funding Sources Document

Group Monitoring Plan

Measures of Success Survey

Monitoring Equipment Directory

New Monitoring Site Request Form

Private Property Access Form

Site Selection Guide

Supply Request Form

Texas Stream Team Calendar

Texas Stream Team Dataviewer and Datamap

Texas Stream Team Online Store

Texas Stream Team Partners List

Texas Stream Team Quality Assurance Project Plan (QAPP)

Texas Stream Team Trainers List

Texas Stream Team Trainings and Programs

YouTube Quality Control and Parameter Videos

For additional forms and resources please visit the Texas Stream Team Forms and Resources page.

Glossary

Algae – Plants that lack true roots, stems, and leaves. For the physical assessment described herein, algae consist of nonvascular plants that attach to rocks and debris or are free floating in the water. Such plants may be green, blue-green, or olive in color, slimy to the touch, and usually have a coarse filamentous structure.

Channel –That portion of the landscape which contains the bank and the stream bottom. It is distinct from the surrounding area due to breaks in the general slope of the land, lack of terrestrial vegetation, and changes in the composition of substrate materials.

Chromatography – A method used in laboratories to separate mixtures, including detecting optical brighteners in water. It is a complex and expensive technique typically used in scientific labs, in contrast to the more accessible tampon method used in community science.

Contact Recreation – Recreational activities involving a significant risk of ingestion of contaminant water, including wading by children, swimming, water skiing, diving, and surfing.

Effluent – Wastewater (treated or untreated) that flows out of a treatment plant or industrial outfall (point source), prior to entering a waterbody.

Enteroccocus – A bacteria that lives in the gut of humans and warm-blooded animals, however, associated with human fecal matter. Enterococci are a relatively reliable indicator of potential human fecal matter contamination in a waterbody (mainly salt water).

Escherichia coli (E. *coli*) – A type of diverse coliform bacteria that lives in the guts of people and animals. Most of the time, E. coli bacteria are harmless, but some can be pathogenic, meaning that they cause disease. Used as an indicator of fecal contamination typically in freshwater.

Estuary – Regions of interaction between rivers and near shore ocean waters, where tidal action and river flow create a mixing of fresh and salt water.

Fluorescence – The emission of light by a substance that has absorbed light or other electromagnetic radiation. In the case of optical brighteners, they emit blue fluorescence when exposed to UV light, allowing their detection in water bodies.

Illicit Discharges –Unauthorized discharges of pollutants, including optical brighteners, into water systems. This is often the result of improper waste disposal or industrial activities that bypass the regular treatment processes.

Nonpoint Source – Pollution sources which are diffuse and do not have a single 38 point of origin or are not introduced into a receiving stream from a specific outfall. The pollutants are generally carried off the land by stormwater runoff. The commonly used categories for nonpoint sources are: agriculture, forestry, urban, mining, construction, dams and channels, land disposal and saltwater intrusion.

Nutrient – Any substance used by living things to promote growth. The term is generally applied to nitrogen and phosphorus in water and wastewater but is also applied to other essential and trace elements.

Optical Brighteners – Chemical compounds used to enhance the brightness and whiteness of materials, often found in household products like laundry detergents and personal care items. They fluoresce under UV light, which makes them detectable in environmental monitoring.

Outfall – A designated point of effluent discharge.

Point Source – A specific location from which pollutants are discharged. It can also be defined as a single identifiable source of pollution (e.g., pipe or ship).

Pollution – The man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water (EPA CWA definition).

Reservoir – Any natural or artificial holding area used to store, regulate, or control water.

Runoff – The part of precipitation or irrigation water that runs-off land into streams and other surface water.

Sediment – Particles and/or clumps of particle of sand, clay, silt, and plant or animal matter carried in water and are deposited in reservoirs and slow-moving areas of streams and rivers.

Septic System – A small-scale wastewater treatment system commonly used in rural areas that treat and dispose of household wastewater. When septic systems fail, untreated wastewater can seep into nearby water bodies, introducing contaminants like optical brighteners.

Spectrophotometry – A technique that measures the amount of light that a sample absorbs. In environmental monitoring, it can be used to quantify the concentration of certain chemicals, including optical brighteners, though it requires specialized equipment.

UV Light (Ultraviolet Light) – A type of electromagnetic radiation that is invisible to the human eye but can be detected using special instruments. UV light is used in optical brightener detection because it causes these substances to fluoresce or glow, making it easier to identify their presence in water samples.

Watershed – The area of land from which precipitation drains to a single point. Watersheds are sometimes referred to as drainage basins or drainage areas.

Wastewater Treatment Plant (WWTP) – A facility that processes and cleans wastewater from homes, industries, and commercial establishments before releasing it back into the environment. Optical brighteners are often not fully removed during treatment, which can lead to their accumulation in rivers, lakes, and other water bodies.