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July 2005

Cluster Course 1. Sampling, Disinfection Monitoring, and Compliance Investigations

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Cluster Training Course

TEXAS SMALL PUBLIC WATER SYSTEM OPERATOR TRAINING PROGRAM

TCEQ-1250
July 2005

Sampling and Process Control

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Cluster Training Module

TEXAS SMALL PUBLIC WATER SYSTEM OPERATOR TRAINING PROGRAM (TSPWSOTP)

TEXAS SMALL PUBLIC WATER SYSTEM OPERATOR TRAINING PROGRAM (TSPWSOTP)
Training Module TCEQ-1250
July 2005

Sampling and Process Control

Purpose:	Operators will demonstrate the knowledge and practice the skills required to properly collect and handle different types of water samples. Operators will develop and implement process control procedures.
Target Audience:	Operators of groundwater or purchased water systems serving 3,300 people or less.
Time Required:	Approximately three hours (3.0 hours) for a class of eight to ten.
Documents Required:	The monitoring plan for the water system.
Sample Containers Needed:	Sample bottles (plastic or glass)

Preface

This training module provides operators with the information and skills needed to properly collect, analyze, and process a representative sample from their water system. Good sampling techniques will be briefly discussed. The types of samples that operators collect and analyze will be identified. There will be a discussion on the samples that they collect and send to laboratories for analysis. Operators will learn about the chemical sampling done by the TCEQ sampling contractor. A systematic approach to process control is presented. Operators will use this approach to establish critical control points, critical limits, and corrective actions.

TEXAS SMALL PUBLIC WATER SYSTEM
OPERATOR TRAINING PROGRAM
Training Module TCEQ-1250
July 2005

Sampling and Process Control

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References

1. "Drinking Water Sampling Guide (2005)," Public Drinking Water Section, Texas Commission on Environmental Quality (TCEQ)
2. "How to Develop a Monitoring Plan for a Public Water System (RG-384, Dec. 2003)", Water Supply Division, TCEQ
3. "Coliform Sampling for Public Water Systems (RG-421)," Water Supply Division, TCEQ
4. "Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Systems (RG-346, Feb. 2004)," 30 TAC Chapter 290 Subchapter F

1 Water Quality Sampling

Introduction

This training module explains how operators properly collect, preserve, handle, and process various samples from their water system and use this information for compliance monitoring and process control.

The first part of this module discusses who samples and why, what makes a good sample, and what types of samples are important to collect. Then the module addresses how samples are collected, preserved and shipped (if necessary). Sampling safely, while maintaining "quality assurance and quality control", is presented. The last section covers a systematic approach to process control called "Hazard Awareness and Critical Control Points."

The regulatory structure of public health protection is based on an operator's ability to collect representative samples of their water and obtain a correct analysis. Proper sampling is one of the most important skills operators learn. Water systems, the public, and state and federal regulatory agencies make decisions based on sample results. After completing this module, you should be able to sample correctly and consistently.

1.1 Who Has to Sample?

Public water systems have the potential to cause serious harm to their customers. These health risks are unseen and could go unrecognized without proper sampling. Taking regular samples of the water is the best way to assure that it is safe.

State and federal regulations require that community and nontransient noncommunity (NTNC) public water systems conduct sampling and develop a monitoring plan describing their required sampling activities. Each system is regulated according to the source of water used.

- Systems that treat surface water and groundwater under the influence of surface water (GUIs) must submit monitoring plans for approval by the state. Because surface water is more likely to contain pathogens and more compliance monitoring is required, it is regulated more closely.

- Groundwater and purchased water systems must have plans available for review during compliance inspections by the state and whenever the sampling contractor comes to collect chemical samples.

- If you purchase water, you may need to coordinate a monitoring plan with your supplier. Conversely, if you sell treated water to other systems, you must make a plan available to them.

Monitoring plans describe sampling requirements that the public water system and the state use to determine compliance with state and federal regulations. There are other types of samples operators collect that are not required to be part of the monitoring plan. These will be discussed later in the module.

1.2 Why Sample?

There are important reasons for collecting and analyzing samples from water production plants and distribution systems. These include:

- Compliance samples are used to verify and document compliance with standards.
- Process control samples are used to monitor and control the water system.

Compliance Samples

Compliance samples are collected to verify that water distributed to the public meets state and federal standards for drinking water quality. Examples are chlorine residual samples, coliform samples, and lead and copper samples. Operators collect compliance samples at frequencies specified by the regulatory agency and at locations specified in the water system's monitoring plan. The results of any samples collected at a sampling point that has been designated as a compliance sampling point must be included when determining compliance—that is, all compliance sample locations count. The results of samples collected are recorded and reported.

Process Control Samples

Equally important are samples collected to monitor and control water treatment processes. Operators may also use compliance samples for process control. Process control samples may not be used for compliance purposes unless the samples were collected from a compliance monitoring point.

1.3 What Makes a Sample Valid?

Sampling is the process of taking a representative part of a larger whole for the purpose of determining its quality.

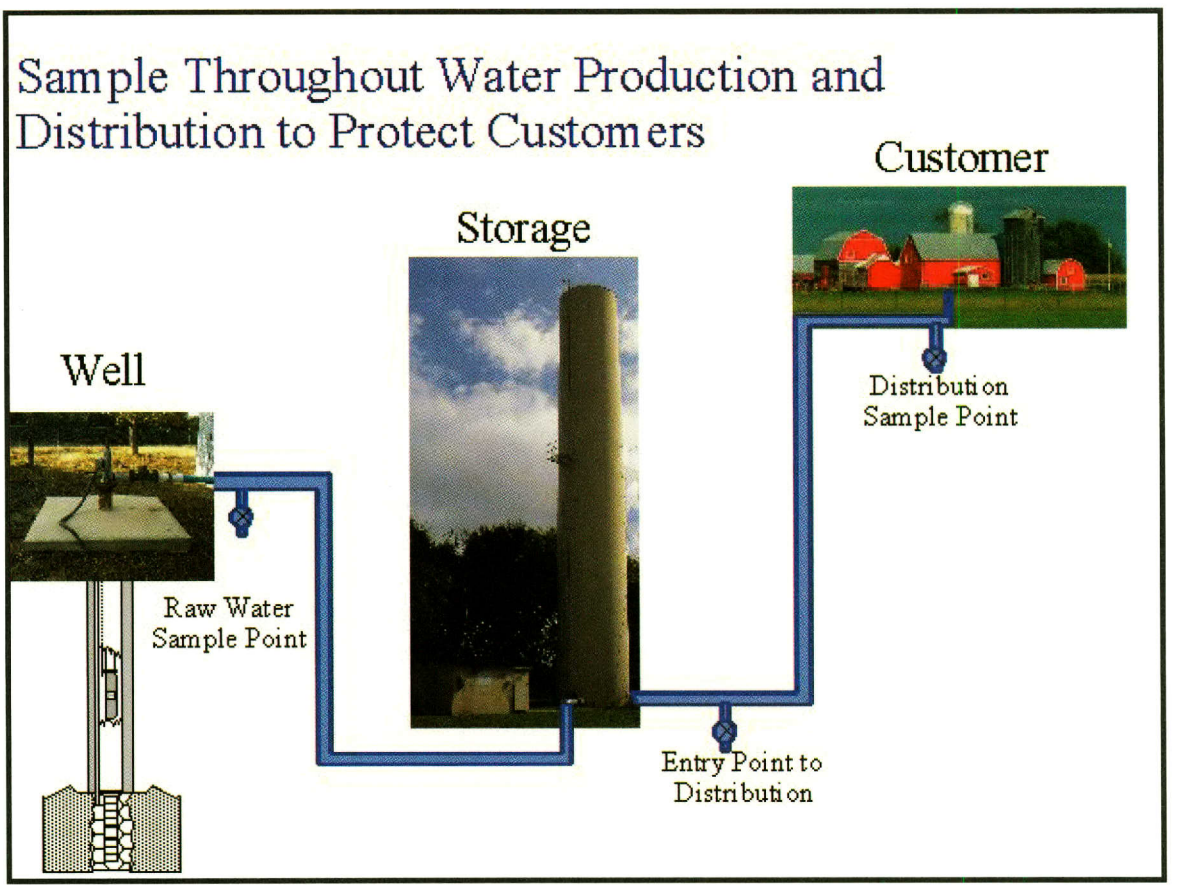
Anytime you collect a sample, there are potential opportunities for error. These must be minimized in order for the sample to be valid. To be a valid sample, several things must happen correctly. A valid sample is representative, collected using the proper method, and properly preserved, stored, and shipped (if necessary). Finally and importantly, document the sample properly.

Representative Samples

A sample must be representative of the larger whole. If you're sampling a large body of water, taking only a single sample from one location does not reveal all of the true characteristics of the water's quality. Similarly, one sample from a distribution system is not enough to allow you to say with any certainty that the water is safe. On the other hand, taking a sample at each home is not

practical. Therefore, a better method is to sample from different locations and analyze them individually. The more locations from which you sample, the more confident you are that the set of data is truly representative of the larger whole.

Figure 1. Representative Sample Points



Of course, how often and where you collect samples depends on the kind of information you are trying to obtain. For example, if you want to know the quality of source water before treatment, you collect a sample at the well discharge before any treatment processes. Likewise, if you want to know whether there are bacterial contaminants in the distribution system, it makes sense to collect samples from the distribution system and not a storage tank. The objective of the analysis determines the number and type of sampling sites.

Sample Collection

Drinking water quality can change over time. If information is needed about how it changes as time passes, a single sample from one location is not the best approach. If you want to know how quality changes with time, you must sample over a span of time.

There are two general kinds of samples:

- Grab samples, and
- Composite samples.

Grab. Grab samples are used when an analysis of the water's characteristics is needed for a single point in time. Since things like pH, temperature, and coliform bacteria will change over time, it's important to know that a grab sample measures only that particular location at that particular time. Grab samples are generally collected manually.

Composite. Composite samples are collected when you need to know how the water's characteristics change over time or location. In composite sampling, samples are collected at one location at regular time intervals or at several locations throughout the distribution system. Sample portions are then combined into one sample and analyzed. Composite samples are collected either manually or by automatic samplers.

Proper collection also means using the correct container. Since almost everything eventually dissolves in water, you don't want to use a container that has held other substances. Glass containers and some kinds of plastics are used because they don't react with the water or allow foreign chemicals to leach into the water. Testing procedures state the type of container and preservation method that samplers must use.

Proper collection technique also ensures that no foreign matter enters the water sample. For instance, wind-blown particles can change the characteristics of water substantially. As we will see later, written procedures are commonly used to make sure that all these factors are taken into account.

Preservation, Storage, and Shipping

A valid sample is also one that is preserved, stored, documented and when appropriate, shipped properly. It would be ideal if all samples were analyzed immediately, thereby eliminating the possibility of the sample changing with time. This is impractical because of the nature of some of the tests and the limited laboratory facilities of small systems.

There are some parameters (characteristics) that must be analyzed on-site. Analyze temperature, pH, and chlorine residual samples immediately (within 15 minutes) because the results change with time.

If immediate analysis is not possible, samples are preserved and transported to other locations. In these cases, sometimes a preservative is added to the container to stop any further chemical reactions from occurring. For example, in a disinfection byproduct (DBP) sample, DBPs continue to form if the chlorine in the sample is not quenched with a reducing agent.

Note that some preservatives are strong acids. Strong acids are a health risk and hazard requiring precautions when handling. You must be very careful not to splash any of the preservative on yourself or inhale its fumes. Don't spill or remove any of the preservative from the container.

Another common way to preserve samples is to place them on ice so their temperature remains at 1-4 °C. This cold temperature reduces the rate of chemical reactions in general and minimizes the growth of bacteria. An important part of sample collection is how a sample is handled. Samples are only valid if stored properly and for the prescribed holding time. A sample cannot be collected, left in a truck for several days and then sent to the laboratory for analysis. Deliver samples to the testing laboratory within the stated maximum holding time.

In addition to proper collection, storage and shipping, completion of a laboratory submission form or a chain-of-custody form is required so the lab can clearly identify each sample. If you place more than one sample in an ice chest, each sample must have its own paperwork. If the lab is unable to match a sample to its form(s), they are required to invalidate the sample. You will then have to re-sample, re-preserve, and re-send. The best way to handle these forms is to place them (one set per sample) in an individual sealable plastic baggie and tape it to the inside lid of the ice chest or box. Don't forget to include the PWS ID number with each sample submission form.

Finally, make sure the complete name and address of the receiving laboratory is clearly marked on the outside of the shipping container. It is a good idea to register the package with the U.S. Postal Service and request a return receipt. These receipts or bills of lading become part of the chain-of-custody records.

Quality Assurance and Quality Control (QA/QC)

You have heard the terms "quality assurance (QA)" and "quality control (QC)" when the accuracy of laboratory data is discussed. These terms also apply to water utilities that perform their own analyses of water quality.

"Quality assurance" is a set of planned activities designed to ensure that a product or service (such as a sample analysis) is of the highest quality. "Quality control" is the set of techniques and operating practices used to provide this assurance. In practice, QA/QC leads to data of known and documented quality.

QA/QC includes, but is not limited to:

1. Proper sample collection procedures
2. Chain-of-custody
3. Use of standardized methods
4. Use of reference standards
5. Data validation through the use of blanks, spikes, and duplicates
6. Use of documentation and records
7. Environmental controls
8. Personnel training (this course is an example)
9. Instrument calibration

The use of standardized methods and 'best practices' creates a uniform system of compliance monitoring. In other words, you, your neighbor system, the state and federal regulatory agencies, and the public can all measure and discuss drinking water quality the same way.

In order for a community to have confidence that their drinking water is safe, the operator must demonstrate competence in sampling and analysis procedures. For the operator, QA/QC means that you conform to all of the required steps when collecting bacteriological samples and analyzing for chlorine residual.

Maintaining accurate records is also important to QA/QC practices. Operators use a logbook to document the date of collection, the address and location of the sample site, the method of analysis, the result, and the initials of the person performing the analysis. Also, when you calibrate instruments, you need to keep records of that calibration.

Operators also compile records for submittal to TCEQ. Be sure to use the right forms.

Activities

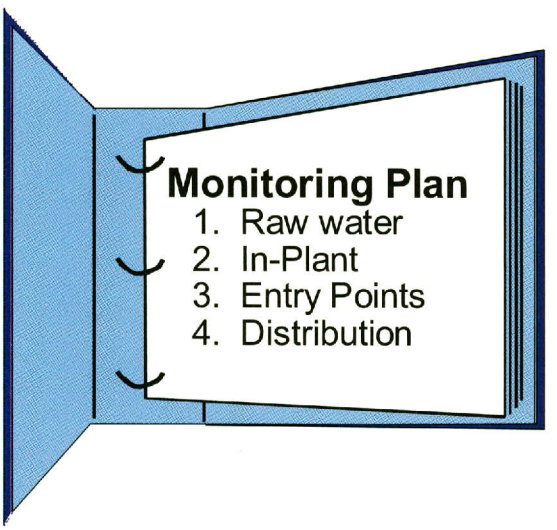
Activity 1. Water System Overview and Sample Points

2 Types of Samples

There are different ways to describe and discuss samples. As we saw in our discussion of grab vs. composite sampling, one way has to do with sampling frequency and location, while another is based on whether the sample is of a regulated substance or constituent. Additional forms of sampling include compliance sampling and process control sampling.

2.1 Compliance Samples vs. Process Control Samples

A compliance sample is a sample that a public water system is required to collect, analyze, and report to the TCEQ in order to determine compliance with the Drinking Water Standards (30 TAC Chapter 290, Subchapter F).



On the other hand, a process control sample is collected by a water system in order to make good operational decisions. This type of sample is not reported to TCEQ. Most operators understand the need for additional monitoring beyond the minimum required by governmental agencies.

Operators may want to affix a permanent tag to each tap described in their monitoring plan. The tag would identify the sample number, sample type (e.g. raw, entry point, distribution), and parameters sampled (e.g. coliform and chlorine residual.

In discussing compliance samples, it helps to think of them as collected from four general locations:

- Raw water
- In-plant
- Entry points
- Distribution system

Raw Water

Systems that treat surface water are required to collect raw water samples for coliform and total organic carbon. Before a new well can be put into service, the raw water must be sampled for bacteria and chemicals.

At the present time, groundwater and purchased water systems do not have to routinely collect raw water samples, but that is expected to change. In the future, groundwater systems located in hydrogeologically sensitive areas may be required to sample their raw water. You should anticipate the need to better understand your well water quality and begin to collect raw water samples periodically for coliform bacteria.

In Plant

Compliance samples are sometimes collected from within the treatment plant or well site. Most small groundwater systems do not perform in-plant sampling on a routine basis.

Entry Points

An entry point is where a treated water source first enters the distribution system. A sampling site is established in the monitoring plan for each entry point. The sampling site is always after treatment (and preferably after storage), but before the first connection. Make sure your monitoring plan clearly shows each sampling site for each entry point, in order to avoid confusion when inspectors or sampling contractors visit your system. Sampling taps must be located at each sampling site.

Groundwater and purchased water systems are required to maintain a disinfectant residual at entry points and in the distribution system. TCEQ's sampling contractor uses entry points as locations from which to take their chemical samples, so you should be familiar with them. This is discussed later in this section.

Distribution System Sampling

You will collect bacteriological samples and chlorine residuals from representative points within the distribution system. The sampling contractor also collects samples for disinfection byproducts and asbestos from the distribution system.

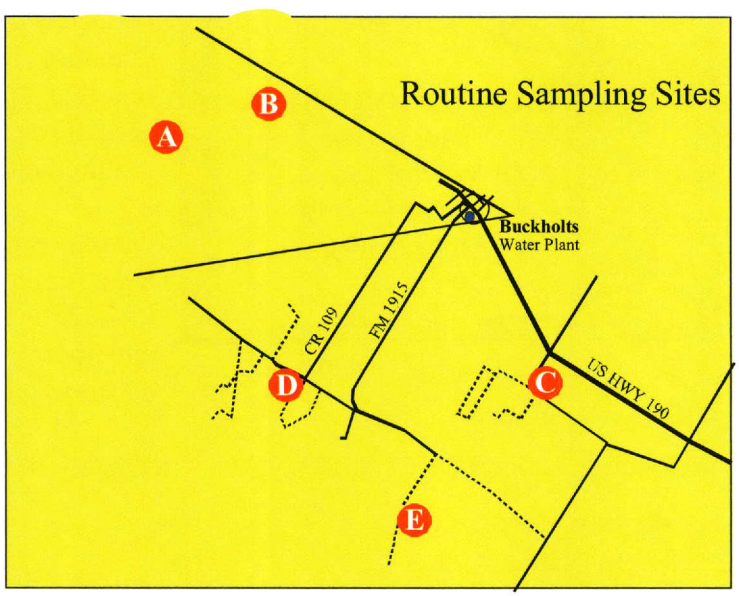


Figure 2. Distribution Sampling Sites

2.2 Who Does What?

There are many substances that are sampled and analyzed in drinking water. Some you are responsible for collecting and analyzing, others you collect and send to laboratories for analysis. Occasionally, TCEQ or its contractors come to your system to collect samples. This section defines sampling responsibilities.

Samples Collected by Operators

Most monitoring for groundwater and purchased water systems takes place in the distribution system. All systems that operate a distribution system perform sampling and monitoring for disinfectant residuals, microbial contaminants, and a large number of chemicals, including disinfection byproducts. Some systems also monitor for lead, copper, and asbestos. Fortunately, you are not responsible for all of these samples.

You are responsible, as the system operator, for sampling and measuring disinfectant residuals in your distribution system. If you use chlorine gas, you will monitor for free chlorine. If you use chlorine and ammonia, you will monitor for chloramines and ammonia (and perhaps pH and nitrite).

You are also responsible for collecting (but not analyzing) samples for:

- Microbial contaminants (these are referred to as coliform samples);
- Interim approval of new sources (before TCEQ gives final approval of a new well); and
- Lead and copper.

Two things are your most important sampling responsibilities, measuring chlorine residuals and taking samples for coliform bacteria. It is critical that you learn how to do both well.

Chemical Samples Collected by TCEQ Sampling Contractor

In order to relieve water systems of the burden of taking so many samples and having them analyzed, TCEQ contracts private firms, whose responsibility it is to come to your system regularly and pick up samples for analysis.

TCEQ sampling contractors will collect samples for:

1. Disinfection byproducts
2. Asbestos
3. Final approval of wells
4. Inorganic and organic chemicals.

The sampling contractor schedules time with you to come by, at least once each summer, and collect disinfection byproduct samples. Disinfection byproducts include total trihalomethanes (TTHM's) and haloacetic acids (HAA5, because there are 5 acids). These samples are taken in the distribution system where the chlorine contact time is the longest.

Monitoring for inorganic and organic chemicals (there are a large number of them) is done in the distribution system, usually at entry points. These chemicals are listed in Table 1 below.
As samples are taken, you will sign one or more forms for each sample and receive a copy to keep for your records. Table 1 shows who collects samples for groundwater and purchased water systems, and how often.

Table 1. Sampling Responsibilities and Frequency

	Operator-Collected	Sampling Contractor
Constituent or Analyte	**Frequency of Collection***	
Disinfectant residual (chlorine or chloramines)	When bacteriological samples are collected, plus daily or weekly as required	Whenever they collect other samples (below)
Coliform bacteria	1, 2, or 3 samples monthly, depending on population	
Inorganic contaminants (IOC) such as arsenic, asbestos, chromium, fluoride, mercury, nitrates/nitrites		Most - every three years Nitrate - annual Nitrite and asbestos - once in first three years of a nine-year cycle
Organic contaminants Synthetic [SOCs] or Volatile [VOCs]		SOC - every three years, if initial sampling rounds detect nothing VOC - may be waived if initial rounds detect nothing
Radionuclides (not radon)		Once every three years at groundwater entry points
Disinfection byproducts (DBPs)		One sample per year per plant during month of warmest water temperature, reduced to once per three years for low levels
Lead and copper	Two sets of initial tap samples during two consecutive six-month periods, plus distribution sampling	Every three years by sampling contractor. See inorganic contaminants, above

***Note: This table does not include sampling frequencies for new systems or sources. Sample frequency may be increased, decreased, or waived by TCEQ. New systems should pay close attention to the rules and their initial rounds of sampling.**

2.3 Monitoring Plans

All community and nontransient noncommunity public water systems are required to have a monitoring plan. If your system treats groundwater or purchases treated water, you do not have to send in your monitoring plan. The TCEQ will look at the plan during the sanitary survey and the sampling contractor will look at it when they collect chemical samples. Or, TCEQ may request that you forward it for review.

Components of a Monitoring Plan

A monitoring plan has several required components, including:

- Raw Water Sampling
- In-Plant Sampling
- Entry Point Sampling
- Distribution System Sampling
- Schematics

An example of a monitoring plan for a groundwater system with one well is shown in the Workbook. This example is provided along with complete instructions for completing a monitoring plan in TCEQ publication RG-384: "How to Develop a Monitoring Plan for a Public Water System." Obtain a copy of RG-384 by going online or calling the TCEQ Publication Section at 512-239-0028.

Activities

Activity 2. Monitoring Plans

3 Collecting, Preserving, Handling, and Processing Samples

Operators of small groundwater or purchased water systems are primarily concerned with collecting and processing three samples:

- Disinfectant residuals
- Coliform bacteria
- Lead and copper

The following sections provide instructions for collecting, preserving, handling, and processing these three samples.

3.1 Disinfectant Residual Samples

Disinfectant residual samples for compliance monitoring are collected at the frequency and locations specified in the water system's monitoring plan. For groundwater and purchased water systems serving fewer than 750 people, at least one sample is collected each week. For systems serving greater than 750 people, at least one sample is collected each day.

To maintain proper disinfectant residuals in the treated water and throughout the distribution system, operators take samples for process control more frequently than required by regulations. Some systems use an on-line chlorine analyzer to monitor the disinfectant level entering the distribution system.

Sample Collection

1. Use a sample tap without attachments to collect disinfectant residual samples.
2. Thoroughly flush the sample line before collecting the sample.
3. Collect disinfection residual samples in clean glass containers that have been rinsed with distilled water and with the sample water. Samples may be collected directly into sample analysis cells.
4. Avoid exposing the sample to sunlight and minimize agitation.

Preservation

Disinfectant residual samples cannot be preserved. Analyze samples as soon as practical but not later than 15 minutes after collection.

Handling and Processing

Operators determine the disinfectant residual concentration in milligrams per liter (mg/L) using an approved method and procedure.

3.2 Bacteriological Samples

Coliform samples for compliance monitoring are collected monthly by alternating through the five routine sample sites specified in the water system's monitoring plan. The number of samples required each month depends on the population served.

Table 2. Minimum Number of Distribution Coliform Samples

Population Served	Number of Coliform Samples Required
1,000 or fewer	1
1,001 to 2,500	2
2,501 to 3,300	3

In addition, operators take raw water samples, construction samples, special samples, and repeat samples as necessary to ensure the safety of the water supply.

Sample Collection

1. Use a sample tap without attachments to collect coliform samples.
2. Thoroughly flush the sample line before collecting the sample.
3. Flame or apply a bleach solution to the sample faucet.
4. Collect coliform samples in sterile sample bottles obtained from the testing laboratory.
5. Do not rinse the sample bottle prior to filling.
6. Fill the sample with a pencil-size stream and avoid contamination.
7. Mark the sample bottle with the sample number and chlorine residual.

Preservation

Coliform samples are preserved by refrigeration to 1-4 °C.

Handling and Processing

Refrigerated coliform samples should be delivered to the testing laboratory as soon as practical after collection. If the sample must be mailed, it must arrive at the testing laboratory within 30 hours of collection.

3.3 Lead and Copper Samples

Groundwater systems are monitored for minerals and metals, including lead and copper, every three years at entry points by TCEQ's sampling contractor. Lead and copper are two metals that can be toxic when present in sufficient quantities.

Lead and copper are most likely found in the customer's tap water when the home has lead pipes or copper pipes with lead solder. Homes served by lead service lines are also at risk. A second risk factor is corrosion. Where there is evidence of corrosion in the plumbing, lead and copper levels are often elevated.

Water systems are responsible for monitoring lead and copper in the distribution system through tap sampling. Either water system personnel or system residents collect the tap samples.

Prior to Collecting Lead and Copper Samples

1. The water system conducts a distribution system and interior plumbing materials survey to determine what type of plumbing materials are present in the water system.
2. The water system must pick sample sites with the highest risk to leach lead or copper into the drinking water.
3. The water system identifies and lists their lead and copper sample sites on a Sample Site Selection Form. The total number of sites identified must equal the number of sites the water system is required to sample.
4. Community systems must confirm with the occupant of each sample site that they are willing to participate in the sampling program before choosing their residence as a sampling site.
5. Contact customers and let them know that you will bring the bottles to their homes for sample collection. Provide each customer with sampling instructions.

Sample Collection

1. Always collect samples from the cold-water tap. Use the kitchen tap in a residence or an interior tap where water is typically consumed in a non-residential building.
2. Never collect samples at outside taps or faucets; at taps with water softeners or reverse osmosis units; at vacant houses, apartments or buildings; or at infrequently used taps. Testing at these sites increases the chances for your water system to exceed the lead and copper limits.
3. Collect samples only in containers provided by the state for lead/copper sampling.
4. All samples must be "first draw" water. The taps from which samples are collected must not have been used for at least six hours but not more than 18 hours when the sample is collected. Residential customers must fill their sample bottles first thing in the morning, or upon returning home from a full day at work, before any other water is run from that tap. Prior to the 6-hour minimum hold time, customers can use all the water they want. Samplers are encouraged to flush the line to the faucet (let the water run a good five minutes) to bring in fresh water before the hold time starts.
5. The sample bottles are opened, placed under the tap, and then the first draw tap water sample is collected without spillage.
6. Fill the bottle to the top. Do not rinse the sample bottle at any time.
7. Be sure to tighten all sample bottle caps to prevent leakage.

Preservation

The lead/copper sample bottles come with an acid preservative in the bottle. After collecting the sample, no additional preservation is required. Return samples to the Texas Department of Health Laboratory within 14 days of collection.

Handling and Processing

If a customer fails to return a sample bottle, call the state for another bottle. A complete set of samples is required or the water system will be in violation of the Lead/Copper Rule.

1. Attach labels to the upper left corner of the individual lab form on each corresponding sample bottle. Place all lab forms in a plastic bag so they will stay dry during shipment if one of the bottles leaks. Sign and date the form using waterproof ink.
2. All the information requested on the lab form must be provided. The laboratory must reject any samples without paperwork, paperwork with no collection date, or inadequately labeled bottles.
3. Make sure the shipping box is sturdy enough to withstand abuse during shipment. Use a large, sturdy box and plenty of packing material to cushion the sample bottles.
4. Use a shipping service that is convenient. Remember that samples must reach the lab within 14 days after collection. Always obtain a receipt that clearly shows that you shipped water samples and when you shipped them. Use a tracking service for proof of shipping and delivery.
5. The current price for analyzing one sample is approximately $24.00.

The number of sample sites depends on the size of your system and whether or not your system is in compliance with the 90th percentile requirement for lead and copper action levels (see Table 3 below). The action levels for lead and copper are 0.015 mg/L and 1.3 mg/L respectively. If 10% of your samples exceed these limits, you will have to begin a corrosion control program including analyses of several water quality parameters. For water systems serving fewer than 101 people, the 90th percentile level is calculated by taking the average of the highest two sample results.

Table 3. Initial and Reduced Monitoring for Lead and Copper

System Size (no. of people served)	Initial Monitoring Sites	Reduced Monitoring Sites
<101	5	5
101 – 500	10	5
501 – 3,300	20	10

Your monitoring can be reduced to once every three years at the reduced number of sites in the table above if initial testing shows lead and copper levels less than 0.005 mg/L and 0.65 mg/L. Otherwise, reduced monitoring occurs yearly during the summer months.

Small systems serving a population less than 501 people can apply to have their monitoring frequency reduced to once every nine years if certain conditions apply. Contact TCEQ if your system's distribution system, service lines, and residential connections and plumbing contain no lead or copper-containing materials, and if the first round of testing shows that its 90th percentile of lead and copper do not exceed 0.005 mg/L and 0.65 mg/L respectively.

If your system ever exceeded the action limits for lead or copper, or for any other regulated contaminant for that matter, you may be on an alternate, more frequent sampling schedule. Pay close attention to any notification or schedule change from TCEQ, and retain it in your records. Also pay close attention to your sampling protocol and sample results. Any invalid sample can subject your system to more stringent monitoring.

New systems should contact TCEQ if they do not receive a sampling schedule from them. New systems perform materials survey of their system to identify potential sources of lead and copper and establish and get approval of a sample monitoring plan. Two sets of testing are conducted during two consecutive six-month monitoring periods, the first beginning within the year of receiving a system identification number, and the second within six months thereafter.

Activities

Activity 3. Collecting Lead/Copper Samples

4 Process Control

A useful approach to process control is called Hazard Analysis and Critical Control Points (HACCP). HAACP is a systematic approach to the identification, evaluation, and control of a process. Operators can use its seven guiding principals to manage any water treatment process.

4.1 HACCP Guiding Principles

1. Conduct a process analysis.
2. Determine the critical control points (CCPs).
3. Establish critical limits.
4. Establish monitoring procedures.
5. Establish corrective actions.
6. Establish verification procedures.
7. Establish record-keeping and documentation procedures.

4.2 Definitions

Hazard. A biological, chemical, or physical agent that is reasonably likely to cause illness or injury in the absence of its control.

Control. Control means to manage the conditions of an operation to maintain compliance with established criteria.

Step. A step is a procedure, operation, or stage in the process from source water protection to delivery at the customer's tap. Critical steps in groundwater systems are production, disinfection, storage, pressure maintenance, and distribution.

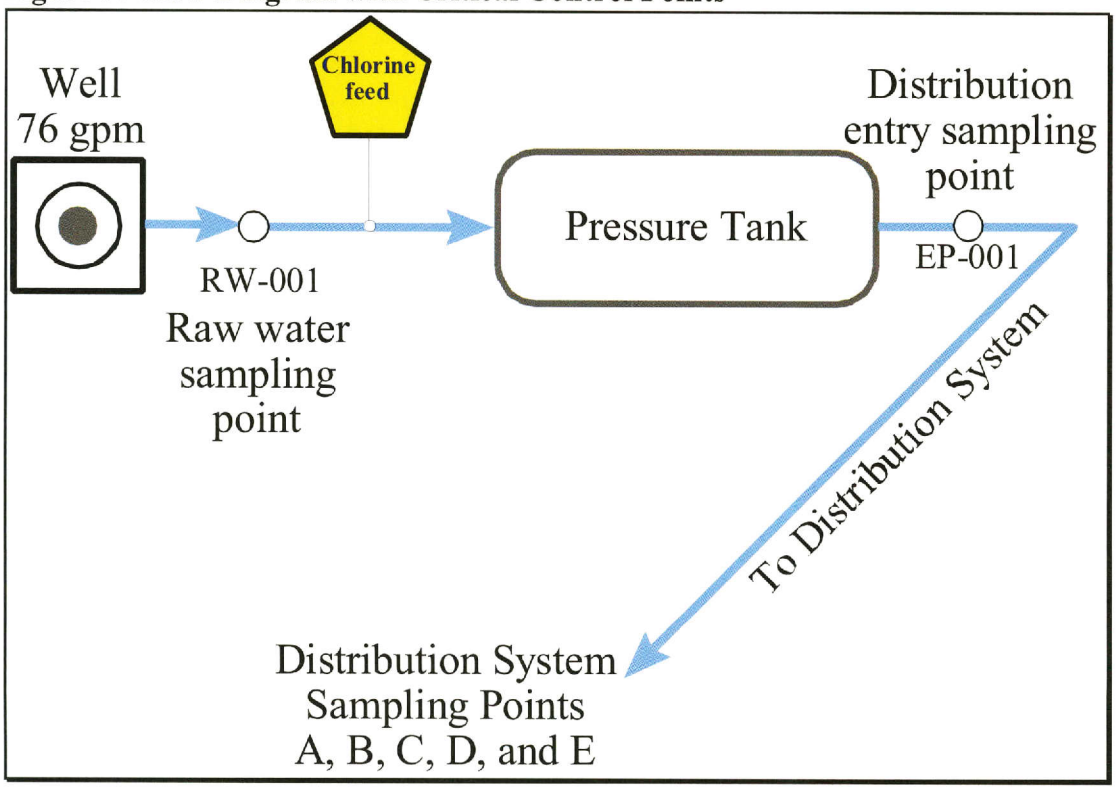
Control Point. Any point in the water treatment process at which operators control biological, chemical, or physical factors. An example of a control point is a chemical addition point.

Control Measure. Any action or activity that prevents, eliminates or reduces a hazard.

Deviation. A deviation occurs when a critical limit is exceeded.

Flow Diagram. A flow diagram is a clear, concise schematic of the steps in the process showing the critical control points.

Figure 3. Flow Diagram with Critical Control Points



4.3 Implementing HACCP

Management provides:

1. Adequate resources (people and monitoring equipment).
2. Training for employees who will implement the plan.
3. Resources to develop procedures and corrective actions.

HACCP implementation involves the continual application of the monitoring, record-keeping, corrective action procedures, and verification procedures described in the plan.

Conducting a Process Analysis

The purpose of a process analysis is to develop a list of the hazards that are reasonably likely to cause injury or illness if not effectively controlled. Safety hazards associated with the production of safe drinking water include the following:

1. Pathogenic organisms
    a. Bacteria (pathogenic *E. coli, Shigella or Salmonella)*
    b. Viruses (hepatitis)
    c. Protozoa (*Giardia* and *Cryptosporidium*)
2. Chemical hazards
    a. Disinfection byproducts (TTHMs or HAA5)
    b. Heavy metals (lead and copper)
    c. Inorganic substances (arsenic or nitrate)

3. Contaminants introduced through cross-connections
    a. Drain lines without containment air gaps
    b. Chemical cross connections
    c. Customer's private wells
4. Hazards that may be introduced during processing
    a. Overfeeding chemicals
    b. Improper water stability

Determine the Critical Control Points

For every significant hazard identified in the hazard analysis there must be a point at which operators apply a control to prevent, eliminate, or reduce the hazard to an acceptable level. These are called critical control points (CCP). Where the disinfectant is added is an example of a CCP in a groundwater system.

Establish Critical Limits

A maximum and/or minimum value to which a biological, chemical or physical parameter must be controlled at a critical control point to prevent, eliminate, or reduce to an acceptable level the occurrence of a hazard. A critical limit distinguishes between safe and unsafe operating conditions. Critical limits for disinfection would be free chlorine residuals of no less than 0.2 mg/L nor greater than 4.0 mg/L.

Monitoring Procedures

Monitoring occurs when operators collect specific quantifiable information to allow comparisons between the actual process and the goals. For example, utility personnel measure critical control parameters, such as disinfection residuals, using required procedures to determine whether or not the treatment process meets control limits. Often, the regulatory agency specifies the minimum monitoring frequency and testing procedures. The collected monitoring data must reflect actual plant performance. All samples must be representative of conditions within the water system.

Monitoring is a planned sequence of observations or measurements collected to assess whether a process is under control and to produce an accurate record for future verification. Monitoring is necessary to indicate proper control and to determine if deviations occur that require an appropriate corrective action. Monitoring also provides written documentation for use in verification.

Establish Corrective Actions

When a deviation occurs, operators follow a corrective action or procedure. An important purpose of the corrective action is to protect the public from any hazard that might reach consumers through drinking water. Any time there is a deviation from an established critical limit, there must be an appropriate corrective action taken. Corrective actions include the following elements:

1. Determine and correct the cause of the deviation.
2. Record the corrective actions that have been taken.
3. When public notification is required, use proper procedure and language to notify the public.

Operators develop, in advance, specific corrective actions for each CCP described in the HACCP plan. As a minimum, the plan specifies what is done when a deviation occurs, who is responsible for implementing the corrective actions, and how a record of the action taken is developed and maintained.

Establish Verification Procedures

An important aspect of verification is the initial HACCP plan validation. Verification determines that the plan is sound, all hazards have been identified, and the plan effectively controls the identified hazards. Information needed to validate the HACCP plan includes expert advice and special studies along with in-plant observations, measurements, and evaluations. Verification also includes activities over and above routine monitoring that confirm the validity of the HACCP plan. Verification shows that the operator's process control actions implement the plan.

Water systems should perform periodic verifications. Verification activities are carried out by qualified utility personnel, third party experts, or by regulatory agencies.

Water systems conduct verification:

- Routinely and/or randomly to assure CCPs are under control.
- When there are concerns about the safety of the water supply.
- When the water has been implicated as a disease vehicle.
- To confirm that changes have been implemented after a HACCP plan has been revised.
- To assess whether a HACCP plan should be modified due to a change in water source, process, or equipment.

Establish Record-Keeping and Documentation Procedures

The records maintained for the HACCP should include the following:

1) A summary of the hazard analysis, including the rationale for determining the hazards and control measures.
2) The HACCP plan documents:
   a) The roles and responsibilities of each staff member that participates in the development or implementation of the HACCP plan
   b) Flow diagram
   c) Plan summary table
      i) Steps in the process that are CCPs
      ii) Specific hazards
      iii) Critical limits
      iv) Monitoring
      v) Corrective actions
      vi) Verification procedures
      vii) Record-keeping
3) Support documentation such as validation records
4) Records generated during plant operation

Activities

Activity 4. Process Control

5 Conclusion

The process for monitoring water supplies is critical to the health and safety of the public using that supply. Operators are charged with the responsibility to maintain a safe water supply while complying with state regulations. It is a complicated task.

Here are important sampling considerations to remember:

1. Drinking water sampling is one of the operator's most important jobs.
2. Good samples are representative samples. They are properly collected, preserved, transported and analyzed. Clear and accurate documentation is required.
3. There are different types of samples. Compliance samples require the most care.
4. Operators are responsible for collecting and analyzing samples for disinfectant residual.
5. Operators are responsible for collecting and shipping bacteriological samples. An approved laboratory analyzes these samples.
6. When coliform organisms are found, a special set of repeat samples is required. Additional samples must be collected the following month.
7. Operators or customers with assistance from operators collect samples for lead and copper within the distribution system. The state or its contractors sample for other substances.
8. There are specific procedures for taking samples that the operator follows to insure accuracy, timeliness and compliance.

One final caution: When a repetitive activity such as sampling becomes routine, carelessness can occur. Don't let this happen. The customer's health is at stake.

TCEQ-1251
July 2005

Disinfection and Coliform Monitoring

Grant Number: 582-4-61142

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Cluster Training Module

TEXAS SMALL PUBLIC WATER SYSTEM OPERATOR TRAINING PROGRAM (TSPWSOTP)

TEXAS SMALL PUBLIC WATER SYSTEM OPERATOR TRAINING PROGRAM
TCEQ-1251
July 2005

Disinfection and Coliform Monitoring

Purpose:	Operators will demonstrate the knowledge and practice the skills required to assure the microbiological safety of a public water supply in accordance with TCEQ Rules **30 TAC 290.109** and **290.110**.
Target Audience:	Operators of groundwater or purchased water systems serving 3,300 people or fewer.
Time Required:	Approximately four hours (4.0 hours) for a class of eight to ten students.
Documents Required:	The monitoring plan for the water system. If a monitoring plan is not available, extra time will be required to develop a basic plan for disinfection monitoring.
Monitoring Equipment Required:	Field test equipment for chlorine residual monitoring. A hand-held colorimeter is the most commonly used monitoring equipment. Color comparators are used if this is the only equipment available to the operators.
Sample Containers Needed:	Plastic bacteriological sample bottles obtained from an approved testing laboratory and maintained in clean, sanitary condition.

Preface

This training module is for operators of small public water systems, serving 3,300 or fewer people using groundwater or purchased water only. It covers knowledge and skills required to implement the requirements in Chapter 290, Subchapter F: Drinking Water Standards Governing Drinking Water Quality and Reporting requirements for Public Water Systems, 30 TAC Section 290.109: Microbial Contamination and 30 TAC Section 290.110: Disinfectants. Additional guidance is available in TCEQ Regulatory Guidance – RG-407, RG-421 and RG-384.

TEXAS SMALL PUBLIC WATER SYSTEM
OPERATOR TRAINING PROGRAM
Training Module TCEQ-1251
July 2005

Disinfection and Coliform Monitoring

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1 Introduction

1.1 Public Health Protection

Disease-causing organisms can invade public water systems in a variety of ways and without warning. Just ask the people who lived in Georgetown, Texas in 1980 or Milwaukee, Wisconsin in 1993 or Brushy Creek, Texas in 1998.

Public water systems are regulated under the Safe Drinking Water Act of 1974 which was amended in 1986 and 1996. Microbial contamination is regulated under the Surface Water Treatment Rule and the Total Coliform Rule. The State of Texas implements these rules.

All public water systems (PWS) are required to routinely monitor their tap water for total coliform bacteria. The presence of total coliform in drinking water indicates that the water can support the presence of pathogenic organisms. Water systems in Texas must also monitor for chlorine residual to ensure the required and effective disinfectant level is continuously maintained in the customer's water.

Operators are responsible for protecting customers from disease-causing organisms.

1.2 Disease-Causing Organisms

Disease-causing organisms, also called pathogens, include viruses, bacteria, and protozoa. The common traits of these pathogens are:

- may cause serious illness when ingested with water or food.
- very small in size and cannot be detected by visual observations.
- easily carried by water.
- often found in the water contaminated by human or animal fecal matter.

You are probably familiar with some of the diseases caused by these micro-organisms. They include: typhoid fever, cryptosporidiosis, giardiasis, hepatitis, and dysentery.

TDH News Release: TDH Confirms Parasitic Illness in Brushy Creek Residents . . . July 28, 1998

TDH Confirms Parasitic Illness in Brushy Creek Residents

Texas Department of Health (TDH) laboratory tests have confirmed the parasite *Cryptosporidium parvum* in nine of twelve stool samples from Brushy Creek Municipal Utility District water customers who have experienced diarrhea and other symptoms of gastrointestinal illness.

But TDH officials say they have not made a definite link between these findings and a July 14 sewage spill that may have contaminated four of five water wells operated by the utility district. "We can't ignore the possibility," said TDH epidemiologist David Bergmire-Sweat, "but we haven't established a scientific link yet." TDH and Williamson County and Cities Health District officials are continuing to investigate.

Some 125 Brushy Creek residents have reported symptoms of gastrointestinal illness since July 21, the day the Brushy Creek utility district stopped using water from wells it operates and switched all of its customers to water from the Round Rock municipal water system.

Health officials say private well owners in the Brushy Creek area whose wells have not been tested since July 17 should consider having their well water tested. Brushy Creek water district customers do not need to have their water tested.

Brushy Creek residents who have had unexplained nausea, abdominal cramps, vomiting or watery diarrhea since July 17 are asked to call the Williamson County health department's Round Rock clinic at 248-3257.

Health officials say cryptosporidiosis is not usually life-threatening to healthy individuals, but young children, the elderly and persons with weakened immune systems could have complications from severe diarrhea or vomiting and should consult a physician if they experience these symptoms.

TDH News Release: Brushy Creek Update . . . July 29, 1998

Brushy Creek Update. . . More than 300 people from the Brushy Creek area near Round Rock have called the Texas Department of Health (TDH) or the Williamson County Cities Health District (WCCHD) to report having diarrhea and other symptoms of gastrointestinal illness.

TDH laboratory tests have confirmed the parasite *Cryptosporidium parvum* in 9 of 17 stool samples from Brushy Creek Municipal Utility District water customers who have become ill.

1.3 Preventing Disease Outbreaks

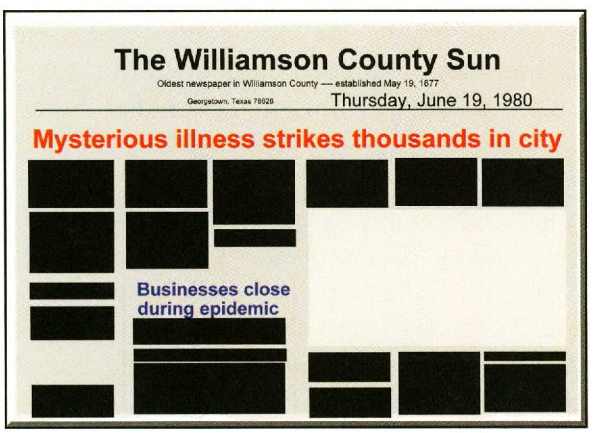
Constant vigilance is needed to rid our water supplies of harmful microbiological invaders. Four critical questions must be considered:

1. Is the source water protected from contamination?
2. Does the water receive effective filtration, either in underground water-bearing formations, or by such processes as complete surface water treatment or membrane filtration?
3. Is the water supply properly disinfected?
4. Is the water supply protected as it travels from the water plant to the customer?

Protect the water supply by making sure that vectors, such as insects and rodents, cannot enter. Ensure that the water has been adequately treated and disinfected before sending it to distribution. Make sure that the water system has an effective cross connection control program. Continuously maintain adequate disinfection residuals and water pressure throughout the water system.

The Workbook presents portions of news articles. These articles were written about breakdowns in water supply protection. Although such events are rare, in each case the water system was taken by surprise and unprepared for the response of the public and news media.

Figure 1. Waterborne Disease Outbreak in Georgetown


The Williamson County Sun

Oldest newspaper in Williamson County — established May 19, 1877

Georgetown, Texas 78626 Thursday, June 19, 1980

Mysterious illness strikes thousands in city

Businesses close during epidemic


The Sunday Sun

Williamson County 's Only Sunday Newspaper

Georgetown, Texas 78626 Sunday, June 22, 1980

The bug digs in: experts test the water

VIRUSES IN THE WATER?

We don't drink water, but we keep laughing

Activities

Activity 1. Waterborne Disease Outbreaks

2 Disinfection

Disinfection is the process of treating water to kill or inactivate disease-causing organisms. Chlorination and boiling are examples of disinfection processes.

2.1 Water Supply Disinfectants

The most common chemical disinfectants used by public water systems are free chlorine, monochloramine, chlorine dioxide and ozone. Chlorine dioxide and ozone are used only at the treatment plant. Operators maintain a free chlorine or monochloramine residual in the distribution system. These chemicals are called oxidizing agents because they chemically burn (oxidize) the genetic materials that allow organisms to grow and reproduce. The two most common nonchemical disinfection processes are boiling and ultraviolet light.

Free chlorination. Free chlorine is added to a water system by feeding gas chlorine or a hypochlorite solution. This results in the formation of free chlorine residual in the form of hypochlorous acid (HOCl) and hypochlorite ion (OCl^-). Undesirable and potentially cancer-causing disinfectant byproducts (DBPs) such as trihalomethanes and haloacetic acids can result when free chlorine reacts with certain types of organic and inorganic substances in the water supply.

Chloramination. When a water supply contains too much organic matter, operators avoid formation of DBPs by adding chlorine and ammonia. This is called chloramination. In the chloramination process, free chlorine reacts rapidly with ammonia to form monochloramine. Monochloramine is a weak but longer-lasting oxidizing agent. Monochloramine forms fewer disinfection byproducts than free chlorine and is a more stable disinfectant in the distribution system.

When using chloramination, a series of chloramine compounds can form starting with monochloramine, then dichloramine and trichloramine. The proper proportion of chlorine and ammonia forms mainly desirable monochloramine with little or no free chlorine or ammonia remaining. Therefore, the ratio of chlorine to ammonia is critical. If too much chlorine is added, undesirable dichloramine, trichloramine and DBPs can form. When too much ammonia is added, unreacted ammonia remains. Unreacted ammonia can result in nitrite and nitrate formation in the distribution system which may lead to a serious problem called denitrification.

Operators must carefully monitor and control the chloramination process. This is accomplished by using colorimeters or other instruments to measure ammonia, total chlorine residual, monochloramine residual, and free chlorine residual. The goal is to maximize monochloramine while leaving or creating minimal amounts of DBPs, ammonia, free chlorine, dichloramine, and nitrogen trichloride.

2.2 How Disinfection Is Achieved

Disinfection is achieved when a disease-causing organism is exposed for a sufficient time to a sufficient level or concentration of disinfecting agent. The important factors are:

- Type of disinfectant
- Concentration of the disinfectant (C)
- Time of exposure (T)
- Temperature
- pH

To be effective the disinfecting agent must come in contact with the disease-causing organism. Dirty water can shield organisms from disinfectants. Some organisms like *Giardia* and *Cryptosporidium* are present as oocysts (eggs). This protective shell is harder for disinfectants to penetrate.

For groundwater systems and purchased water systems the disinfection requirements are:

1. The residual disinfectant concentration in the water entering the distribution system shall be at least 0.2 mg/L free chlorine or 0.5 mg/L chloramine.
2. The residual disinfectant concentration in the water throughout the distribution system shall be at least 0.2 mg/L free chlorine or 0.5 mg/L chloramine.
3. The running annual average of the free chlorine or chloramine residual within the distribution system shall not exceed 4.0 mg/L.

Adequate disinfection is achieved by maintaining at least the minimum required disinfection residual every where in the distribution system.

When ammonia is added to the water supply to create a monochloramine residual, the water system tests for "Total Chlorine Residual" in the distribution system. If ammonia is not added, water systems test for "Free Chlorine Residual."

2.3 Evaluating the Disinfection Process

Concentration • Time or **"CT Values"** are used to evaluate disinfection processes. A water system calculates a CT value by multiplying the disinfectant residual concentration, measured in milligrams per liter (mg/L), by the effective contact time measured in minutes.

Example CT calculation. Free chlorine is added to the water supply as the water leaves the well and goes into a storage tank. When the water reaches the first customer's connection, the free residual concentration is always above 0.5 mg/L. A tracer study indicates that the time required for the first 10 percent (T10 value) of the water to reach the customer's connection is 80 minutes. The minimum CT achieved is: 0.5 mg/L × 80 minutes or 40 mg/L-min.

Example tables in the Student Workbook show CT values required for inactivation of *Giardia* and viruses by free chlorine and chloramine. More extensive CT tables may be found in *Guidance Manual for Compliance With The Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*, Office of Drinking Water, USEPA, Washington D.C., October 1989, or RG-211, Water Supply Division, TCEQ.

CT tables indicate that using free chlorine with a 40- CT Value, a pH below 8.5, and temperature above 20 °C inactivates about 95% of *Giardia* cysts and greater than 99.99% of viruses.

Further examination of these tables reveals that free chlorine is much more effective than monochloramine for inactivating viruses and *Giardia* cysts. Free chlorine is also more effective against viruses and bacteria than it is against *Giardia*.

There is another important fact to remember. For all practical purposes, free chlorine and monochloramine are completely ineffective against *Cryptosporidium* oocysts.

Activities

Activity 2. Using CT Tables

2.4 Disinfection Residuals

There are several types of disinfection residuals that may be present in the water supply. The two most commonly used by small systems are:

- Free chlorine residual
- Monochloramine residual

Free Chlorine Residual

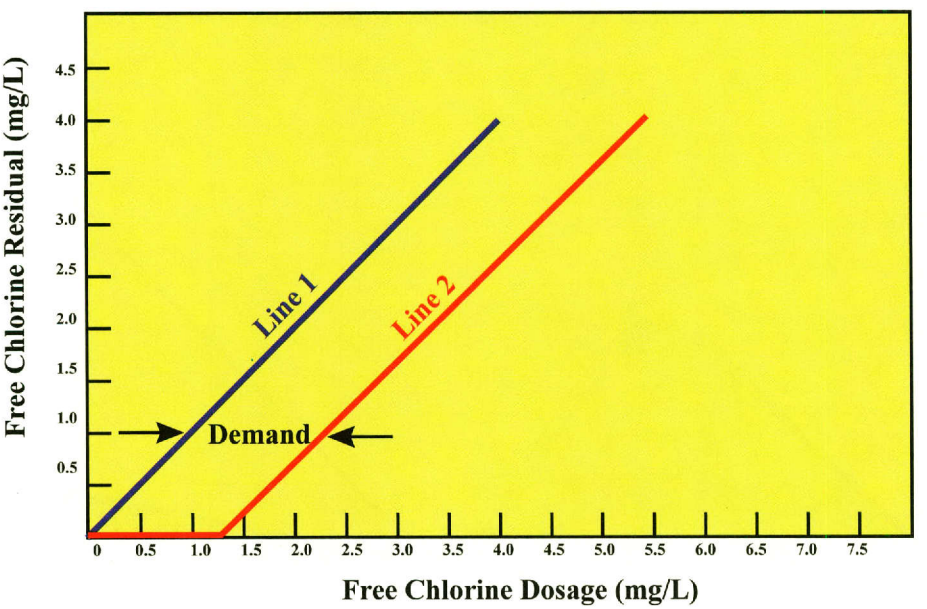
A free chlorine residual is obtained when enough chlorine (in the form of gas chlorine, calcium hypochlorite, or sodium hypochlorite solution) is added to the water to overcome chlorine consuming materials and produce hypochlorous acid (HOCl) and hypochlorite ion (OCl^-).

Four important terms are:

Dosage is the amount of chlorine added to the water.
Demand is the amount of chlorine used up by reacting with materials in the water.
Residual is the amount of chlorine that can be measured in the water.
Breakpoint occurs when the demand has been met and free chlorine residual is present.

Figure 2 shows the relationship between these disinfection terms.

Figure 2. Free Chlorine Dosage and Response Curves



Line 1 shows an ideal water with no chlorine demand. All of the chlorine applied as a dosage shows up as chlorine residual. There is no demand so chlorine residual equals chlorine dosage.

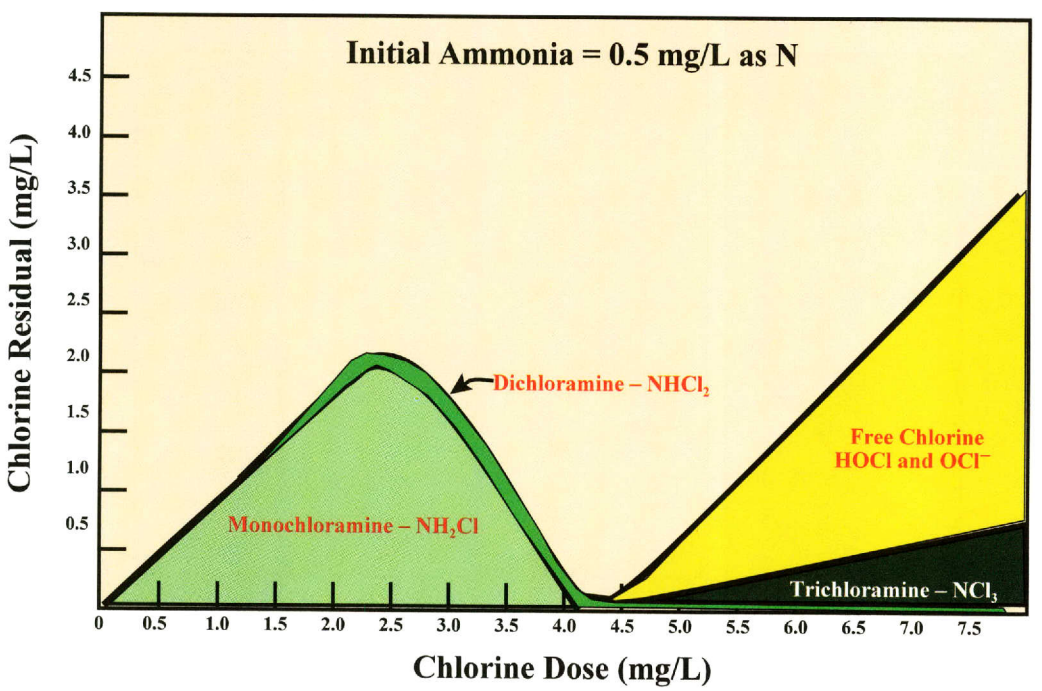
Line 2 shows a water supply with a strong chlorine demand as might be created by ferrous iron or hydrogen sulfide in the well water. Until the dosage reaches 1.3 mg/L there is no chlorine residual. When the demand has been met, the breakpoint is reached and additional chlorine added shows up as chlorine residual. The formula is: Chlorine Residual = Chlorine Dosage - Chlorine Demand.

Monochloramine Residual

The second most common disinfectant in the distribution system is monochloramine. Monochloramine forms rapidly when free chlorine and ammonia come into contact. Several different chlorine and chloramine compounds are formed by reactions involving chlorine, ammonia and water.

Figure 3 shows what happens when free chlorine is added to a water supply containing 0.5 mg/L ammonia-N. Initially chlorine reacts with ammonia to form monochloramine. As more chlorine is added the reaction forms dichloramine then trichloramine. At the breakpoint and beyond, free chlorine residual is formed.

Figure 3. Chloramine Residual Curves

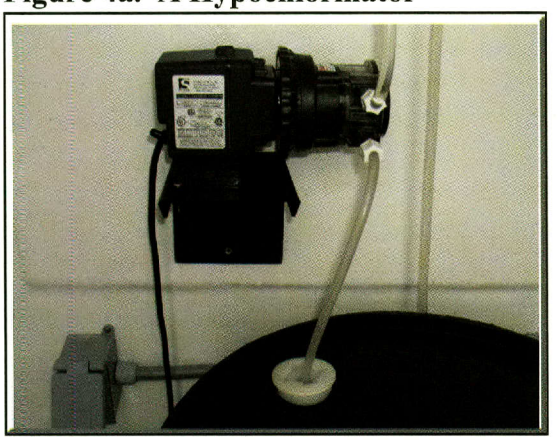


2.5 How Disinfectants are Added

Small water systems often use hypochlorinators to inject a chlorine solution into the water as it travels from the well to storage. When properly maintained, hypochlorinators are reliable. They are also easily replaced. Keep a spare on hand because state rules require that water systems have the ability to continuously feed chlorine.

The most common type of hypochlorinator is a positive displacement feeder or chemical feed pump. This unit uses a piston or diaphragm to inject the chlorine solution. The unit is adjustable by varying the stroke length or stroke rate and when properly calibrated gives reliable and accurate chlorine feed rates.

Figure 4a. A Hypochlorinator



A peristaltic pump is sometimes used for chlorine injection. By compressing a plastic tube, the solution is forced from the feed tank to the injection point. The normal injection point is between the well discharge and the first storage tank.

Peristaltic pumps are usually more reliable, maintain prime better, and easier to maintain than diaphragm pumps, but they generally cost more.

Figure 4b. A Gas Chlorinator

Another type of chlorinator is called a gas chlorinator. With this feed system, a small, secondary water stream, usually from the high-service pump, travels through an injector creating a vacuum. The vacuum opens valves in the chlorinator and pulls gas chlorine from a chlorine cylinder into the secondary water stream. A rotameter measures the chlorine gas flow as it travels from the chlorine cylinder through the chlorinator. The secondary water stream then mixes with water coming from the well and chlorine is dosed into the water supply.

3 Disinfection Residual Sampling and Analysis

3.1 Procedures for Measuring Chlorine Residuals

Acceptable Methods for Analyses

To meet state and federal requirements, operators must use an approved method. Table 1 lists acceptable methods and test equipment commonly used by small water systems for measuring chlorine residuals.

Table 1. Acceptable Methods for Chlorine Residual Analyses

Parameter	Minimum Accuracy[1]	Acceptable Methods[2]	Examples of Commercial Test Kits/Equipment[3]
Free or Total Chlorine	± 0.1 mg/L	DPD, Colorimetric[4] (SM 4500-C1 G)	Hach DR100, DR700, DR/2000, etc. & Hach Pocket Colorimeter La Motte DC-1100CL & LaMotte SMART Colorimeter Hach CL17 (on-line)

Notes:
(1) Minimum accuracy needed to comply with TCEQ requirements. The value shown may be different from the value contained in Standard Methods or EPA procedures.
(2) Standard Methods, 19th Edition. EPA Methods of Analysis
(3) This is not a complete list of all commercially available test kits nor an endorsement of any specific product.
(4) Color comparator test kits, such as Hach's color wheels and LaMotte's Octet comparator, are not acceptable for in-plant (CT) testing. These test kits may be used for distribution testing although more sophisticated colorimetric meters are recommended and will be required in the future.

Equipment

- Hand held colorimeter
- Clippers or scissors (for opening powder pillows)
- Secondary standards
- Sample vials

Samples must be analyzed immediately and cannot be preserved for later analysis.

3.2 Quality Assurance and Quality Control

There should always be a sample, a blank, a duplicate, and a standard analyzed each day you conduct routine chlorine residual samples. You should keep a record of each of these test results.

While a hand-held colorimeter is an USEPA accepted method, operators must use correct procedures and followed quality assurance requirements. This means that results are not acceptable for compliance reporting unless:

1. Instrument operating instructions are followed.
2. Secondary standards are analyzed each day the instrument is used.
3. Reagents are not used beyond their expiration date.
4. At least one duplicate sample is analyzed each day the instrument is used.
5. The instrument is properly calibrated according to manufacturer's instructions.

Figure 5. Hand-Held Colorimeter

3.3 Preparing to Measure Disinfectant Residuals

Follow these guidelines before analyzing a potable water sample for residual chlorine:

1. Flush the faucet thoroughly to ensure that stagnant water has been replaced by water from the main.
2. Analyze samples immediately after collection. The chlorine residual continues to change with increasing time, temperature increases, and exposure to sunlight, air, or chlorine-consuming materials.
3. Collect samples in cleaned and rinsed glass containers or directly into sample analysis cells.
4. Keep sample cells clean, rinsing with distilled water and the sample to avoid contaminating materials. Use the "blank" cell only for running blanks.

5. Do not use the same sample cell for both free and total chlorine residual tests. For best results dedicate a set of cells for each test and keep them separate.
6. Use a sample analysis form to record the results of all analyses. An example form is provided in the Student Workbook.

3.4 Procedure for Samples in the Instrument's Low Range

The procedure for free or total chlorine residual is easily conducted with a hand-held colorimeter. Follow the operating instructions for your instrument. An example procedure is:

1. After flushing the sample line, collect 50 mL of sample in a clean and rinsed 100 mL or larger glass beaker.
2. Immediately rinse and fill three 10 mL sample cells (blank, test, duplicate) from the glass beaker or rinse and fill the three sample cells directly from the tap. Accurately adjust the sample volume to the 10 mL mark on each cell.
3. Press the power key to turn on the instrument.
4. Remove the meter cap. Place one of the sample cells (a sample blank) in the cell holder. Rotate the cell until the diamond alignment mark faces forward. Seat the meter cap over the sample.
5. Press the Zero/Scroll button. The display will show "- - - -" then "0.00". If the meter shows "0.0" it is set to read a high range sample and must be reset for the low range. Refer to instrument instructions to set the proper range for the colorimeter.
6. Remove the sample blank.
7. To a second 10-mL cell add the contents of one DPD Free Chlorine Powder Pillow for a free chlorine residual analysis or one DPD Total Chlorine Powder Pillow for total chlorine residual analysis.
8 Cap the cell and shake gently for 20 seconds. A pink to red color will quickly develop if chlorine is present. If the sample turns yellow after reagent addition or if the display shows over range you must use the correct procedure for high range samples.
9. For free chlorine, place the prepared sample cell in the cell holder, cover with the meter cap. Rotate the cell until the diamond alignment mark faces forward. Press READ/ENTER **within one minute** after adding the DPD Free Chlorine Powder Pillow.
10. For total chlorine, place the prepared sample cell in the cell holder. Cover the sample with the meter cap. Rotate the cell until the diamond alignment mark faces forward. **At least three minutes** after adding the DPD Total Chlorine Powder Pillow but not longer than six minutes, press READ/ENTER. The instrument will show "- - - -" followed by the results in mg/L chlorine.
11. Record the results on the chlorine analysis sample form on the line for the Sample Reading.
12. Repeat steps 7 through 11 for the third sample cell. Record the results on the line for the Duplicate Sample Reading.

3.5 Procedures for High-Range Samples

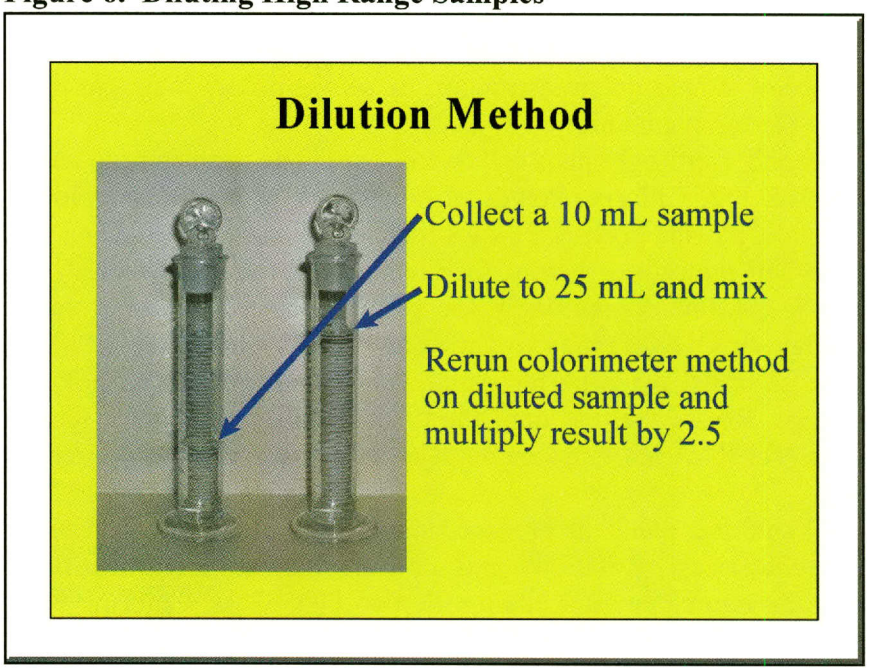
When the chlorine concentration is above the instrument's low range a proper high-range procedure must be used. You cannot pour the prepared sample into the high-range sample cell and reread the result on the instrument's high range. You must repeat the chlorine analysis using either the dilution procedure or the high range procedure.

Dilution Method for High-Range Samples

You need a 25-mL graduated cylinder with a stopper and chlorine demand-free purified water for the dilution procedure.

1. Accurately measure either 5 or 10 mL of the sample to be analyzed into the 25-mL graduated cylinder and fill the cylinder to 25-mL with demand-free purified water. If a 5-mL sample is used the multiplier will be 5. If a 10-mL sample is used the multiplier will be 2.5.
2. Shake the stoppered cylinder gently to thoroughly mix the sample with the dilution water.
3. Repeat the procedure for free or total chlorine residual described above on the diluted sample and record the results on the sample form for the Diluted Sample Reading.
4. Multiply the Diluted Sample Reading in mg/L by the Dilution Multiplication Factor to obtain the sample's actual chlorine concentration. Record the results on the form on the line labeled Chlorine Concentration (mg/L).

Figure 6. Diluting High Range Samples



To accomplish the sample dilution conveniently, pipet the chosen sample portion into a clean graduated cylinder (or clean volumetric flask for more accurate work) and fill the cylinder (or flask) to the desired volume with deionized, chlorine demand-free water. Mix well. Use the diluted sample when running the test.

As an aid, Table 2 shows the amount of sample taken, the amount of deionized water used to bring the volume up to 25 mL, and the multiplication factor.

Table 2. Sample Dilution

Sample Volume (mL)	Deionized Water Used to Bring the Volume to 25 mL (mL)	Multiplication Factor
12.5	12.5	2
10.0	15.0	2.5
5.0	20.0	5
2.5	22.5	10
1.0	24.0	25

Instrument High-Range Method

1. Fill the 1-cm light path cell with the sample (blank) and cap.
2. Turn on the instrument. Set the meter to the high range by following the instrument instructions.
3. Place the blank into the cell holder with the diamond alignment mark facing the keypad and seat the meter cap over the sample.
4. Press the Zero/Scroll button. The display will show "- - - -" then "0.0". If the meter shows "0.00" it is set to read a low range sample and must be reset for the high range. Refer to instrument instructions to set the proper range for the colorimeter.
5. Remove the sample blank.
6. Fill a second 1-cm light path cell to the 5-mL line with sample and add the contents of two DPD Free Chlorine Powder Pillows for a free chlorine residual analysis or two DPD Total Chlorine Powder Pillows for total chlorine residual analysis.
7. Cap the cell and shake gently for 20 seconds. A pink to red color will quickly develop if chlorine is present. If the sample turns yellow after reagent addition or if the display shows over range you must use the dilution method.
8. For free chlorine, place the prepared sample cell in the cell holder, cover with the meter cap. Rotate the cell until the diamond alignment mark faces forward. Press READ/ENTER within one minute after adding the two DPD Free Chlorine Powder Pillows.
9. For total chlorine, place the prepared sample cell in the cell holder. Cover the sample with the meter cap. Rotate the cell until the diamond alignment mark faces forward. At least three minutes after adding the two DPD Total Chlorine Powder Pillows but not longer than six minutes, press READ/ENTER. The instrument will show "- - - - " followed by the results in mg/L chlorine.

10. Record the results on the chlorine analysis sample form on the line for the High Range Reading.
11. Repeat steps 6 through 10 for the third sample cell. Record the results on the line for the Duplicate Sample Reading.

Figure 7. High-Range Method

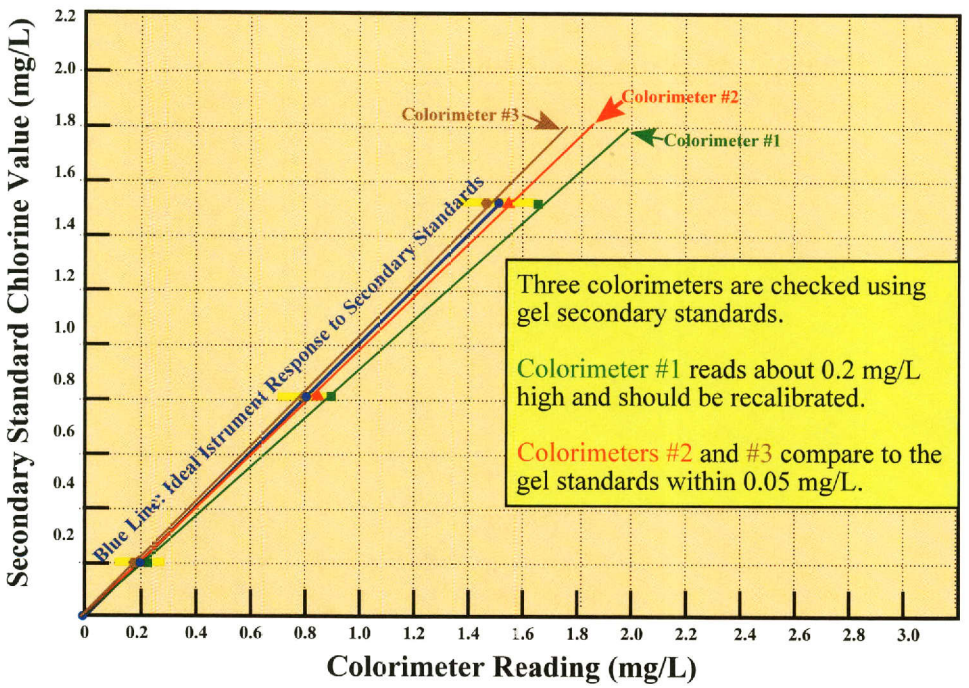
3.6 Checking the Instrument and Procedure

Instrument Repeatability Check

Secondary Standards are available to check the instrument. These standards are analyzed by the manufacturer and used to ensure that the instrument is working consistently. The certificate of analysis on each secondary standard lists the expected value and the tolerance range. The secondary standards cannot be used to calibrate the instrument.

1. Place the secondary standard marked "blank" in the sample cell, seat the meter cap and press the ZERO/SCROLL button. The display will show "- - - -" then "0.00".
2. Place each of the other three secondary standards in the sample cell, seat the meter cap and press the READ/ENTER button. The display will show "- - - -" followed by the results in mg/L. Record each of these results on the chlorine analysis form.
3. When the instrument is working properly each secondary standard should produce a colorimeter reading within the tolerance range.
4. If the instrument does not produce results within the tolerance range, it needs calibration or new values are needed for the secondary standards. Instrument calibration and assigning values to secondary standards are laboratory procedures.

Figure 8. Instrument Check Using Gel Secondary Standards



Accuracy Check by the Spike Recovery Method

Operators must verify that their reagents and procedures can detect a known amount of chlorine added to a sample. This is achieved by "spiking" a sample with a standard chlorine solution and determining the percent recovery of the spike. Chlorine standards in sealed ampules are obtained from testing equipment manufacturers.

1. Store the chlorine standards in a refrigerator until they are used.
2. Protect the standards from light and temperature excesses.
3. Discard the standard when the expiration date is exceeded.

The procedure for the spike recovery method is:

1. Perform a chlorine residual analysis on a potable water sample by adding the DPD reagent to a 10.0-mL sample and mixing.
2. Measure and record the mg/L chlorine in the sample. If this value is at least 0.2 mg/L but not more than 1.0 mg/L proceed with spike recovery.
3. Use the ampule breaker to break the top off the chlorine standard ampule.
4. Use an accurate pipettor to spike 0.1 mL of the chlorine standard to the original prepared sample. Gently shake or swirl to mix.
5. Read the chlorine residual of the spiked sample. Each 0.1 mL of standard chlorine solution spiked into the original 10.0-mL original prepared sample should cause an

increase in the chlorine reading by one percent of the concentration of the ampule standard.

For example, if a 0.1 mL spike of a 27.7 mg/L standard is added to a 10-mL prepared chlorine sample the chlorine reading should increase by 0.27 mg/L. A recovery between 90 and 110 percent of the spike is acceptable. For this example, the amount of chlorine spike recovered should be between 0.24 and 0.30 mg/L

The spike recovery procedure performs satisfactorily when there is a small chlorine residual in the sample and the spike is added after the DPD reagent is added to the sample. It will not work if the sample has a chlorine demand and if the standard is added before addition of the reagent.

Figure 9. Standard Additions for Checking the Procedure

Accuracy Check by the Standard Additions Method

The Standard Additions Method is used to check the accuracy of the chorine residual testing procedure. This is done by adding incremental volumes of a standard chlorine solution to demand-free water and running the chlorine residual. Obtain sealed ampules of chlorine standard from the testing equipment manufacturer.

1. Store the chlorine standards in a refrigerator until they are used.
2. Protect the standards from light and temperature excesses.
3. Discard the standard when the expiration date is exceeded.

The procedure for the standard additions method is:

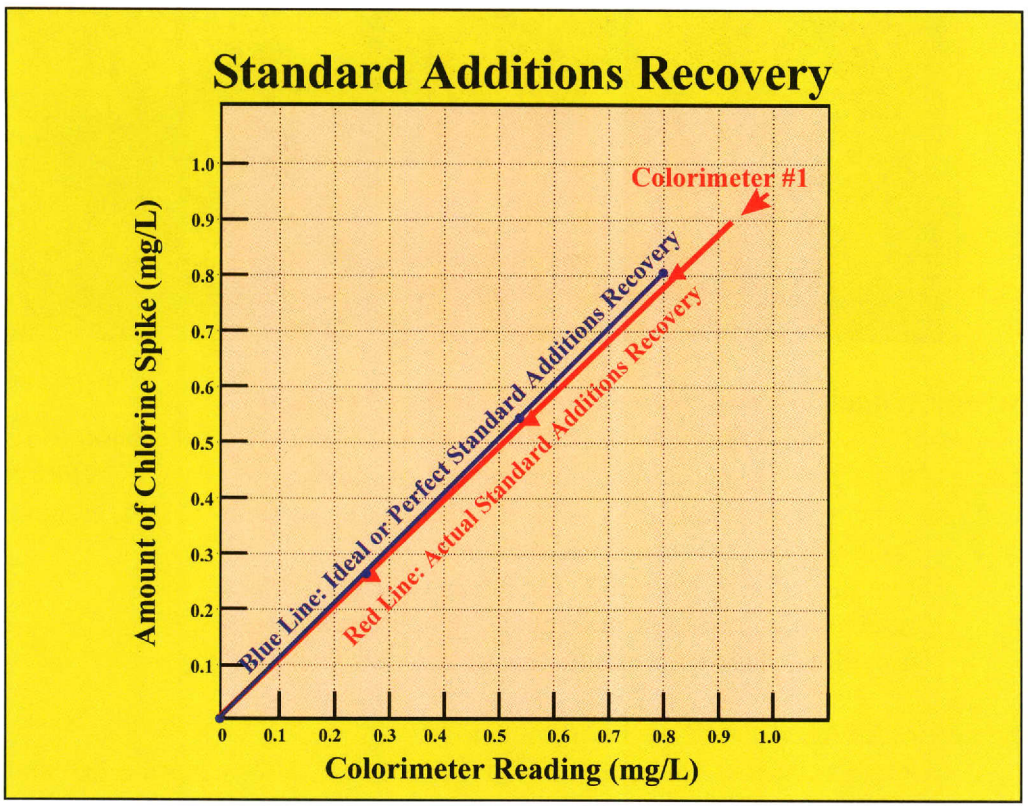
1. Obtain sufficient chlorine demand free water. Note: Chlorine demand free water is laboratory purified water that does not consume chlorine.
2. Prepare three 10.0-mL samples using chlorine demand free water. Make sure the sample volume is 10.0 mL. Add a 10-mL DPD powder pillow to each of the three samples and swirl to mix.
3. Use one of the samples to zero the colorimeter.

4. Use the ampule breaker to remove the top from a low range chlorine standard ampule.
5. Use an accurate pipettor to add 0.1, 0.2, and 0.3 mL of chlorine standard to the three 10.0-mL samples. Shake gently or swirl to mix.
6. Read the chlorine residual of each of the samples. Each 0.1 mL of standard added to the sample should cause an incremental increase in chlorine.
7. Follow the instructions that came with the chlorine standard to calculate the expected incremental increase in chlorine concentration.

Instrument Calibration

Calibrate instruments used for chlorine residual analysis as required by approved analytical methods. Calibration is accomplished by qualified personnel under carefully controlled conditions. A certified laboratory is a good resource for calibrating a colorimeter. The Student Workbook has a worksheet for recording the results of chlorine residual tests.

Figure 10. A Standard Additions Recovery Curve



Color Comparator Kit - Sample Collection and Handling

1. After thorough flushing, collect sufficient water in a clean glass container from the sampling tap at a location described in your monitoring plan.
2. Follow the manufacturer's directions for using the color comparator kit.
3. Rinse the two viewing tubes with distilled water. Rinse and fill the control tube to the graduation mark with sample water. Clean the tube carefully with a wipe and place it in the opening behind the color scale.
4. Rinse and fill the sample viewing tube to the graduation mark with sample water.
5. Add the complete contents of a pre-packaged color reagent. Use a DPD Free Chlorine Reagent packet when testing for free chlorine residual. Use a DPD Total Chlorine Reagent packet when testing for monochloramine residual. Swirl to dissolve the reagent and remove air bubbles.
6. After adding the DPD reagent, wait at least 15 seconds but not more than 1 minute for free chlorine residual. Wait at least 3 minutes but not more than 6 minutes when determining total chlorine residual. Then clean the sample tube carefully with a wipe before placing it into the sample opening.
7. Hold the comparator up to strong bright light. Sunlight is best, but the sun should not be directly behind the comparator. Then compare the sample viewing tube to the color scale and find the color match. Record the value in mg/L.
8. Discard the contents of the sample tube and rinse again with distilled water. Repeat steps 4 through 7 when performing a duplicate. A duplicate is required each day that chlorine residuals are determined.
9. Record the results on the chlorine residual report form.

Please note that if, after sampling, you find the chlorine residual is less than 0.2 or 0.5 mg/L (depending on the type of residual), take immediate steps to determine the source of the problem and correct it. Then take another sample and re-analyze it.

Activities

Activity 3. Operating a Colorimeter

Activity 4. Chlorine Residual Testing

Activity 5. Spike Recovery

Activity 6. High Range Samples

4 Bacteriological Sampling

Water used for drinking, cooking, or washing dishes must not be contaminated with microorganisms that may cause disease. Unsafe water can spread a number of diseases that are known as waterborne infections including such illnesses as typhoid, cholera, and dysentery.

Most of the microorganisms that cause waterborne diseases are difficult to detect in water samples. However, a group of bacteria called "coliform bacteria" is relatively easy to detect in water. Coliform bacteria usually do not cause disease, and are found throughout the environment (soil, natural water). Some of the coliform bacteria, such as fecal coliform and *E.coli*, are found when the water has been exposed to fecal matter. Therefore, if coliform organisms are present there is a possibility that fecal coliform are also present (even if they were not detected). If fecal coliform are present, or may be present, disease-causing organisms may also be present.

4.1 How to Prevent Contamination of Your Water Sample

Sometimes the presence of coliform organisms in a water sample results from mistakes in the sampling process. Poor sample sites and poor sampling procedures cause many of the coliform positive results. Consider these questions.

Is the water system properly maintained?
Has the water system selected good sample sites?
Are proper sampling techniques used?

Routine System Maintenance

1. Flush dead end mains monthly.
2. Perform area-wide flushing if:
   a. You are unable to maintain adequate chlorine residuals.
   b. You have experienced water outages or have lost pressure.
   c. You have coliform positive samples or frequent samples marked "unsuitable for analysis."
3. If any portion of the distribution system is opened for repairs or construction, flush, disinfect, and collect construction or special coliform samples. When possible, do not return lines to service until coliform sample results are negative.
4. Maintain adequate chlorine residuals throughout the water system including remote connections. Consider increasing chlorine residuals if a sample is coliform positive.
5. Do not collect coliform samples if there is no chlorine residual. Instead, correct system problems as soon as possible and flush to restore consistent and adequate chlorine residuals.

Sample Site Selection

1. The TCEQ recommends using a hose bibb faucet located outdoors and away from sources of contamination. Avoid drinking fountains, restroom faucets, and faucets in food preparation areas. Faucets should be accessible and located at least 18 inches above the ground.

2. Sample sites should be representative of the entire distribution system and should be carefully selected. Know the sample sites listed in your monitoring plan.
3. Know the sites that were previously sampled and the sites that need to be sampled.

4.2 How to Collect a Bacteriological Sample

Obtain and use sample containers provided by an approved testing laboratory that are less than 6 months old. Obtain and use the correct sample submission form. Provide all required information on the form.

Prior to taking the sample check the following:

- When sampling outside is required, avoid windy and rainy days.
- Remove hoses, vacuum-breakers, or other attachments from faucets to prevent contamination from these sources. Ensure that the faucet is clean. The faucet should not leak.
- Allow the faucet to flow full long enough to clear the line, this would typically be for at least two minutes (sometimes much longer) or until the water reaches a constant temperature.
- After flushing the line, it can be shut off and chlorine or a small flame can be used to sanitize the faucet. These sanitizing techniques are optional but are highly recommended.

Sample Carefully

- Samples are easily contaminated, so use care during the sampling procedure. Wash your hands with soap and dry them with a clean towel just prior to sampling. Sample containers should be stored and handled using sanitary precautions. Avoid touching internal surfaces of the sample container, lid or seals.
- The sample container should be clean and sterile. It will contain a white tablet, a crystalline residue, or a few drops of liquid. This material is sodium thiosulfate which is needed to neutralize any disinfectant residual that may be in the sample water. Do not rinse the sample container. It is meant to be opened, filled, and resealed only.
- Establish a slow, steady flow (about pencil size) from the faucet.
- Carefully open the sample container and carefully fill the container with product water to the fill line (100 mL). Do not overfill the container, an air space is needed for sample mixing at the laboratory. While filling the sample container avoid contact

with the sample or inside surfaces of the sample container or lid. Seal the container. Then shut off the water.

- Dry, number and date the sample bottle. Record the chlorine residual on the bottle. Examine the sample for leakage. Leaking samples can not be accepted by the lab.

- Place the sample in a clean refrigerated container away from any source of heat or direct sunlight. Sample preservation requires refrigeration to between 1°C and 4°C from the time the sample is collected until it is received by the testing laboratory. Put the sample bottle into a clean plastic bag if it could come into direct contact with ice water.

- The sample must be transported to the testing laboratory as soon as practical but no later than 30 hours after collection. It must arrive at the testing laboratory at a day and time acceptable for testing. Deliver (preferred) or mail (if you can't deliver) the sample to the nearest approved lab.

Complete the sample submission form TCEQ-10525

Local laboratories may have their own similar form. It is a good practice to fill out most of the form in advance. Complete the form with the following information:

Public water system identification number (a correct PWS ID has 7 digits)
Report date
Public water system name and county
Name and mailing address in area designated as "Send Results To:"
Sample Site (must correspond to a bacteriological sample site)
Name and phone number of person who collected sample
For "SYSTEM TYPE" mark "Public"
For "SAMPLE TYPE" mark "Distribution" if it is a routine sample. Mark "Repeat" if the sample follows notification that a previous sample contained coliform organisms.
For "WATER SOURCE" mark "Groundwater" or "Surface Water" as appropriate.

Complete the following information in the field as samples are collected:

Date and time of sample collection
Record the disinfectant residual and type.

The laboratory will complete the sample identification including:

Lab ID, sample number and date received.

Do not falsify or make up any portion of the sample collection procedure or sample record. This process is a critical check on the bacteriological safety of the water supply.

If the bacteriological sample submission form is not filled out correctly, the sample will not be counted for compliance. Water systems may receive monitoring violations if the operator fills out the form incorrectly. The lab or TCEQ cannot fixed incorrect forms.

Activities

Activity 7. Coliform Sampling

4.2 What the Results Mean

The results will be mailed to you after completion of the analysis. If coliform is found, the lab or TCEQ contact the system by phone. The key words on the report are:

Total Coliform Organisms	☐ **Found**	☐ **Not Found**
Fecal Coliform/*E. coli*	☐ **Found**	☐ **Not Found**

When coliform organisms are found, this is called a **positive** result. This means that coliform organisms were present in the sample, the drinking water supply may be contaminated, and corrective actions may be necessary.

When coliform organisms are not found, this is called a **negative** result. Negative means that coliform organisms were not present in the sample and the water was considered to be bacteriologically safe at the time of sampling. A long, uninterrupted history of negative results is the most desirable result for a public water supply.

When Coliform Organisms are Found. If you need help, contact the TCEQ Public Drinking Water Section for guidance. Otherwise, the water system should flush and disinfect any section of the water system that indicates contamination. When you learn of a positive coliform result, repeat samples must be collected within 24 hours. If you are not able to meet the 24-hour requirement, call the Public Drinking Water Section at 512-239-4691 and ask to speak to a member of the Bacteriological Subgroup. Instructions are found in 290.109.

When the Sample is "Unsuitable for Analysis." This means that the lab was unable to conduct a valid test. The water supply must submit a replacement sample within 24 hours. Make sure that proper sampling procedures are followed. Samples must be collected in approved, sterile containers provided by the testing laboratory, and every precaution must be taken to avoid contamination. Otherwise, lab analysis results are without value and the drinking water may be unsafe.

4.3 Bacteriological Sample Analysis

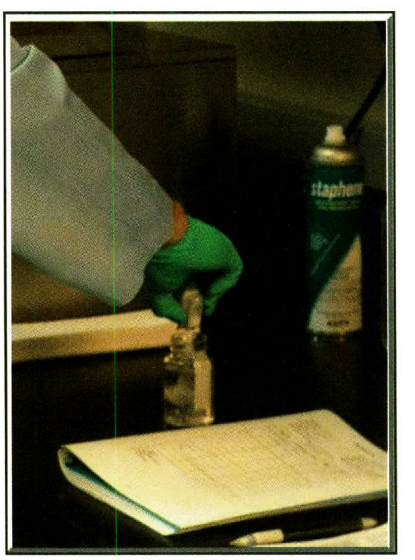
Coliform test methods simultaneously detect total coliform and *E. coli* in water samples. When total coliform bacteria metabolize the nutrient indicator, the sample turns yellow. When *E. coli* metabolize a second nutrient indicator, the sample fluoresces. One colony forming unit per 100 mL sample can be detected within 24 hours even when 2 million heterotrophic bacteria per 100 mL sample are present.

Samples are initially logged in and numbered when they arrive at the testing laboratory.

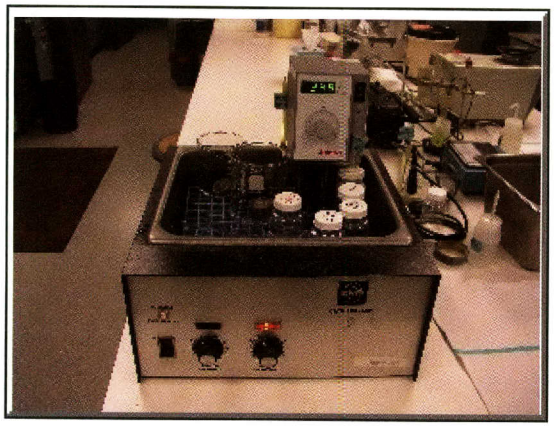
Samples are then placed into a refrigerator unless the analysis procedure is started quickly.

Samples are checked for correct volume, leaks, dirt, or other problems before the testing procedure is started.

The sample nutrients used by the lab are for a 100 mL sample. Samples that are less than 97.5 mL or more than 102.5 mL are not suitable for analysis.



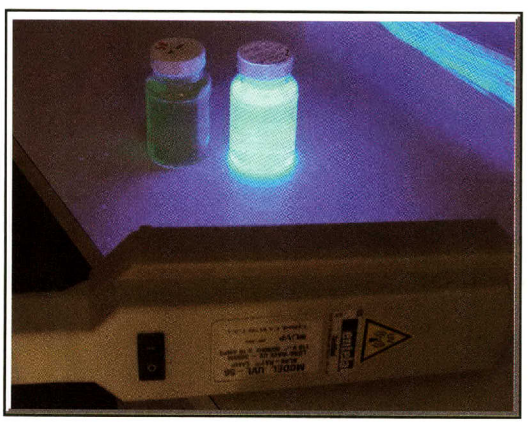
The sample nutrient media simultaneously detects total coliform and *E. coli* in water.



After nutrients are added, samples are brought up to incubator temperature in a water bath. This ensures that each sample is incubated at 35°C ± 0.5°C for 24 hours. The incubation temperature is tightly controlled and monitored with two calibrated thermometers.

After 24 hours test results are interpreted by lab personnel. If the sample color is less yellow than the reference, the sample is negative for total coliform and *E. coli*. If the sample is yellow equal to or greater than the reference, it is positive for total coliform. In this picture the reference is the middle bottle, a negative sample is on the right and a positive sample is on the left.

If the sample is yellow and fluorescence equal to or greater than the reference, the sample is positive for *E. coli*. Below the left sample is total coliform positive and the right sample is positive for total coliform and *E. coli*.



4.4 Response to a Coliform Positive Sample

- A water system must collect three (3) repeat samples for each coliform positive result or four (4) if only one (1) routine sample is collected per month.
- A water system must collect at least five (5) routine samples during the next month.

Collect the required set of repeat samples within 24 hours of being notified of the positive result or as soon as possible if the local testing lab is closed. Collect all repeat samples on the same day.

Table 3. Requirements for Collecting Repeat Samples Following a Coliform Positive

Population Served	Routine Samples Required	Minimum Number of Repeat Samples Required	Where Samples Are Taken*
1 to 1,000	1	4	1 at the original sample point 1 within five connections upstream 1 within five connections downstream 1 additional within five connections
1,001 to 2,500	2	3	1 at the original sample point 1 within five connections upstream 1 within five connections downstream
2,501 to 3,300	3	3	1 at the original sample point 1 within five connections upstream 1 within five connections downstream

* If a water system has a single service connection, they may collect daily repeat samples at that single service connection until the required repeat samples have been collected.

The TCEQ may invalidate a total coliform positive sample under certain conditions such as:

1. An improper sample analysis at the laboratory caused the coliform positive.
2. The laboratory establishes that the sample was unsuitable for analysis.
3. The coliform positive resulted from a domestic or non-distribution system plumbing problem.
4. The water system provides written documentation that shows the coliform positive result is due to a circumstance or conditions which does not reflect water quality in the distribution system.

If a sample is invalidated, the water system must collect another sample at that location within 24-hours of being notified.

4.5 Compliance and Public Notification

Acute Violation. A repeat sample is fecal coliform positive or *E. coli* positive. A total coliform positive repeat sample follows a fecal coliform positive or *E. coli* positive routine sample.

Non-Acute Violation. If more than one sample collected during a month is total coliform positive, but none of the routine or repeat samples are fecal coliform positive or *E. coli* positive. A repeat total coliform positive sample, not invalidated by TCEQ, is a non-acute violation

Monitoring Violation. The water system fails to provide the required number of suitable samples.

Reporting Violation. The water system fails to report the results when required.

Reporting
A water system that has a fecal coliform positive or *E. coli* positive must report the findings to TCEQ by the end of the day that the system receives notification.

A water system which commits a MCL violation must report the violation to TCEQ immediately after it learns of the violation, but no later than the end of the next business day.

A water system which has failed to comply with a coliform monitoring requirement must report the monitoring violation to TCEQ with 10 days.

Public Notification
Water systems that have microbiological violations are required to notify the public in accordance with notification standards. The TCEQ will direct water systems in public notification procedures.

An acute violation requires public notification within 24 hours by radio or television in addition to a local newspaper. The words "Serious Health Concern" are required in this notification.

A non-acute violation requires public notification within 30 days by newspaper, mail delivery, or hand delivery. The words "Possible Health Concern" are required in this notification.

Learn more about disinfection residual reporting requirements from TCEQ's RG 421: Coliform Sampling for Public Water Systems. You can get a copy of RG 421 online or from TCEQ's Publication Section at 512-239-0028.

5 Disinfection Residual Reporting

In January 2004, all community and nontransient noncommunity public water systems that use only purchased water or groundwater were required to begin reporting their distribution system disinfection results.

5.1 Maximum and Minimum Disinfectant Residual Levels

Minimum disinfectant residual levels in the distribution system are critical because disinfection kills disease-causing microorganisms. Waterborne diseases including diarrhea, typhoid, and hepatitis are prevented by proper disinfection.

Maximum disinfectant residual levels are also regulated because there may be increased risks of cancer to people who drink water with very high levels of free or combined chlorine. Table 4 shows both the minimum and maximum allowable free chlorine and chloramine residual levels in distribution samples.

Table 4. Maximum and Minimum Disinfectant Residual Levels for Free Chlorine or Chloramine

Disinfectant	Minimum Residual Measured in the Distribution System	You are in compliance if:	Maximum Residual Disinfectant Level (MRDL)	You are in compliance if:
Free chlorine	0.2 mg/L	No more than 5% of your distribution system samples are at or below these minimums. To determine this, each month look at the sample results taken that month and the month before. For this two-month set of samples, calculate the percent of samples that are at or below the minimum.	4.0 mg/L	The Running Annual Average (RAA) of all distribution samples is at or below 4.0 mg/L.
Combined chlorine (also called chloramines)	0.5 mg/L		4.0 mg/L	

The number of samples that the PWS must take depends on the number of customers served. Table 5 shows that the disinfection residual samples must be taken:

- at the same time that coliform samples are taken
- routinely throughout the distribution system

Table 5. Minimum Number of Disinfectant Residual Samples

Population Served	Disinfectant Residual Samples Collected with Coliform Samples	Frequency of Routine Disinfectant Residual Samples Required
1 – 750	1 per month	Weekly
750 – 1,000	1 per month	Daily
1,001 – 2,500	2 per month	
2,501 – 3,300	3 per month	
3,301 – 4,100	4 per month	
4,101 – 4,900	5 per month	

- For systems serving fewer than 750 people, weekly disinfectant residuals are required along with a disinfectant residual sample taken when a coliform sample is collected.
- For systems serving more than 750 people, daily disinfectant residuals are required along with a disinfectant residual sample taken when coliform samples are collected.
- You may use the disinfectant residual measurement from a scheduled coliform sample as the measurement for that day or week.
- If you collect many coliform samples on one day, the residuals count for that day only. For example, if you take three coliform samples and disinfectant residuals on Tuesday, you must still measure disinfectant residuals every other day of the week.

The best way to keep track of this is to make a distribution system sample site list and follow the sample schedule. Examples are shown in Tables 6 and 7.

Table 6: Example Sampling Schedule for a System Serving 1 to 750 People

Sample Site		When the Sample Is Collected	
		Coliform	Disinfectant Residual
A	Water District Office (North)	First Monday or Tuesday of each month alternating through the five routine sample sites. (Avoid late week and late month samples so there is time for retesting and repeat samples.)	Monday or Tuesday of each week alternating through the five routine sample sites.
B	234 Midtown Drive		
C	354 South Street		
D	1215 West End		
E	322 Eastward Ave.		

Table 7. Example Sampling Schedule for a System Serving 750 to 4,900 People

Sample Site		When Sample Are Collected	
		Coliform	Disinfectant Residual
A	City Hall (middle of town)	First Tuesday of each month alternating through the five routine sample sites	Every Monday
B	123 Wayout North Street		Every Tuesday
C	654 Waydown South Street		Every Wednesday
D	1000 West Side		Every Thursday
E	2322 Eastward		Every Friday
F	157 Lake Way View (operator's house)	Alternate Site: Use when a site listed above cannot be used.	Every Saturday
G	157 Lake Way View (operator's house)		Every Sunday

5.2 Reporting Requirements

Water systems that use groundwater or purchased water began mandatory reporting of distribution disinfectant levels in 2004. Keep track of disinfectant sample results and send reports to TCEQ according to the schedule shown in Table 8.

Table 8. Submitting Quarterly Reports to TCEQ

Quarter 1	Quarter 2	Quarter 3	Quarter 4
January, February, March	April, May, June	July, August, September	October, November, December
Due April 10	Due July 10	Due October 10	Due January 10

5.3 Compliance

If a PWS has more than 5 percent of samples collected that measure less than the minimum residual disinfectant concentration each month for any two consecutive months, it commits a non acute treatment technique violation. Public notice to customers is required.

If a PWS has a running annual average of all distribution samples that is greater than 4.0 mg/L, it commits a non acute treatment technique violation requiring public notification.

Failure to monitor or send in reports may result in a non acute monitoring violation requiring public notification. Learn more about disinfection residual reporting requirements from TCEQ's RG 407: Disinfectant Residual Reporting for Public Water Systems.

The Student Workbook has worksheets and forms used to keep your water system's disinfection residuals and report the information to the state. You can get a copy of RG 407 online or from TCEQ's Publication Section at 512-239-0028.

Activities

Activity 10. Completing the Monthly Report

TCEQ-1252
July 2005

Preparing for a Compliance Investigation

Grant Number: 582-4-61142

This grant is funded by the U. S. Environmental Protection Agency through the Texas Commission on Environmental Quality.

Cluster Training Module

TEXAS SMALL PUBLIC WATER SYSTEM OPERATOR TRAINING PROGRAM (TSPWSOTP)

TEXAS SMALL PUBLIC WATER SYSTEM
OPERATOR TRAINING PROGRAM
Training Module TCEQ-1252
July 2005

Preparing for a Compliance Investigation

Purpose:	Operators will demonstrate the ability to conduct a self-investigation of their water system.
Target Audience:	Operators of groundwater or purchased water systems serving 3,300 or fewer persons.
Time Required:	Approximately three hours (3.0 hours) for a class of eight to ten.
Documents Required:	TCEQ-required plans, maps, reports and records.

Preface

This module prepares operators of groundwater and purchased water systems for compliance investigations. It is a thorough review of the many regulatory design and operational requirements in Chapter 290, especially Subchapters D, F, and H. It provides the operator with an understanding of the most common violations, provides checklists, and explains how to perform a self-investigation prior to the investigator's arrival.

You may have heard them called any number of things: sanitary surveys, annual inspections, compliance investigations, or comprehensive compliance investigations. For many operators they may mean the most stressful time of the year.

There is another way to look at these events. Compliance investigations, which are what we call them, can be opportunities for learning and system improvement. It's all a matter of point-of-view.

In this module, we examine what compliance investigations are intended to do, how they are used, what role the operator plays, and what goes on before, during, and after the investigation. In this module you have an opportunity to play the role of the investigator using checklists created by the agency. You will learn how to prepare, what to do during the investigation, and how to respond to letters of deficiency or notices of violation.

This information can take the stress out of investigations and make them a positive experience.

TEXAS SMALL PUBLIC WATER SYSTEM
OPERATOR TRAINING PROGRAM
Training Module TCEQ-1252
July 2005

Preparing for a Compliance Investigation

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1 The Compliance Investigation

1.1 Purpose and Frequency

A compliance investigation is a formalized review by a regulatory agency of the equipment, treatment techniques, and the operations, maintenance, and management practices of a water system. You may have also heard them referred to as 'sanitary survey' or 'annual inspection'.

In a perfect world, systems would be inspected at least once a year – or maybe not, depending on how you feel about investigations. Because of limited staff and resources in our state and federal governments, most small systems will be inspected at least every three years. However, surface water systems, groundwater systems under the influence of surface water, and systems with excessive problems or violations are inspected more frequently. That's not too bad, is it?

1.2 Use

There are three parties involved in every compliance investigation, and each uses the investigation in slightly different ways:

- The operator and the water system
- The agency and its investigator
- The public

The Operator and the Water System

Investigations are your opportunity to learn what you're doing right, and what parts of your operation need improvement.

Operators sometimes think that investigators just want to find faults, and indeed that's how the process may look at first glance. But viewed another way it confirms that, except for a few corrections, the hundreds of other things you're doing to run a water system are done correctly. Most systems do far more things correctly than incorrectly. When viewed that way, investigations become a positive process for you and your system.

Operators should use the compliance investigation as their opportunity to:

1. Show their owners how well the system is operating;
2. Identify work that needs additional resources; and
3. Bring the system up to state and federal standards.

Investigations are your chance to identify and present the need for more resources on your site to the owners. There's nothing like hearing "The State says we have to do this" to get decision-makers to understand the need for additional resources and improvements.

Figure 1. A TCEQ investigator (second from left) listens to water system staff during a records review.

The Agency and the Investigator

Regulatory agencies use compliance investigations as an opportunity to verify that a water system is complying with all the rules. Yes, there are lots of rules.

Providing drinking water to the public is highly regulated. State and federal agencies have a public obligation to ensure that the entities they regulate are playing by the rules. That is their job.

The Texas Commission on Environmental Quality (TCEQ) has heard all the complaints about how investigators are inconsistent when interpreting regulations. TCEQ goes to great lengths to ensure, first, that each investigator is consistent and fair, then second, that each region in the state applies the rules consistently.

According to the agency:

The TCEQ Field Operations Division is committed to investigating each regulated Public Water Supply (PWS) facility within the time frame established in our targeting strategy. The TCEQ Field Operations Division makes every effort to perform investigations at PWS facilities as consistently as possible across the State. Our consistency is obtained by providing classroom training and on-the-job training (to our staff). The Agency/Division also provides standard operating procedures for staff to follow... *(October, 2004)*

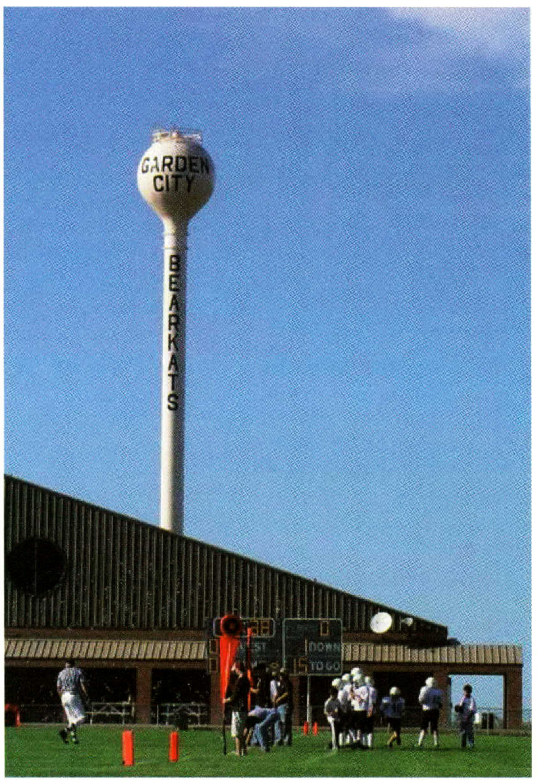
Inspecting systems requires not only knowledge of operations, but also training specific to inspecting those operations. Both jobs, operations and investigations, are important and deserve mutual respect.

The Public

Finally, and most importantly, the public relies on investigations to maintain confidence that their health is protected and their water is safe to drink. They get that reassurance in the form of the consumer confidence report and sometimes from the agency's investigation results.

All of these roles and each of these uses are legitimate and valuable.

Figure 2. Public reliance on safe water



Activities

Activity 1. Benefits of Compliance Investigation.

2 Participating in a Compliance Investigation

2.1 Role of the Investigator

TCEQ's field investigators, headquartered in sixteen regional offices, inspect public water systems. Investigators are well-trained, experienced, and qualified as either a Basic Investigator or a Senior Investigator. A Basic Investigator requires two years of on-the-job experience, health and safety training (including the 40-hour OSHA course), 90 hours of operator training (the same courses you take), and the agency's own internal training for investigators. Additionally, a Senior Investigator completes over one hundred 100 more hours of operations training and several years of experience inspecting water systems, including surface water treatment facilities.

Investigators play several roles during an investigation:

1. They are charged with being the agent of the state and federal governments.
2. They have information that you might not have. They are a resource to the operator/owner on regulatory matters not easily understood or accessible.
3. The investigator's findings are the impetus for making system improvements.
4. Finally, and most importantly, they help you safeguard your customers' health.

Unless there are unusual circumstances (serious problems, complaints, or the entity is under enforcement action) the investigation is scheduled in advance. It is not a surprise visit. The investigator contacts the owner or chief operator to make an appointment prior to performing the investigation.

2.2 Role of the Operator

In addition to normal operational duties, water systems are responsible for making information available to the investigator and helping them understand the system and its operation. Since an investigator may be unfamiliar with a particular system, the operator's knowledge of the system makes the investigation go more quickly and smoothly.

Operators are also the communications link between the owner and the agency in many cases. Your city council or board of directors depends on you to represent the system in a professional manner and to report what the investigator found during their visit. Operators should take detailed notes of issues the investigator brings to their attention, and when possible, make an effort to fix minor problems at that time.

2.3 Preview of the Components

More information will be provided in the next chapter, but for now, compliance investigations consist of three major components: 1) records review, 2) facility inspection, and 3) exit interview.

Not all investigations contain all three of these components. An investigator's schedule, the time between investigations, and other factors determine the investigation's thoroughness.

Records Review

Most investigators want to see your records first. For many water systems the process of record gathering is time consuming and tedious.

However, one way to make a good first impression is by having your records (see Chapter 3) complete, organized and laid out for review. This means that prior to the investigation, you need to spend some time gathering and organizing all the maps, reports, plans, and maintenance records that the investigator needs to see.

Facility Investigation

After reviewing the facility's records, the investigator expects to see the system's plant sites, pump stations, storage facilities, and distribution system. Generally, they begin by going to the source of the water; for instance, the wellhead or interconnection with another system. Then, they ask to see the pump stations and storage facilities. The investigator then asks to see one or more entry points and sampling points in the distribution system. Operators may even be asked to measure a disinfectant residual and check system pressures. Most investigators prefer to do these themselves, but if asked, you should be prepared.

Exit Interview

Once the investigator completes the investigation, the exit interview is conducted. During this interview, the investigator explains their findings. This is your opportunity to discuss how to make corrections, determine dates and methods of communication.

The exit interview is your final chance to establish credibility with the agency. It is important to listen carefully, take good notes, and communicate clearly what you plan do and when you plan to do it. Be polite, ask questions when you don't understand, and respect the investigator's observations. After all, you both have the same interest – you want to see the system improve and function as it should.

3 Prior to Investigation

This chapter provides detailed information on how you prepare for the investigator's arrival.

3.1 Assemble the Records

As you already know, drinking water treatment involves a great deal of paperwork. That means maps, plans, monitoring records, and a variety of reports. And it seems like almost everything in the system has to be counted and recorded.

To help make this easier for you, Table 1 contains the list of records, maps, and statistics you should begin to assemble immediately when the investigator calls. About half of these records are required to be maintained for a period of time after their use. Table 2 shows a records retention schedule that should be helpful.

It is important that the investigator can review your documentation in an environment that allows you to easily reference your records according to Table 1. For instance:

- Use a large office or conference room and lay out the records the investigator will want to see. You might even number them according to Table 1 to help you locate them during the investigation.
- Since this document review will take an hour or more, provide the investigator with a comfortable chair.
- It is important at this point, to take detailed notes of any comments the investigator makes. Notes help you remember what you discussed or the investigator recommended.

Activities

Activity 2. Experience with Compliance Investigations

Table 1. Records Required for Groundwater or Purchased Water Systems

1	Number of retail meters, population served, and water rates
2	Number of master meters (apartments & mobile home parks)
3	Number of equivalent living units (individual apartments units & mobile homes)
4	Wholesale contracts with maximum purchase rate indicated in GPM and number of meters
5	"Monthly Reports of Water Works Operation" including: a. Average daily water usage of entire system for past 12 months b. Maximum daily water usage of entire system for past 12 months (date & amount)for systems with over 250 connections. Systems having under 250 connections require weekly production figures.
6	Copy of Monitoring Plan with system map showing bacteriological and chemical sample sites
7	Twelve latest months of bacteriological or chemical results
8	Public notices issued for bacteriological or chemical violations
9	Distribution system map
10	Equipment capacities a. Well pumps (gpm & well depths) b. Service/filter/transfer pumps (gpm) c. Ground storage (gal) d. Elevated storage and height of tank overflow (gal) e. Pressure tanks (gal)
11	Annual tank investigation forms
12	Sanitary control easements and deed for land owned by water system
13	Verification of Plumbing Code Ordinance or Service Agreement
14	"Customer Service Inspection" and "Backflow Prevention Assembly Test Report" forms
15	Consumer Confidence Report
16	Verification of ANSI/NSF Standard 60 for chemical additives (including bleach) and Standard 61 for vertical turbine lubricating oil
17	Documentation of TCEQ plan review approval for new wells, treatment facilities, and storage tanks
18	Weekly or daily chlorine residual monitoring records from distribution
19	Records concerning a variance or exemption granted to the system
20	Operator licensing (including CSI license if necessary)
21	Drought contingency plan
22	Plant operations and maintenance manual
23	Records of flushing dead end mains
24	Calibration log (well meter: once every three years)
25	Complaints of quality, pressure or outage received by the system, including: a) date, b) location, and c) nature of complaint

Table 2. TCEQ-Required Records Retention (§290.46(f))

Minimum Retention Time	Type of Record
2 Years	Daily* amount of chemicals used
	Daily* volume of water treated
	Dates of dead-end main flushing and storage tank cleaning
	Equipment and facilities maintenance
	Complaint log (date, location, nature)
3 Years	Notices of Violations (NOV) and records of corrective actions
	Public Notices
	Calibrations: lab equipment, plant flow meters, on-line monitors
	Backflow Prevention Assembly Test (BPAT) Reports
	Daily distribution system chlorine residual monitoring
	Individual filter turbidities
5 Years	Coliform sample results
	Storage and pressure tank and pressure filter inspections
	Exemptions and Variances
	CT studies (surface water plants)
	Recycling practice reports
10 Years	Comprehensive Compliance Investigations (CCI)
	Customer Service Inspection (CSI) reports and program documentation
	Chemical analyses results
	Monthly Operating Reports (MOR)

*Weekly amounts if less than 250 connections

3.2 Self-Inspection

The best way to prepare for an investigation is to do a self-inspection following the same procedures the state uses. Do it yearly as part of your normal routine. Don't wait until an investigation is announced because you won't have time to correct everything. Each time you perform a self-inspection, it gets easier.

Assume the role of an investigator, walk through your system and look for things the investigator checks. Your objective is to reduce the number of violations by finding them first, then fixing them.

As one of the activities during this module, you will use the checklist found in Section B2 to self-inspect your system or your neighbor's. Walking through a system without the investigator present allows you to become comfortable with the process and gives you practice in looking for things that need attention.

Begin your self-inspection by locating your previous investigation letter and reviewing its findings. Then, walk through each part of the system while reviewing the checklist item by item and making notes (a clip board is handy here) of anything you observe that might catch the eye of an investigator. Pay particular attention to the items noted in the previous investigation. It's important the investigator sees that previous violations or problems remain corrected.

Activities

Activity 4. Inspecting Well Facilities

Activity 5. Inspecting Disinfection Equipment

Activity 6. Inspecting Storage Tanks

4 During the Investigation

4.1 Investigation Activities

As you learned, most investigations consist of three phases:

- Records Review
- Facility Investigation
  - Source water
  - Treatment
  - Storage and pumping
  - Distribution
- Exit Interview

Records Review

You will be prepared if you make all the records listed in Figure 3.1, available for an investigation. Lay out your records in a location convenient and comfortable for reviewing by the investigator, and label them so you can present them to the investigator when asked.

Facility Investigation

After the records review, the investigator tours the water system. Remember:

1. They're not being picky; their job is to point out violations of the rules.
2. If you don't understand, say so and ask questions. It's far better to clear up misunderstandings while you're looking at the problem, than trying to do it over the phone a week later.
3. Correct what you can at the time. If there's not time, tell the investigator what you will do to fix the problem. Show the investigator you will cooperate. A cooperative attitude goes a long way.
4. Take notes!

At the well site, investigators look at:

1. **The well.** Know how to manually turn on the well pump to measure its flow in gallons per minute (gpm) using your flow meter.
2. **The concrete sealing block.** Does it extend 3 feet from the casing? Is it six inches thick? Does it slope away from the casing?
3. **The well head seal.** Is it sealed with a gasket? Is it vented? Is a screen in place?
4. **Security.** Is the fencing of proper height and construction? Are doors and hatches locked?
5. **Source water protection.** Is there livestock encroachment? Are there any sources of pollution or other unused wells nearby?
6. **Safety issues.** Are there any hazards such as overturned chemical containers? Is construction properly barricaded?

Table 4.1 in the next section provides a more complete list of common violations. Do any of these violations look familiar to you? Are there places where you could make corrections now?

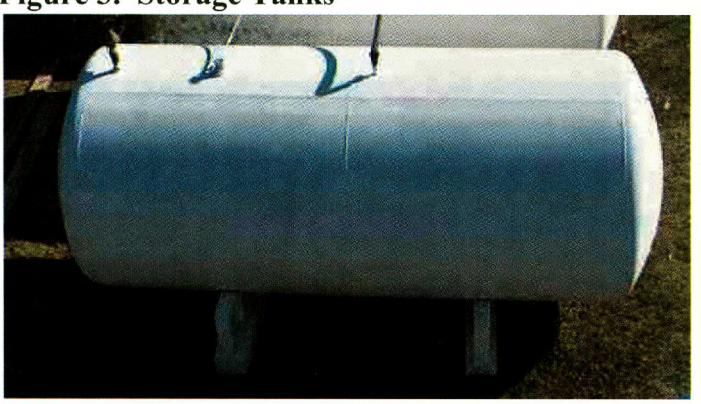
At chemical addition facilities, investigators check that:

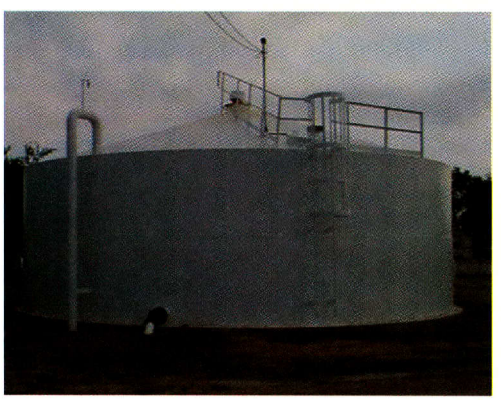
1. Disinfection facilities are provided.
    a. Are there chlorine leaks?
    b. Is automatic proportioning and switchover provided?
    c. Are all bottles chained?
    d. Is the piping watertight?
2. Do chemicals conform to ANSI/NSF standards?

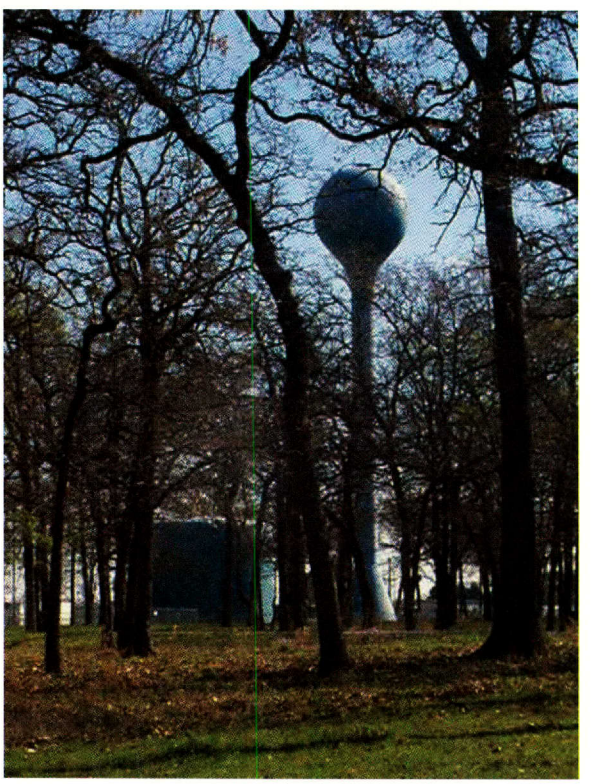
At storage facilities, inspections will include:

1. **Location of elevated and ground storage tanks.** Are there any pollutant sources nearby?
2. **Access ports, roof vents, drains, sample connections, overflows, and liquid level indicators.** Do they meet AWWA standards?
3. **Roof vents.** Are they screened with 16-gauge mesh or smaller?
4. **Overflow pipes.** Are they above ground level? Do they have hinged covers?
5. **Valves, piping, and fittings.** Are they tight against leakage?
6. **Tanks.** Do they have drains to remove accumulated silt?

Figure 3. Storage Tanks







For pressure tanks:

1. Are they steel with welded seams?
2. Do the tanks have name plates, access ports, pressure gauges, and pressure relief valves?
3. Do any pipes, valves, and fittings leak?
4. Are they painted inside and out?
5. If they are fiberglass, are they smaller than 300 gallons?

Figure 4. Checking storage and pressure tanks is an important part of every investigation.

Investigators will also want to see parts of the distribution system. They may ask you to measure the chlorine residual. Make sure you have the proper kit and know how to use it!

In the distribution system, investigators check that:

1. Lines are buried at least 24 inches and rated for 150 psi or more.
2. New pipe is at least 2 inches in diameter.
3. Minimum pressure is 35 psi (take a pressure gauge).
4. Service connections have meters.
5. There are valves and blow-offs for flushing and repairs.
6. Dead-end mains have flush valves that have been used.
7. Repairs and new lines are flushed, disinfected, and sampled for bacterial contamination.
8. No cross connections exist.
9. Backflow devices are in place as needed.
10. Overhead bulk water stations have air gaps.

There are other things they will inspect, refer to your checklist for a more comprehensive listing.

Finally, the length of an Investigation may vary depending on the weather, their schedules, and whether there are complaints from customers. It's in your best interest to stay attentive, be cooperative, and be responsive.

Exit Interview

Before the investigator leaves, you will discuss the results of the Investigation, usually in an office setting.

The investigator will tell you about:

1. Areas of concern
2. Violations
3. Corrective actions and a schedule

Areas of concern are conditions that if left uncorrected could lead to more serious violations later. When you respond to the investigator's letter, it is important that you address those concerns in writing.

Actual violations demand your immediate attention, either with corrective action or a plan for action.

Take good notes during the interview, and if possible, indicate what will be done and by when. The exit interview is your last opportunity to leave the investigator with a positive impression of your system, so be courteous and cooperative. Final impressions last a long time.

The agency welcomes feedback about your investigation experience. You should always feel free to contact one of their regional offices.

4.2 Safety Considerations During Investigations

Conducting an investigation should not be dangerous. It is important to eliminate or minimize safety hazards at plant sites. The investigator should not find a safety hazard that you have left unresolved.

Consider the following safety points when preparing for the investigation:

1. If you use chlorine gas, make sure you have a full-face self-contained breathing apparatus or supplied air respirator and know how to use it correctly. The investigator may ask you to demonstrate its proper use. Have a small bottle of ammonia solution available for locating chlorine leaks.
2. Check that chemical feed rooms are ventilated properly.
3. Don't leave open containers of chemicals unattended. Make sure every drum or package is sealed and properly labeled. MSDS sheets should be available for every substance where one is required.

4. Clean up spills immediately. A coating of slime on the floor indicates a leaking pipe, even if the pipe's been recently repaired.
5. Don't enter, or allow an investigator to enter, a confined space without observing the OSHA requirements for a permit, entry equipment, and back-up personnel, if required.
6. Ensure that all hatches are locked except during maintenance and investigation.
7. Any open pits or excavations are properly signed and barricaded.
8. Make sure that gates are locked and fences are secure.
9. Check that electric wiring is in a securely mounted conduit.

Safety violations are inherently dangerous, and they reduce an operator's credibility in general. Work hard to eliminate unsafe conditions.

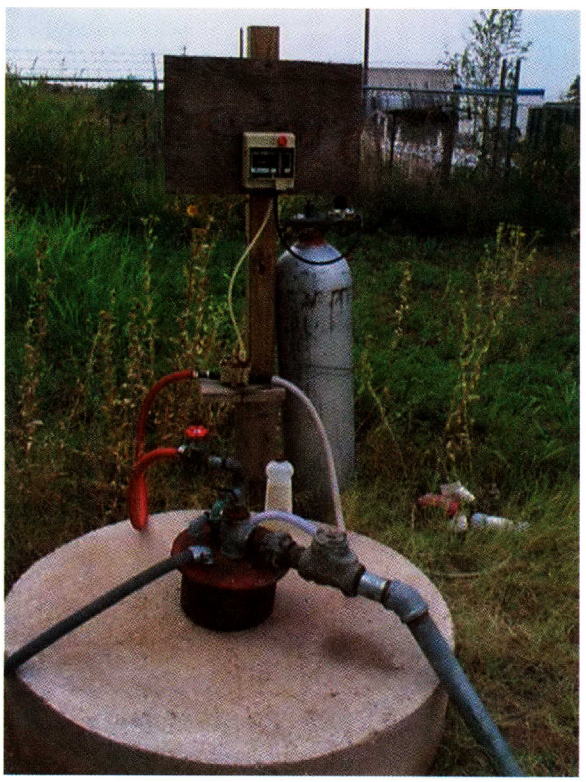


Figure 5. Do you recognize safety hazards in this photograph?

5 Common O&M Deficiencies

The regulatory agency performs thousands of investigations each year. Over time, certain patterns emerge that inform us of the violations most commonly found during investigations.

5.1 Common O&M Deficiencies

The agency maintains lists of common deficiencies found by investigators. Table 3 lists examples of the most common violations found by one veteran investigator during his career. You can use this information to make sure your facility avoids the violations on this list.

Table 3. Common Violations Cited During TCEQ Compliance Investigations

WORK AREA	DEFICIENCY
	Lack of a (or inadequate...)
Administration	Monitoring plan
	Distribution map
	ANSI/NSF certifications
	Storage tank inspections
	Purchased water contracts
	CSI and BPAT records
	Chlorine residual log
	Calibration records
	Plumbing ordinance or customer service agreement
	Failure to submit repeat and follow-up bacteriological samples
	Quarterly/Annual fluoride notices
	Well logs
	Sanitary control easements
Groundwater Production	O & M Manual
	Concrete sealing slab
	Wellhead seal
	Casing vent screen
	ARV screens
	Livestock encroachment
	Daily master meter readings
Distribution System	Grounds maintenance
	Security fencing
	Ownership notification signs
	Venting in chlorine rooms
	Storage tanks – Vents, Overflow, Roof hatches, Level indicator
	Pressure tanks – Pressure relief valves, Gauges, Oil Separator
	Leaking packing glands
	Venting & screening of ARV
	Overhead bulk water dispensing stations
	Faulty electrical wiring

Here are some suggestions for curing or preventing these deficiencies:

No monitoring plan. Coliform and chemical sampling sites must be identified in a monitoring plan. The monitoring plan identifies all sampling locations, describes the sampling frequency, and specifies the analytical procedures and laboratories that the public water system will use to comply with the monitoring requirements.

No distribution map. The location of each distribution system sample site must be designated on a distribution system schematic. The distribution system schematic must clearly indicate the location of all pump stations, ground and elevated storage tanks, and chemical feed points in the distribution system. Also, an accurate and up-to-date map of the distribution system must be available so that valves and mains can be easily located during emergencies.

No ANSI/NSF certifications. All chemicals, coatings, pipes, hoses and any additional or replacement process media used in treatment of water supplied by public water systems must conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives. Conformance with these standards must be obtained by certification of the product by an organization accredited by ANSI. An "NSF" logo on the product label is acceptable documentation.

No records of storage tank inspections. Water system personnel or a contracted inspection service must inspect each of the system's ground, elevated, and pressure tanks annually. Keep a record of these inspections for at least five years.

No copies of purchased water contracts. Keep copies on hand of any contracts you enter to purchase water from or sell to other systems. The contract must show the maximum amount of water you can purchase.

No CSI/BPAT records. Keep copies of every customer service inspection performed in your system for ten years and every backflow prevention assembly tested for at least three years.

No chlorine residual log. Operational records detailing the amount of water hauled, purchases, microbiological sampling results, chlorine residual readings, dates of disinfection, and source of water must be maintained.

No calibration records. Laboratory equipment used for compliance testing shall be properly calibrated. This includes pH meters and chlorine residual analyzers. The accuracy of manual disinfectant residual analyzers must be verified at least once every 30 days using chlorine solutions of known concentrations. Begin keeping a log of when you check the standards in your chlorine test kit.

No plumbing ordinance or customer service agreements. Begin keeping copies of your plumbing ordinance or your customer service agreements in a place where you can easily find them.

Failure to submit repeat and follow-up bacteriological samples. If one of your bacteriological samples comes back 'positive', you must take repeat samples within 24 hours of notification by the lab or by TCEQ. You must collect four repeat samples if you normally take only one monthly sample. If you take more than one, you must collect three repeat samples for each 'positive' sample. Make sure you follow the commission's requirements for location: collect one at the original positive location, and the others within five connections upstream and downstream of the positive-result connection. The following month you must take five follow-up routine samples.

Failure to submit quarterly/annual fluoride notices. When a water system's finished water contains more than 2.0 but less than 4.0 mg/L of fluoride public notification is required. The notice must be made annually by including it with the water bill or by separate mailing to all customers. If the system continues to produce water with more than 4.0 mg/L fluoride, it must notify its customers within 30 days and then every three months thereafter as long as the violation continues.

No O&M manual. An operations manual must be compiled and kept up-to-date for operator review and reference. This manual should be of sufficient detail to provide the operator with routine maintenance and repair procedures, with protocols to be utilized in the event of a natural or man-made catastrophe, as well as provide telephone numbers of water system personnel, system officials, and local/state/federal agencies to be contacted in the event of an emergency.

Inadequate concrete sealing slab. Concrete sealing blocks around the wellhead must extend at least three feet from the well casing in all directions, with a minimum thickness of six inches and sloped to drain away at not less than 0.25 inches per foot.

Inadequate wellhead seal. Wellheads and pump bases must be sealed by a gasket or sealing compound.

Missing or inadequate screens on vents or air relief valves. Obtain and install sufficient 16-mesh or finer screen material to cover the opening.

Livestock encroachment. Livestock in pastures must not be allowed within 50 feet of water supply wells. Make sure your fences are tight.

Sanitary control easements. You'll find the commission enforces this requirement fairly strictly. Unless the public water system owns all real property within 150 feet of the well, groundwater sources are required to have a sanitary control easement or easements covering land within 150 feet of the well. Political subdivisions can use ordinances or land use restrictions that provide at least as much protection. Refer to the commission's regulations before you begin this process. You must have a deed showing the property owned by the water system.

Daily master meter readings. If you have a master meter somewhere within your system, begin making and recording daily or weekly flow readings.

Grounds maintenance. The grounds and facilities must be maintained to minimize rodents, insects, and other disease vectors, and prevent contamination of the water.

Security fencing and signs. An intruder-resistant fence must enclose treatment plants, storage tanks and pressure tanks. Lock gates and doors whenever the facility is unattended. Community water systems must post signs at all production, treatment, and storage facilities identifying the system owner and providing a telephone number for emergencies. You can bet the investigator will notice if even one sign is missing.

Venting chlorine rooms. This is an important safety requirement, and one that all investigators will note. Both high level and floor level screened vents must be present, and if you store more than one cylinder, you must also have fans and an outside switch.

Overhead bulk water dispensing stations. If you make water available to contractors or others, make sure the dispensing station has an air gap between the source and the receiving tank.

Faulty electrical wiring. This is another safety-related requirement. As wiring ages and becomes frayed, replace it with wiring of the appropriate size, insulation, and grounding.

5.2 Most Serious Violations

Some violations are more serious than others and will result in enforcement action by the regulatory agency. Section C1 of the Student Workbook provides you with a checklist of the 12 most common serious violations found by TCEQ investigators, along with a more complete list of other common violations in Section C2. Read them and know them.

Some of the most serious violations are:

1. Producing water that exceeds the maximum contaminant levels;
2. Not monitoring for bacteriological contaminants;
3. Not having disinfection facilities or maintaining a disinfectant residual;
4. Not submitting reports as required;
5. Not providing notice of exceedances to customers when required; and
6. Not having one or more licensed operators.

Review the checklist to make sure your system doesn't become a Category A violator. Enforcement actions are time-consuming and expensive. Your time and money are better spent maintaining a safe water supply for your customers.

6 Communicating After the Investigation

Once the investigation is over, you want to make sure the agency sees that you corrected all the deficiencies that were found during the investigation.

6.1 TCEQ Investigation Reports and Notifications

After returning to their office, investigators do two things:

1. Write an investigation report, and
2. Notify the system in writing of their findings and any areas of concern or violations.

The investigation report becomes part of the public file kept by the agency. It is available to everyone who asks to see it.

If only minor violations are found, you will usually be given **14 days** in which to fix any problems and submit verification documentation. This avoids having to respond in writing to TCEQ's written notice of violation (NOV).

If numerous or more serious violations are found, you will receive a NOV letter usually within 21 – 30 days after the investigation. See Section D for an example of a NOV letter. The letter will contain a summary of the investigator's findings and provide you with timeframes for correction. You may be asked to provide a detailed plan or schedule of correction, depending on the nature of the violation.

You should do three things when you receive a NOV:

1. Inform the system owner of the violations and your planned response;
2. Make corrective actions; and
3. Respond to the agency.

6.2 Your Response – Repairs and Documentation

Once you and the owner have determined an appropriate response to the violations, correct the violations that can be resolved in a couple of weeks, and then respond in writing to the investigator's letter. Provide them with written or photographic documentation that violations they found have been corrected, or give them a timetable for corrective action.

Send your response by registered mail. Keep a copy of this and any other correspondence you send the agency.

The worst thing you can do after an investigation is fail to respond, so make sure your response arrives on the investigator's desk. Then, once you have corrected any unresolved violations, send documentation (photographs preferably) to the investigator's attention. Again, keep your own copy of correspondence. Follow up with a telephone call to make sure your response was received and no further action is needed on your part.

6.3 Source for Assistance

Part of TCEQ's function as a regulatory agency is to provide assistance. You should take advantage of these services.

The Small Business and Environmental Assistance Division (SBEA) offers services to a variety of customers, including small businesses and local governments; industries and manufacturers; agricultural operations, students and academia; and anyone interested in environmental stewardship.

The Small Business and Local Government Assistance Program's activities include:

1. Free technical assistance, on-site and through hotlines
2. Resources and assistance for regulatory compliance
3. Assistance on pollution prevention planning and reporting seminars and workshops on regulatory and pollution prevention topics
4. Assistance on environmental management systems, tax exemptions for pollution control equipment, and other innovative programs, practices, and technologies
5. Resources and assistance to market compost and products that are recycled or recyclable
6. Opportunities and resources for environmental education
7. Awards and special events to recognize environmental leadership
8. Recycling and disposal opportunities for urban, rural, and agricultural communities
9. Recycling information and resources for individuals, communities, schools, businesses; and
10. Voluntary programs, advisory committees, and partnerships encouraging public participation

If you encounter a problem you cannot resolve by yourself, contact SBEA toll-free at:

1-800-447-2827, or

http://www.tnrcc.state.tx.us/exec/sbea/sblga.html.

Conclusion

Let's end now by reviewing important points:

1. Small water systems are inspected about every two-three years.
2. Investigations are important and valuable to the system, the public, and the regulatory agencies.
3. The operator's job is to help the investigator understand the water system and to serve as a communications link between the agency and the owner.
4. Most investigations include a records review, a facility inspection, and an exit interview.
5. Self-inspections are the best way to prepare for an investigation.
6. Helpful lists of required records, common violations and facilities to be inspected are available.
7. It's important to communicate with the investigator promptly and accurately after the investigation.
8. If you need help, TCEQ has an assistance program that you should contact.

Good luck with your next investigation!!

Activities

Activity 7. Exit Interviews

Additional information for this module is presented in the Student Workbook.

Section A covers Category A violations that require TCEQ to initiate automatic enforcement. Avoiding Category A violations is an important goal for your water system.

Section B is the checklist that operators use to self-inspect. The checklist has an administrative section (B1) and a technical section (B2). The checklist was prepared by SBEA to assist water systems in their compliance efforts. This checklist covers all aspects of the rules, including surface water systems and large systems. **Since many of the numbered checkpoints relate only to surface water and large systems, these items have been removed from the checklist in Section B.** The original numbering system has been retained, so gaps in the numbers are items not required for small groundwater and purchased water systems.

The Student Workbook covers common violations that TCEQ investigators uncover during compliance investigations. Remember it is their job to find these violations so that you can correct them and protect public health.

The Student Workbook provides an example "Notice of Violation" and an example response to a Notice of Violation. We sincerely hope that this module helps you avoid this aspect of the compliance investigation.

Texas Small Public Water System Operator Training Program

Workbook

For Cluster Course 1

Student Activities and Appendices

March, 2005

RG-439

Sampling and Process Control Module

Activity 1. Water System Samples

Purpose: Students describe their water system and the samples they routinely collect to monitor and control the system. Students recognize requirements for valid samples and sample preservation.

Complete this activity form using information from Section 1 (pages 1-6) of the Sampling and Process Control Module and your knowledge of your water system. Your instructor will explain concepts that are new or poorly understood. Is your water system similar or different to other systems?

1. Check each water source that your water system uses. Check all that apply.

☐ Groundwater ☐ Purchased groundwater ☐ Surface water ☐ GUI

☐ Purchased surface water

2. What is the population served by your water system?

☐ 0-100 ☐ 101-500 ☐ 501-750 ☐ 751-1,000 ☐ 1,001-2,500 ☐ 2,501-3.300

3. What is your public water system's type?

☐ Community Public Water System ☐ Non-transient Non-community Public Water System

4. List one type of sample that you collect for compliance with state rules.

5. List one process control sample that you collect.

6. Which of the following are required to obtain a valid sample?

☐ Pick representative sample sites ☐ Use the correct sampling procedure

☐ At least one gallon is required ☐ Use proper sample containers

☐ Use hot water faucets whenever possible ☐ Pick dead ends lines for best results

☐ Use proper sample preservation

7. List the two general types of samples that are collected by water systems.

8. Circle the sample type (from your answers to question 7) that you use the most.

9. List samples that must be analyzed as soon as possible because they cannot be preserved.

10. List samples that are preserved and sent to a laboratory for analysis.

11. Beside each sample put the letter or letters for the correct preservation method.

Chlorine residual	_____ _____ _____	A. Acidify
Coliform bacteria	_____ _____ _____	B. No preservative is used
Lead/copper	_____ _____ _____	C. Cool to 1-4 °C
Temperature and pH	_____ _____ _____	D. Dechlorinate

12. Answer True or False for the following statements.

True	False	
☐	☐	QA/QC is a requirement for all testing procedures.
☐	☐	When testing for chlorine residual, a standard (known sample) must be run.
☐	☐	Training is required for each person who conducts compliance sampling.
☐	☐	Logbooks and/or written sample records are required for compliance samples.
☐	☐	Never perform a duplicate sample, it will invalidate the results.

Activity 2. Monitoring Plans and Sample Points

Purpose: Students review their monitoring plan and describe where, when, and by whom compliance samples are collected at their water system.

Complete this activity using information from Section 2 of the Sampling and Process Control Module and your knowledge of your water system. First, review your monitoring plan and check the plan to make sure it meets state requirements (see Appendix A for an example). Then, draw a simple schematic diagram of your water system showing the water source, where disinfectants are added, pressure tanks, water storage tanks, and the distribution system. See page 18 in Module 1 and Appendix A for an example of a schematic diagram. Label sample points. List samples you routinely collect and samples collected by the state's sample contractor.

On your diagram draw an arrow to and label (with numbers) the following sampling points:

1. Raw water
2. Inside the water production/treatment plant
3. Entry points to the distribution system
4. Distribution

List the samples that you collect along with the sample frequency.

Now look at Table 1 on page 10 of Module 1. List samples taken by the state's sample contractor along with the sample frequency.

APPENDIX A

MONITORING PLAN FOR

RILEY GLEN'S
MOBILE HOME PARK

DATE OF MONITORING PLAN: JAN. 1, 2004
PWS ID# 3650002 - SPRINGER COUNTY, TEXAS
RESPONSIBLE OFFICIAL: DANIEL QUINN, OWNER
WATER SUPPLY CONTACT: JOSHUA SCOTT, OPERATOR, 512-555-2003
P.O. BOX 4511, WASSER, TX 77555

Riley Glen's Mobile Home Park owns and operates one groundwater well. The water system serves 33 people with 15 connections.

A. RAW WATER SAMPLING
We are not required to collect raw water samples.

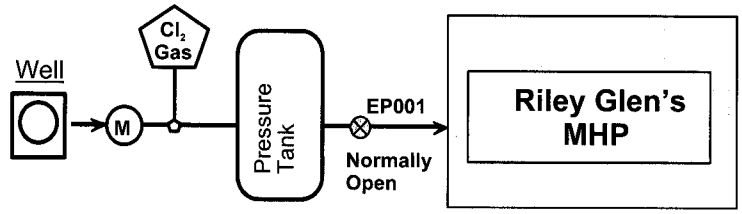
B. IN-PLANT SAMPLING
We have no treatment other than chlorination. We use hypochlorite for disinfection.

C. ENTRY POINT SAMPLING

Entry Point	Sample Site	Source	Plant Name
ep 001	Sample tap on storage tank next to office	Gulf Coast Aquifer	Well 1

Riley Glen's MHP PWS ID 365000

ENTRY POINTS



1. Disinfectant Entering the Distribution System
   Our system uses free chlorine in the distribution system.
   a. Frequency: Groundwater systems are not required to monitor disinfectant at the entry point.

b. Compliance calculations: The system is in compliance if the free chlorine residual entering the distribution system is over 0.2 mg/L.

2. Organic Chemicals, Inorganic Chemicals, and Radiochemicals
   a. Frequency: The TCEQ's sampling contractor collects these samples. Letters informing us of changes in the sampling schedule are attached to the back of this monitoring plan.
   b. Location: The contaminant concentrations for the entry point are measured at the sample tap on the storage tank.
   c. Method: Samples are sent to a certified lab (LCRA) by the TCEQ's sampling contractor.
   d. Compliance calculations: If the concentrations of contaminants are less than the regulatory maximum contaminant levels, our system is in compliance. The TCEQ will inform us of violations. Copies of any letters informing us of violations will be attached in the back of this monitoring plan.

3. Chlorine Dioxide
   We don't use chlorine dioxide.

4. Chlorite
   We don't use chlorine dioxide.

5. Bromate
   We don't use ozone.

D. DISTRIBUTION SYSTEM SAMPLING

The distribution system consists of 15 connections. The system has one well. The water is disinfected with free chlorine. It is stored in a pressure tank. The water then goes out to the connections in the park.

1. Coliform Samples
   a. Frequency: We collect one coliform sample on the first Monday of each month, so we have time to do repeats, if necessary. We rotate through the sample sites below.
   b. Location: The sample is taken from the outside tap on the following units:

1	Unit 1
2	Unit 4
3	Unit 8
4	Unit 11
5	Unit 15

   c. Method: Coliform samples are sent to a nearby lab:
      Bluebonnet Labs
      Attn: Maggie Sue Huisache (512)555-1999
      327 Dewberry Thicket

Acacia, Texas 77556

d. Compliance calculations: The system is in compliance if:
   - no repeat samples are fecal or E. coli positive,
   - no repeat following a fecal or E. coli positive routine sample is positive for total coliform,
   - no more than one of the routine samples are total coliform positive and none of the repeats are fecal or E. coli positive.

2. Disinfectant Residual—Free Chlorine
   a. Frequency: The disinfectant residual is measured at the same time as microbial samples. The disinfectant residual is also measured once every seven days, rotating through the sample sites.
   b. Location: The disinfectant residual is measured at the same place the microbial sample is taken, plus four additional sites representing the whole distribution system. The other sites are the outside taps on Units 4, 11, and 15.
   c. Method: Chlorine is measured using a colorimeter/DPD; Hach Pocket colorimeter.
   d. Compliance calculations: The system is in compliance with the minimum residual requirement if the free chlorine residual throughout the distribution system is always greater than 0.2 mg/L.

      The system is in compliance with the maximum residual disinfectant level (MRDL) if the running annual average of all samples taken in the distribution system in less than 4.0 mg/L.

3. Disinfection Byproducts (DBPs)—TTHM and HAA5
   a. Frequency: The TCEQ's sampling contractor collects these samples. Letters informing us of changes in sampling schedule are attached to the back of this monitoring plan.
   b. Location: The sample is collected from the outside tap on Unit 15.
   c. Method: Samples are taken to a certified lab by the TCEQ's sampling contractor.
   d. Compliance calculations: The system is in compliance if the running annual average of all samples is less than the maximum contaminant level. The TCEQ will notify us of any violation.

4. Lead-Copper

   Our system has received an "all plastic waiver" from the TCEQ and will no longer be sampled for lead or copper.

5. Asbestos

   The TCEQ has assessed our system and determined that we have no asbestos concrete pipe.

6. Chlorine Dioxide

   We don't use chlorine dioxide.

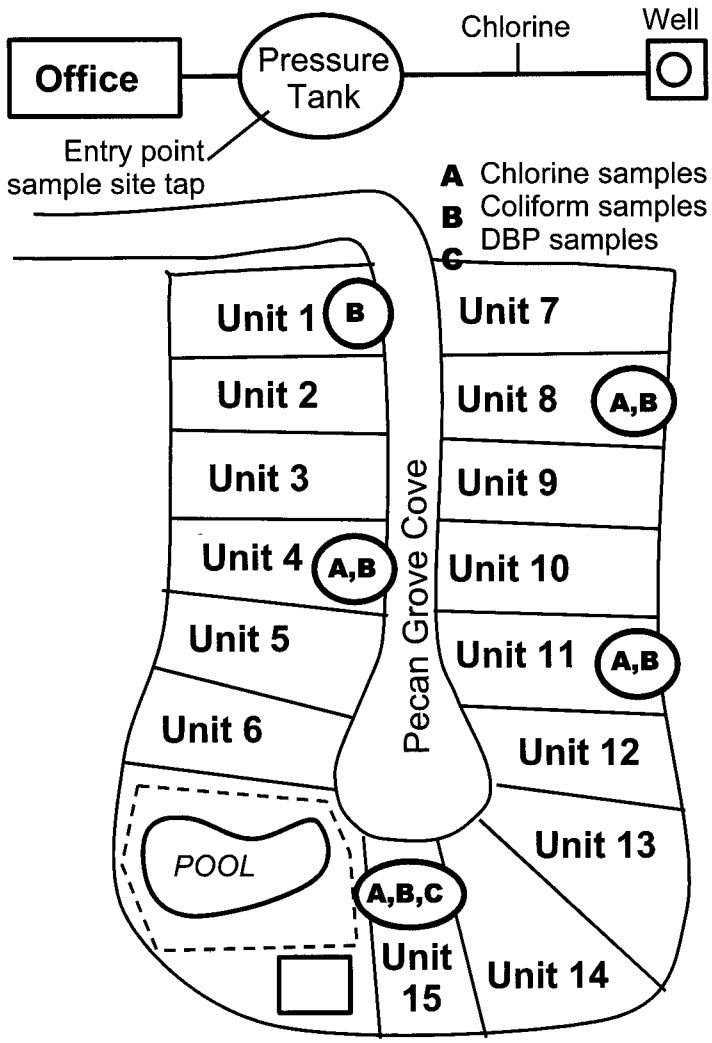
7. Chlorite

   We don't use chlorine dioxide.

E. LAB APPROVAL FORM

A copy of our laboratory approval form is attached as an appendix to this monitoring plan.

Riley Glen's Mobile Home Park



Distribution System

Activity 3. Collecting Lead/Copper Samples

Purpose: Students observe and practice taking samples for lead/copper analyses.

Review the procedure for collecting and processing lead/copper samples on page 14 of the Sampling and Process Control Module. A student demonstrates the sampling procedure. Practice collecting samples lead/copper samples. Follow the TCEQ procedure for collecting lead/copper samples.

Sample Collection

1. Always collect samples from the cold-water tap. Use the kitchen tap in a residence or an interior tap where water is typically consumed in a non-residential building.
2. Never collect samples at outside taps or faucets; at taps with water softeners or reverse osmosis units; at vacant houses, apartments or buildings; or at infrequently used taps. Testing at these sites increases the chances for your water system to exceed the lead and copper limits.
3. Collect samples only in containers provided by the state for lead/copper sampling.
4. All samples must be "first draw" water. The taps from which samples are collected must not have been used for at least six hours but not more than 18 hours when the sample is collected. Residential customers must fill their sample bottles first thing in the morning, or upon returning home from a full day at work, before any other water is run from that tap. Prior to the 6-hour minimum hold time, customers can use all the water they want. Samplers are encouraged to flush the line to the faucet (let the water run a good five minutes) to bring in fresh water before the hold time starts.
5. The sample bottles are opened, placed under the tap, and then the first draw tap water sample is collected without spillage.
6. Fill the bottle to the top. Do not rinse the sample bottle at any time.
7. Be sure to tighten all sample bottle caps to prevent leakage.

Activity 4. Process Control

Purpose: Students apply the process control concepts of "Hazard Awareness and Critical Control Points" to understand how waterborne disease hazards are reduced.

Complete this activity using information from Section 4 of the Sampling and Process Control Module and your knowledge of your water system. Your instructor will provide guidance. The worksheet covers microbiological hazards that are controlled by disinfection. Hazard identification, critical control points, setting appropriate critical limits, monitoring, corrective actions, verification, and record keeping are explained.

1. What specific hazard could cause illness or injury if not controlled by disinfection?

2. List ways that this hazard could enter into the water system.

3. Where is the critical control point for this hazard?

4. What places do you monitor to ensure that this hazard is controlled?

5. What are the critical limits that your water system has established for each monitoring point?

6. How do regulatory limits differ from your water system's critical limits?

7. List some conditions that affect your ability to operate within the critical limits.

8. How frequently do you monitor your water system to maintain the critical limits?

9. How do you record, display, and evaluate the monitoring results?

10. What corrective actions do you take if a maximum or minimum critical limit is exceeded?

11. Are the corrective actions written in a procedure or operations manual?

12. Who is responsible for taking corrective actions when a critical limit is exceeded?

13. How do weather conditions affect the corrective actions?

14. How do water quality conditions such as iron, manganese, hydrogen sulfide, and organic matter affect the corrective action?

15. If deviations occur in localized portions of the distribution system what corrective actions are taken?

16. Has anyone ever verified your monitoring procedures and sample results?

17. Have you received adequate training to conduct chlorine residual testing and take appropriate corrective actions?

18. Do you feel confident about your ability to take the appropriate corrective action when a critical limit is exceeded?

Disinfection and Coliform Monitoring Module

Activity 1. Waterborne Disease Outbreaks

Purpose: Students understand the importance of preventing waterborne disease by reviewing news articles about disease outbreaks.

Each student reads one numbered news article in Appendix A. Highlight or mark statements in your article that you think are important. Starting with the first article, each student reads the important parts of their article. After each student has their turn, the instructor summarizes the critical points.

Appendix A

Article 1

The Williamson County Sun
Sunday, June 15, 1980

Virus sweeps Georgetown

A mysterious stomach virus has filled Georgetown Hospital wards and laid many other residents low at home this week.

The fast-striking malady is characterized by sharp stomach cramps, severe diarrhea, headache and general achiness. Some victims also suffer from fever and vomiting. Fortunately, its duration is brief.

"The water supply has been checked and found to be perfectly safe." said Dr . . .

Also, this illness is more severe in babies and older folks, so parents of infants and elderly people should consult their doctors.

Article 2

The Williamson County Sun
Thursday, June 19, 1980

Mysterious illness strikes thousands in city

. . . an as yet unidentified illness dropped out of nowhere two weeks ago, took root in an unsuspecting Georgetown, and has since spread like wildfire through the population of the city and that of surrounding areas.

As of Wednesday when the SUN went to press, the affliction continued to stump local officials and physicians who have thus far failed to find a name for it to pinpoint its source.

State experts have been called in to help with an investigation of the outbreak and experts from the Federal Communicable Disease Center (CDC) in Atlanta may participate in the inquiry.

Of course it could be a virus, bacteriological infection or chemical pollutant says Dr. . . . But the indications point toward a gastro-intestinal virus.

Very fortunately, the malady does not appear to be life-threatening and relatively few of its victims have wound up in the hospital. But the very old and the very young have been hit the hardest. We've got 20 or 25 cases in the hospital . . .

Another question needing an answer is "Why has the disease hit so many and spread so fast?" Widely varying estimates place the number infected at anywhere from 1,000 to 8,000 persons.

The first cases of illness were reported on or shortly after June 1 and infection may have peaked about the middle of last week. More than half of victims contacted by the SUN say they came down sick either Wednesday or Thursday, June 11 or 12.

Article 3

The Williamson County Sun
Sunday, June 22, 1980

The bug digs in: experts test the water

Unable to pin down the cause of a mysterious stomach disorder which as sickened thousands in Georgetown, health authorities are now urging that residents and visitors stop drinking the city's water unless it has been boiled.

"I want to stress the fact that we have so far gathered no direct evidence that would implicate the City of Georgetown water system in this problem." he said. "In fact all the samples sent to the laboratory so far have been shown to meet every state and federal quality standard."

. . . samples were drawn from faucets in scattered sections of the city and sent to Health department laboratories in Austin for testing . . . department water experts took test water from still more taps Thursday as well as from five city wells. All the samples proved free of common contaminants such as the E. Coli bacteria.

But it was clear that the Georgetown water supply had become the prime suspect in a full scale investigation by [five separate teams of local, state, and federal personnel].

The search for the cause of the malady began to heat up this week after a city-wide survey . . . revealed that up to 70 percent of the Georgetown population had been stricken. . . . the decision to recommend drinking boiled city water was reached after officials became convinced that townspeople had been infected through a common medium.

"Mounting evidence points to this as a common source outbreak. . . . leaving the water as the only shared element. Nothing else in the survey correlated."

Article 4

The Williamson County Sun
Thursday, June 26, 1980

Amount of chlorine boosted in city water

. . . city officials boosted the chlorine concentration in the water treatment process Tuesday in response to TDH and EPA recommendations. The amount of chlorine added to the water supply was roughly doubled – from 1.2 to 2 parts per million. In addition to a doubling of the chlorine concentration, the amount of time the chlorine is in contact with the water – and important factor in the chlorination process – has been tripled.

. . . studies conducted by TDH and CDC "strongly implicate the city water supply as the source of the outbreak victimizing Georgetown residents and visitors with bouts of diarrhea, nausea, cramps, and fever.

"It would still be prudent for Georgetown residents to continue using boiled or bottled water for drinking and cooking."

"Increasing the amount of chlorine in the water supply is the classic response to contaminated water. It should get any bacteria or virus in the supply."

. . . officials are still puzzled about the cause of the gastrointestinal virus which has plagued over 70 percent of Georgetown at least once.

Article 5

The Williamson County Sun
Sunday, June 29, 1980

State takes away water approval [City official] says: prove it

The TDH asked Georgetown officials to remove signs reading "Public Water Supply Approved" Friday morning. [The city official] refuses to tear down the four signs until conclusive proof points to the city water supply as the source of the gastro-intestinal virus afflicting thousands of Georgetown residents.

"The one reason the request was made was that 8,000 people in the city got sick and the decision was made on the assumption that the water supply is to blame."

[The city official] said the request was in no way the result of the city's failure to collect water samples for the month of May and submit them to the health department for bacteriological testing. Only one sample submitted from the city was recorded for the month of May.

. . . raw water samples were found to contain several colonies of coliforms, a bacteria of sewage origin. . . . these coliforms appear in untreated well water occasionally, depending on weather conditions and the time of year. The city is not required to submit raw samples for testing since treated water which passes bacteriological and chlorine tests is sufficient. But samples of untreated water which contain coliform trigger attention from the health department.

[The TDH] had heard that the chlorinator serving three wells at the downtown plant had temporarily malfunctioned in May. [The City Official] affirmed the report explaining that one chlorinator was out for about 18 hours May 25 but chlorine residual was found in samples taken from all over town that day.

The CDC survey results show that if the water were contaminated the episode or event would have occurred around June 7-9 with the incidence of sickness highest around June 11-13. During that time cases increased from four to 40 per day with the incidence of occurrence peaking June 11.

Article 6

The Williamson County Sun
Sunday, July 13, 1980

Water signs improve here

Raw water samples taken Tuesday from the Edwards Aquifer in Georgetown and points between Round Rock and Salado showed a zero fecal coliform level in all wells.

"We have no idea how to explain the lack of fecal coliforms in Tuesday's samples. The results do not necessarily mean that the water is cleared up, we'll just keep testing until a pattern emerges.

In a news release issued Thursday, before the more recent puzzling findings, officials summed up the situation to date by stating the raw water in the aquifer does show evidence of contamination, but added that all standard water tests on water samples of treated water show no bacteria present.

Dr. . . . stated that in the presence of contaminated raw water, these standard tests may be inadequate to insure the safe quality of the water.

Article 7

The Williamson County Sun
Sunday, July 20, 1980

Hepatitis cases on the upswing

Fourteen suspected cases of infectious hepatitis in Georgetown, roughly double the normal incidence of the virus during summer months here, had been reported to local officials as of late Thursday afternoon. The rise in the serious disease could well be connected to Georgetown's recent problems with its water.

It can spread through a water supply, but the really bad outbreaks usually occur because of [exposure] to large concentrations of fecal material in food."

"The incubation period of the hepatitis virus is a minimum of 15 days. The virus typically takes three weeks to surface, and by four weeks most cases have developed. The three week period has passed, and new cases from the water are on the decline."

. . . and a petition calls for apology

. . . two petition forms, one demanding a public reprimand for contradictory and irresponsible statements made by [the city official] concerning the safety of the Georgetown water supply were presented. [Citizens] heatedly asked [city officials] to schedule a public hearing at which residents could "vent their anger and feel that they are participating."

. . . [the city official] made a statement Tuesday on an Austin newscast that the water supply was safe to drink despite warnings from health officials to boil water or use bottled water. "Our anger lies in that you do not have the authority to make such statements."

"We . . . feel the [city official] has acted irresponsibly during the last couple of months by continually contradicting both county and state health officials about the safety of our water."

Article 8

The Williamson County Sun
Thursday, July 31, 1980

Officials say city's water is safe now

[Officials] announced to a congregation of nearly 500 people Monday night that the order to use boiled or bottled water had been lifted and that "the city water is probably as safe now as it ever was."

While they were unable to pinpoint the cause of the disease, the officials said improvements to the chlorination system that should ward off any potential viral or bacteriological hazards led to the removal of the "boil water" edict.

The boil water warning on June 19 followed preliminary results from the TDH survey that indicated 70 to 80 percent of Georgetown's population had contracted the disease. [He] added that the incidence of infectious hepatitis reached 29 cases for the month of July, but the number of new cases seems to have peaked July 12.

"We had very strong evidence that the disease was waterborne." stated a TDH epidemiologist. "From patient specimens, we found different organisms in the stool samples. The contamination may have been of a varied nature, consistent with infection from sewage."

[A TDH official] stated that the four wells at the central pumping station in downtown Georgetown were the route of infiltration for contamination. "Three things may have contributed to the outbreak. The well water at the main plant was contaminated by an unknown source, the chlorinators were not adjusted to take care of the greater bacteriological load, and the chlorine contact time was not enough." Sewer line leaks, contaminated abandoned wells, and septic tanks were cited as possible contamination sources.

Boiling water order lifted

[Health official] said the decision to lift the boiling recommendation was made after authorities determined a higher percentage of chlorine from 1.2 parts per million to 3 ppm and the use of longer contact time increased up to 150 minutes were adequate safeguards against the possibility the mysterious bug was still in the water.

Article 9

Round Rock Leader
Thursday, July 23, 1998

Brushy Creek shuts down 4 wells

Four of the Brushy Creek MUD's five raw water wells that serve nearly 1,900 homes were shut down Tuesday after tests results showed contamination from 100,000 gallons of raw sewage that spilled into the creek last week.

State officials said the contamination won't taint the district's drinking water supply. Although the raw water wells were contaminated, the treated water sent to homes in this MUD of 10,000 residents is safe for consumption. But a Round Rock environmental engineer said a possible problem exists. The indicator bacteria found in Brushy Creek's water supply suggest a possible threat to residents, he said.

Because not all of the viral contaminants found in coliforms can be effectively destroyed by Brushy Creek's chlorination process, the possibility for contamination exists. Water-borne diseases such as hepatitis, diarrheal illnesses, and cryptosporidium can be spread through the water supply.

"We're pretty confident that Round Rock's water is safe." said a [city official].

Under state direction MUD employees have been checking their treated water every day and no bacteria has been found.

Article 10

Round Rock Leader
Monday, July 27, 1998

MUD reviews actions following sewage spill. *Area is vulnerable to contamination; State says water is safe to drink.*

This area is always vulnerable to contamination threats. Brushy Creeks sits in the Edwards Aquifer recharge zone, a potentially volatile area for water wells. In the Edwards Aquifer, water travels through porous limestone quickly and in many directions. It's not like groundwater where the water travel slowly through sand, allowing for natural filtration. The recharge area is where the limestone of the aquifer reaches the ground surface. The wells can be contaminated quickly.

State officials know Brushy Creek's wells constantly show fecal coliforms, but the drinking water tests safe, so somehow the water is filtered – how quickly and thoroughly is what officials hope to learn.

A series of microscopic tests began Thursday. If results show that Brushy Creek's water supply is directly and regularly influenced by surface water, the state will require the MUD to install a filtration treatment facility.

So far, the TDH has not received any calls from Brushy Creek residents complaining of bad water. [A citizen says] "I'm drinking the water that's in our system right now. So I want to make doggone sure we're drinking safe water."

Article 11

Round Rock Leader
Thursday, July 30, 1998

Officials disagree on sewage-disease link. *Nine of 12 diagnosed with parasitic disease*

Nine Brushy Creek residents have cryptosporidiosis, but MUD officials dispute a connection to a 170,000 gallon raw sewage spill more than two weeks ago. By Tuesday afternoon, more than 175 people had called health officials complaining mostly of stomach cramps and diarrhea, some with fever and vomiting.

Cryptosporidiosis. A tiny parasite causes crypto in both humans and other warm-blooded animals. Infected people or animals spread crypto through their fecal matter. Common symptoms include diarrhea, nausea, fever, stomach cramps and vomiting. People said they noticed the symptoms last weekend. Since the parasite takes from one to 12 days to incubate, the parasite's link to the July 14 sewage spill is uncanny.

Article 12

Round Rock Leader

Monday, August 3, 1998

Officials ponder leak detection system.

13 Brushy Creek MUD residents diagnosed with illness after spill

While the 400 phone calls to health departments suggest there really is something in the water, officials begin to chip away the details of why 170,000 gallons of sewage spilled in the first place.

Tests showed that 13 out of the 24 people they tested had cryptosporidiosis, a parasitic illness that affects the digestive tract. All 13 were served by the Brushy Creek MUD's water supply and people out here want to know how things got this bad.

The problem started July 13, when an electrical storm knocked out power and alarms on a City of Austin lift station near Brushy Creek. The 170.000 gallon sewage spill wasn't found until 7 a.m. the next morning by a Brushy Creek employee on his way to work. The district shut down its raw water wells a week later at the state's request. Since then people got sick.

Article 13

Round Rock Leader

Thursday, August 6, 1998

Brushy Creek residents demand answers.

Officials say sewage spill caused illness

They came carrying bottled water – it was the only thing, people felt, that was safe to drink. And nearly 600 people filled Cedar Valley Middle School Monday evening demanding answers.

The district never told me the water was tainted until it was too late. He went to the meeting to find out why.

State officials explained there are no national or state regulations to test for crypto because the tests are difficult to conduct and are inaccurate. To find crypto in water experts must examine hundred of thousands of gallons at microscopic levels.

But the strongest evidence of crypto-tainted water – and the reason the people are sick, scared or both – is the outbreak in the district. As of Wednesday, there were 18 confirmed cases of crypto. Only one person was not from Brushy Creek.

Article 14

Cryptosporidiosis at Brushy Creek

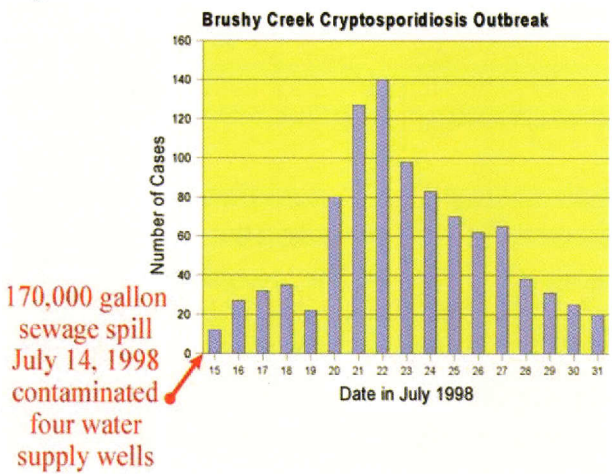
By the TDH Infectious Diseases Epidemiology and Surveillance Division (IDEAS)

A questionnaire and telephone interviews were conducted from July 28 through July 30, 1998.

All residents of the Brushy Creek area who were ill with watery diarrhea (defined as 3 or more loose stools in a 24-hour period) from July 14 through August 15 were considered case-patients.

Of the 189 households interviewed, 47% reported that 1 or more family members became ill. The mean duration of illness was 7 days (range: 1-45 days). The mean number of stools on the worst day of illness was 9 stools (range: 2-25 stools).

The attack rate for illness among exposed residents was 24%. TDH estimates that 1,440 residents became ill during the outbreak. Eighty-five confirmed cases of cryptosporidiosis were officially reported during the outbreak and 45 additional cases were reported from September 1 through December 31, 1998 in Public Health Region 7.



Activity 2. CT Concepts

Purpose 1: Students understand that disinfectant concentration, time, temperature, pH, and pathogen type are important. Students use simple CT tables to determine minimum effective contact times.

Review the four CT tables in Appendix B. Your instructor will explain how each table covers minimum disinfection requirements for a disinfectant type and organism type (for example, Table 1 is for Free Chlorine and Giardia). Students describe their chlorination practices in terms of type of disinfectant, minimum residual, and temperature ranges. Students look up the minimum CT value and time required for each.

Purpose 2: Students learn chlorination terms and understand chlorine dosage and response curves.

Review pages 7 and 8 in Module 2.

Review and mark up Figure 2 on page 7.

1. Write "breakpoint" on Figure 2 and draw a line to indicate where the breakpoint is found on Curves 1 and 2.
2. On Curve 2, when the dosage is 3.0 mg/L, what is the chlorine residual? _____
3. Is this free chlorine or monochloramine? _____

Review and markup Figure 3 on page 8.

1. Write "breakpoint" on Figure 3 and indicate where the breakpoint is found.
2. When the dosage is 2.0 mg/L, what is the chlorine residual? _____
3. Is this free chlorine or monochloramine?
4. When the dosage is 3.5 mg/L, what is the chlorine residual? _____
5. Is this free chlorine or chloramine? _____
6. When the dosage is 6 mg/L what is the total chlorine residual? _____
7. How much of this is free chlorine? _____

Appendix B

Table 1. Time and CT Values for Inactivation of *Giardia* Cysts by Free Chlorine.

Free Residual Chlorine Concentration (mg/L)	pH below 8.5 For 70% or 0.5 Log Inactivation of *Giardia* Cysts					
	Temperature shown in °C					
	0.5		10	15	20	25
0.2	275 min CT = 55	195 min CT = 39	150 min CT = 30	100 min CT = 20		50 min CT = 10
0.5						22 min CT = 10
1.0	61 min CT = 61	43 min CT = 43	33 min CT = 33	23 min CT = 23	16 min CT = 16	11 min CT = 11
1.5	44 min CT = 66	31 min CT = 46	23 min CT = 35	16 min CT = 24	11 min CT = 17	8 min CT = 12
2.0	35 min CT = 70	25 min CT = 49	19 min CT = 37	13 min CT = 25	9 min CT = 18	6 min CT = 12

Table 2. Time and CT Values for Inactivation of Viruses by Free Chlorine.

Free Residual Chlorine Concentration (mg/L)	pH below 9.0 For 99% or 2.0 Log Inactivation of Viruses					
	Temperature shown in °C					
	0.5		10	15	20	25
0.2	30 min CT = 6	20 min CT = 4	15 min CT = 3	10 min CT =2		5 min CT =1
0.5						2 min CT =1
1.0	6 min CT = 6	4 min CT =4	3 min CT = 3	2min CT = 2	1 min CT = 1	1 min CT =1
1.5	4 min CT = 6	3 min CT = 4	2 min CT = 3	2 min CT = 2	1 min CT = 1	1 min CT =1
2.0	3 min CT = 6	2 min CT = 4	2 min CT = 3	1 min CT = 2	1 min CT = 1	1 min CT = 1

Table 3. Time and CT Values for Inactivation of *Giardia* Cysts by Chloramine.

Chloramine Concentration (mg/L)	pH 6.0 - 9.0 For 70% or 0.5 Log Inactivation of *Giardia* Cysts					
	Temperature shown in °C					
	<= 1.0		10	15	20	25
0.5						250 min CT = 125
1.0	635 min CT = 635	365 min CT = 365	310 min CT = 310	250 min CT = 250	185 min CT = 185	125 min CT = 125
1.5	423 min CT = 635	243 min CT = 365	207 min CT = 310	167 min CT = 250	123 min CT = 185	83 min CT = 125
2.0	318 min CT = 635	183 min CT = 365	155 min CT = 310	125 min CT = 250	93 min CT = 185	63 min CT = 125
2.5	254 min CT = 635	146 min CT = 365	124 min CT = 310	100 min CT = 250	74 min CT = 185	50 min CT = 125

Table 4. Time and CT Values for Inactivation of Viruses by Chloramine.

Chloramine Concentration (mg/L)	For 99% or 2.0 Log Inactivation of Viruses					
	Temperature shown in °C					
	<= 1.0		10	15	20	25
0.5						428 min CT = 214
1.0	1243 min CT = 1243	857 min CT = 857	643 min CT = 643	428 min CT =428	321 min CT = 321	214 min CT = 214
1.5	829 min CT = 1243	571 min CT = 857	429 min CT = 643	285 min CT =428	214 min CT = 321	143 min CT = 214
2.0	622 min CT = 1243	428 min CT = 857	322 min CT = 643	214 min CT =428	161 min CT = 321	107 min CT = 214
2.5	497 min CT = 1243	343 min CT= 857	257 min CT = 643	171 min CT = 428	128 min CT = 321	86 min CT = 214

Activities 3 - 6. Chlorine Residual Testing

Activity 3. Instrument Operation

Purpose: Students know the operation of hand-held chlorine colorimeters or visual comparators and how to check instrument operation with gel standards.

Practice using the instrument, switching ranges, and verifying operation with gel standards. End the activity by plotting all the instrument results on a graph so that instruments can be compared. Discuss differences in the instruments and whether one or more instruments are incapable of providing required accuracy. Explain that gel standards can also be inaccurate.

Activity 4. Chlorine Residual Analysis

Purpose: Students conduct a chlorine residual analysis.

Practice chlorine residual analyses on tap water and/or on an instructor-prepared sample. Use one sample collected in a 250 mL or larger beaker for everyone. Ideally, both low (0.2 - 0.8 mg/L) and high (1.0 - 2.0 mg/L) range samples are analyzed. Only free chlorine tests are performed (unless one or more water systems are using chloramine disinfection). Instructor explains proper procedures such as rinsing sample vials and caps, proper reaction times, checking chemical expiration dates, wiping sample vials clean, etc. while students practice analyzing samples. Instructor explains that a duplicate sample is required each day that chlorine residuals are determined for quality control purposes.

Activity 5. Spike Recovery

Purpose: Students practice the spike recovery method to check the chlorine residual procedure.

Students set up duplicate chlorine-demand free samples for chlorine residual testing. DPD is added to the samples and the instrument zeroed. A low range chlorine standard ampoule is opened. Students spike one sample with 0.1 mL of the standard and the second gets a 0.5 mL spike of the standard. Chlorine residuals are determined on the two spiked samples. Results are graphed to compare instruments and procedures. Students discuss the accuracy of the results.

Activity 6. High Range Samples

Purpose: Students practice running high-range (off scale) samples.

Instructor gives students samples that contain 3 to 10 mg/L chlorine residual. Students use either the high-range instrument method or the dilution method. At least one group or student should use the dilution method.

Activities 7 - 9. Field Sampling

Activity 7. Coliform Sampling

Purpose: Students observe demonstration of coliform sampling procedure.

A student demonstrates how to collect a coliform residual sample. Instructor and other students assist so that the procedure is fully discussed.

Activity 8. Chlorine Addition Equipment

Purpose: Students observe how and where chlorine is added in the water system and understand the relationship between water flow, chlorine feed rate, chlorine dosage, and amount of chlorine consumed.

A student familiar with the water system explains how the chlorination system works. Follow the water flow from production to storage and the chlorine flow from the day tank to the application point. Relative position of chlorination point and storage is noted. Locations of sample taps are noted.

Activity 9. Sampling Practice

Purpose: Students practice collecting field chorine residual samples and coliform samples.

Students, working in groups of two or three, go to routine sampling sites and collect a chlorine residual and coliform sample.

Activity 7

NAME OF LAB
Lab Address
Lab Phone Number

SAMPLE IDENTIFICATION

LAB ID _____ Sample Number _____ Date Received _____ *MO/DAY/YR*

PUBLIC WATER SYSTEM ID _____ Report Date _____ *MO/DAY/YR*
Seven digits (REQUIRED)

PUBLIC WATER SYSTEM NAME _____ COUNTY _____

Send Sample Results To:
Name _____
Street Address _____
City, State Zip _____
Phone _____
☐ Owner/PWS ☐ Operator ☐ Other

SAMPLE SITE / COLLECTION DATE and TIME

Date/Time Collected: _____ _____ ☐ ☐
Month Day Year *Time of Day* *am* *pm*

Sample Site: _____
(Address or other description, not sample site number)

Sampler Name/Phone: _____

SYSTEM TYPE	SAMPLE TYPE (check ONE type only) (Public Systems Only)	WATER SOURCE
☒ Public	☐ Distribution ☐ Raw: well #	☐ Groundwater *(Well)*
☐ Private/Individual	☐ Construction ☐ Special _____	☐ Surface water *(Lake, River)*
☐ Other	☐ Repeat for sample # _____	
	☐ Other: _____	

DISINFECTANT RESIDUAL (Mandatory) _____ mg/L ☐ Free Chlorine
(Sample should not be collected if residual is not present) ☐ Chloramine (Total Chlorine)
Number of samples collected on this date _____

LABORATORY REPORT (Collector: Do Not Write Below)

Lab Test Method Used: _____

COLIFORM ORGANISMS:
Total Coliform
☐ Found ☐ NOT Found
Fecal coliform / Escherichia coli (Circle type of organism found)
☐ Found ☐ NOT Found

☐ REPEATS (required for distribution samples only)

☐ Unsuitable for analysis (see below) Analyst Initials: _____

SAMPLE UNSUITABLE FOR ANALYSIS (PWS must replace unsuitable sample with in 24hrs.)

☐ Sample too old. Not received within 30 hours of collection
☐ Quantity insufficient for analysis (100 mL required)
☐ Form incomplete / date discrepancy (CIRCLE errors)
☐ Other reason: DESCRIBE:
☐ Heavy SILT / BACTERIA / TURBIDITY PRESENT (circle).
☐ Sample leaked in transit
☐ Chlorine residual

Submit to TCEQ/Public Drinking Water MC-155, PO BOX 13087, Austin, TX 78711 | Fax Positive to 512-239-3666
TCEQ 10525 (05-14-04) COPIES: CUSTOMER, LABORATORY, TCEQ

Activities 9

Chlorine Residual Sample Results Worksheet			Free or Total (circle one)		Reagent Expiration Date	
Date						
Time						
Sample Site						
Sample Reading (mg/L)						
Duplicate Reading (mg/L)						
Reagent Blank (mg/L)						
Gel Standard 1 ( )						
Gel Standard 2 ( )						
Gel Standard 3 ( )						
Gel Standard 4 ( )						
Spike Amount (mg/L)						
Spiked Sample Reading (mg/L)						
Spike Recovered (mg/L)						
% Recovered						

Activity 10. Monthly Reports

Purpose: Students demonstrate the ability to complete a monthly summary report.

Students calculate the average chlorine residual, count the number of samples with no residual or low residual and fill out a report form.

Data for the Worksheet and Quarterly report

PWS: Butchland Special Utility District
PWS ID: 2990002

Sample Date	Sample Site	Coliform	Residual (mg/L)
1-5-2005	#2		1.2
1-11-2005	#1	Yes	0.8
1-12-2005	#3		0.7
1-19-2005	#4		0.3
1-26-2005	#5		0.1
2-2-2005	#1		0.0
2-8-2005	#2	Yes	0.6
2-16-2005	#3		1.1
2-23-2005	#4		0.9
3-2-2005	#5		0.8
3-8-2005	#3	Yes	1.3
3-9-2005	#1		0.6
3-16-2005	#2		0.5
3-23-2005	#3		0.8
3-30-2005	#4		0.2

Disinfectant Residual Worksheet for MRDL Calculation
Groundwater or Purchased-Water PWSs with Fewer Than 750 Customers

If you wish, use this worksheet to keep track of the residual disinfectant that you collect with your coliform samples.
Do **NOT** send this worksheet to us. You should send your results to us on the DL QOR form.

PWS Name:		PWS ID:	
MONTH:		YEAR:	

Type of Disinfectant Used in Distribution System:

☐ Free chlorine (MIN= 0.2 mg/L) ☐ Chloramine (MIN = 0.5 mg/L)

Disinfectant Residual Collected with Coliform Sample(s)

#	Sample Date	Sample Site	Disinfectant Residual	Less than MIN? Y/N	NO residual? Y/N
1					
2					
3					
4					
5					

Groundwater and purchased water systems that serve up to 1000 people must collect **one** coliform sample a month. The disinfectant should be measured at the same time. If you have a coliform-found sample, you must collect **four** repeat samples immediately. Then, the month after the coliform-found, you must collect follow-up routine samples. Therefore, this worksheet provides room to keep track of more than one sample. If you have multiple positive results, you will need another piece of paper.

Disinfectant Residual Collected in Distribution System

#	Sample Date	Sample Site	Disinfectant Residual	Less than MIN? Y/N	NO residual? Y/N
1					
2					
3					
4					
5					

Groundwater and purchased water systems that serve up to 750 people must collect **weekly** distribution system disinfectant residual samples. This worksheet provides room to keep track of one sample a week for five weeks. If you collect more samples than that, you will need another piece of paper.

Monthly Summary

Number of Samples	Highest Reading	Lowest Reading	Average	# Below MIN	# with NO residual
(1)	(2)	(3)	(4)	(5)	(6)

These are the numbers that you will need to report on the GW PW Monthly Operating Report form.

(1) Add up all the disinfectant results from samples collected with coliform samples, plus weekly distribution system samples. Write that number here.
(2) Write in the highest residual from all your samples.
(3) Write in the lowest residual from all samples.
(4) Add up the residual from all samples and divide by the number of samples. Write that number here.
(5) Write in the number of samples that had less than 0.2 mg/L (if you use free chlorine) or less than 0.5 mg/L (if you use chloramines).
(6) Write in the number of samples that had no disinfectant at all.

Disinfectant Residual Worksheet for MRDL Calculation
Groundwater or Purchased Water PWSs with 750 to 4900 Customers

This worksheet is provided to help systems keep track of the residual disinfectant that you collect with your coliform samples. Do **NOT** send this worksheet to us. You should send your results to us on the DL QOR form.

PWS Name:		PWS ID:	
MONTH:		YEAR:	

Type of Disinfectant Used in Distribution System: Q Free chlorine MIN= 0.2 mg/L Q Chloramine MIN = 0.5 mg/L

Disinfectant Residual Collected with Coliform Sample(s)

#	Sample Date	Sample Site	Disinfectant Residual	Less than MIN? Y/N
1				
2				
3				
4				
5				

Groundwater and purchased water systems that serve up to 1000 people must collect **one** coliform sample a month. The disinfectant should be measured at the same time. If you have a coliform-found sample, you must collect **four** repeat samples immediately. Then, the month after the coliform-found, you must collect follow-up routine samples. Therefore, this worksheet provides room to keep track of more than one sample. If you have multiple positive results, use another piece of paper.

Disinfectant Residual Collected Daily

Sample Date	Sample Site	Residual	Less than MIN? Y/N
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Sample Date	Sample Site	Residual	Less than MIN? Y/N
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			

Groundwater and purchased water systems that serve 750 or more people must collect **one** disinfectant residual sample **daily**. The worksheet provides room to keep track of 31 days. If you collect more than 31 samples in a month you will need another piece of paper.

Monthly Summary

Number of Samples	Highest Reading	Lowest Reading	Average	# Below MIN	# with NO residual
(1)	(2)	(3)	(4)	(5)	(6)

These are the numbers that you will need to report on the GW PW Monthly Operating Report form (TCEQ-0811).

(1) Add up all the disinfectant results from samples collected with coliform samples, plus weekly distribution system samples. Write that number here.
(2) Write in the highest residual from all your samples.
(3) Write in the lowest residual from all samples.
(4) Add up the residual from all samples and divide by the number of samples. Write that number here.
(5) Write in the number of samples less than 0.2 mg/L for free chlorine, or less than 0.5 mg/L for chloramines.
(6) Write in the number of samples that had no disinfectant at all.

DISINFECTANT LEVEL QUARTERLY OPERATING REPORT (DL QOR)

FOR GROUNDWATER OR PURCHASED-WATER PUBLIC WATER SYSTEMS—ANY SIZE

Please print or type. Forms that are not readable will not be processed.

PWS Name:		**PWS ID:**	

Type of Disinfectant Used in Distribution System*:	☐ Free Chlorine MIN = 0.2 mg/L	☐ Chloramine* MIN = 0.5 mg/L

* If you normally use chloramine but you shocked with free chlorine at any time during this quarter, check **both** boxes.

First Month of Quarter: Monthly Summary

Month:		Year:		Was the PWS active this month?	☐ Yes	☐ No

Average of all disinfectant residuals for this month	**% below MIN for this month**	**% with NO residual for this month**

Second Month of Quarter: Monthly Summary

Month:		Year:		Was the PWS active this month?	☐ Yes	☐ No

Average of all disinfectant residuals for this month	**% below MIN for this month**	**% with NO residual for this month**

Third Month of Quarter: Monthly Summary

Month:		Year:		Was the PWS active this month?	☐ Yes	☐ No

Average of all disinfectant residuals for this month	**% below MIN for this month**	**% with NO residual for this month**

Quarterly Summary and Certification

Average of all disinfectant residuals for this quarter	**Lowest residual for this quarter**	**Highest residual for this quarter**

I certify that I am familiar with the information contained in this report and that, to the best of my knowledge, the information is true, complete, and accurate.

Signature:		Date:	
Print Name:			
Title:			

Complete this DL QOR for the previous quarter at the beginning of April, July, October, and January. In time for it to ***arrive*** by the 10th of the month, send it to: **TCEQ / PDW MC-155, Attn: DL QOR, PO Box 13087, Austin, TX 78711-3087**

Preparing for a Compliance Investigation

Activities 1 and 2.

Activity 1. Benefits of Compliance Investigations

Purpose: Students recognize the benefits of a compliance investigation.

Students discuss how the public, water systems, and the regulatory agency benefit from a compliance investigation. Review the Category A Violations in Appendix A. Could any of these apply to your system?

Activity 2. Experiences with Compliance Investigations

Purpose: Students describe their experiences with compliance investigations and learn about the experiences of others.

Students describe their role during a compliance investigation including preparations, review of records, inspections of facilities, and the exit interview. Your instructor will keep the discussion on track (by minimizing complaints and sticking to facts) and ensure that the entire process is discussed. The instructor summarizes by briefly explaining the major parts of the investigation and the role of the operator and investigator.

Appendix A
Category A Violations (Automatic Enforcement)

1. Failure to comply with a Bilateral Compliance Agreement (even if it covers what would normally be a B or C violation)
2. Operating without a permit amendment for a substantive requirement when the amendment is required
3. Operating without a licensed operator
4. Operating with the incorrect level of operator
5. Documented falsification of data, documents, or reports
6. Exposing customers to contaminants that affect or will affect human health and safety or have or will cause a serious impact to the environment, unless immediate action is taken
7. Failure to provide disinfection equipment to maintain the required minimum disinfectant residual
8. Failure to issue Boil Water Notice
9. Second occurrence of low pressure or outage for the same cause
10. Violation of any primary chemical MCL
11. Exceeding the short term acceptable risk level for a given chemical/radiological contaminant other than lead (Phase 2 and 5)
12. Failure to monitor/report the results of any regulated chemical/radiological contaminant other than lead for 2 consecutive compliance periods
13. Failure to submit lead and copper samples for any two consecutive 6-month sample periods
14. Failure to submit lead and copper water quality parameter results for any two consecutive 6-month sample periods
15. Failure to conduct corrosion control study 6 months after due date
16. Failure to conduct bacteriological monitoring for any 6 months in a 12 month period
17. Greater than 50% deficiency of Supply Requirements as defined in 30 TAC 290.45
18. Failure to provide immediate, written notification to TCEQ of system reactivation, 30 TAC 290.38

Total Coliform rule systems on monthly monitoring

1. Four (4) or more combined monthly MCL or major repeat monitoring/reporting violations in any 12 consecutive months
2. Six (6) or more combined MCL or major repeat or major routine monitoring/reporting violations in any 12 consecutive months

   Note: cases will be referred after 4 combined MCL or major repeat or major routine monitoring/reporting violations in any 12 consecutive months in order to meet the time frame for issuance of an Order
3. Ten (10) or more combined MCL or monitoring/reporting violations (major or minor) in any 12 consecutive months
4. One acute MCL and any other coliform MCL or repeat monitoring violations in any 12 consecutive months

Chemical/radiological violations

1. Exceeding the unreasonable risk to health level for a given contaminant (15 mg/L for nitrates)
2. Exceeding the 10-4 risk level for carcinogens
3. Exceeding the MCL but not the unreasonable risk to health level for a period of greater than 7 years
4. Two (2) or more major monitoring violations consecutively if the monitoring period is less than annual (nitrates)
5. One (1) major monitoring violation if the monitoring period is annual or greater

Lead and Copper

1. For initial monitoring, a system that does not correct a violation within:
   (i) 3 months for large systems
   (ii) 6 months for medium systems
   (iii)12 months for small systems
2. Systems with optimal corrosion control treatment installation violation and a 90^{th} percentile lead concentration - 30 µg/L
3. Systems with source water treatment violations and a 90^{th} percentile lead concentration - 30 µg/L
4. Systems with public education violations and a 90^{th} percentile lead concentration - 30 µg/L

Violation of a state formal enforcement action

Repeat Category B violations: formal enforcement action will also be initiated if the same Category B violation is documented at two consecutive investigations and issued in at least one previous written NOV within the most recent 5-year period. There are some exceptions.

Repeat Category C violations: formal enforcement action may be initiated if the entity receives written notification 3 times within the most recent 5-year period for the same Category C violation, including the notification for the current violation.

Activity 3. Examining Records

Purpose: Students understand that the water system's records are examined during the investigation. Students know where their records are located and how to prepare the records for state inspection.

An operator or records manager will retrieve selected records from their filing system and arrange them for inspection. Select records for which operators have primary responsibility such as; monthly reports, bacteriological sample results, monitoring plans, operator licenses, disinfection monitoring, O&M manuals, and flushing records. Students briefly examine and returned the files one at a time.

Review the records list on page 7 of the Preparing for a Compliance Investigation Module and highlight any records that you would not be able to find readily.

Activities 4-6. Inspecting Facilities

Purpose: Students complete a self-inspection by using portions of the the TCEQ self-inspection checklist.

Use the self-inspection checklist in Appendix B2 (pages 38-42 of this section) to determine whether or not your facilities comply with TCEQ regulations. In small groups, you will go through one of the three inspection activities listed below looking for things that need correcting. Then, the instructor will go through the process testing your knowledge of the equipment, its purpose, and its operation. The instructor uses this to provide additional factual information that you may not know or learn things about your system that the instructor may not know. Everyone has an opportunity to learn from each other.

Repeat this procedure for:

1. Activity 4. Well facilities
2. Activity 5. Disinfection equipment
3. Activity 6. Storage tanks

Appendix B
Self-Inspection Checklist

Source: TCEQ Small Business and Local Government Assistance Program, draft dated March 2004

This checklist applies only to existing **community public water systems (groundwater and purchased water)** that have approved plans and specifications from TCEQ or its predecessor agencies. Chapters of the Texas Administrative Code (TAC) that may affect your system:

30 TAC 288, Subchapter A: *Water Conservation Plans*

30 TAC 288, Subchapter B: *Drought Contingency Plans*

30 TAC 288, Subchapter C: *Required Submittals*

30 TAC 30, Subchapter A: *Requirements for Certification of Water Works Operators*

30 TAC Chapter 290, Subchapter D: *Rules and Regulations for Public Water Systems Related to Requirements for Water Treatment Plant Design, Operation and Maintenance.*

30 TAC Chapter 290, Subchapter E: *Fees*

30 TAC Chapter 290, Subchapter F: *Rules and Regulations for Public Water Systems Related to Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Systems.*

30 TAC 290, Subchapter H: *Consumer Confidence Reports*

30 TAC Chapter 291: *Rules and Regulations for Water Utilities Related to Requirements for Rates, Capacity Development, and Certificates of Convenience and Necessity for Utilities.*

30 TAC 293: *Requirements for Water Districts*

To view the most current rules, go to http://www.sos.state.tx.us or http://www.tceq.state.tx.us and look for 30 Texas Administrative Code Chapter 288, 290, 291, and 293.

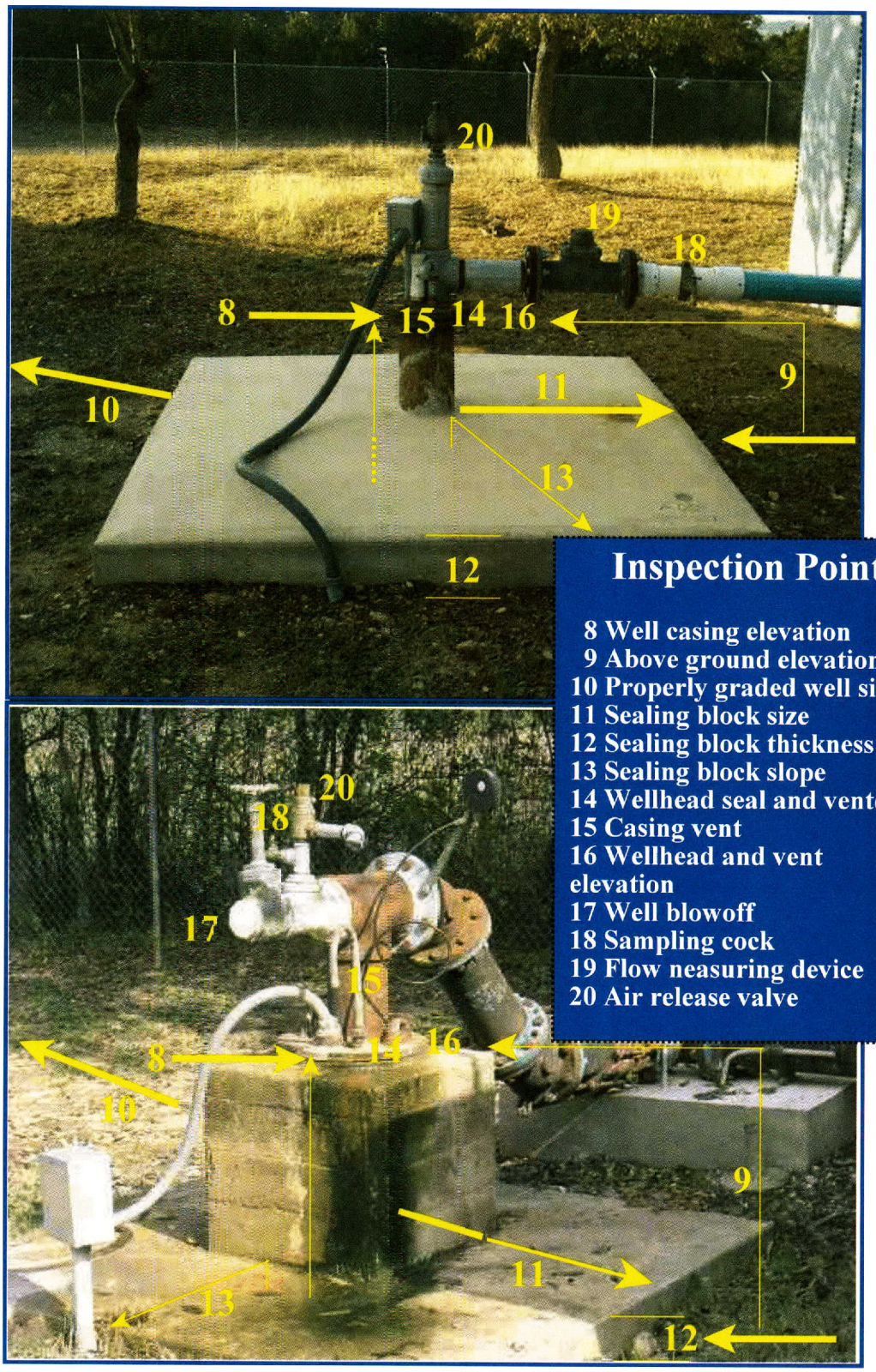
Compliance with this checklist does not guarantee that you will not get any Notice of Violations (NOVs), but it should substantially increase your chances of a zero-error investigation.

1	288.20(a)	A Drought Contingency Plan has been created and approved by the Commission?		
	290.	**SYSTEM DESIGN**		
2	39(e)(1) 39(e)(2)	If deficiencies in design or capacity are identified, has an engineering report been submitted to the Executive Director?		
3	39(j)	Have all changes or additions to the system which resulted in an increase in production, treatment, storage, pressure maintenance, or distribution facilities been submitted to the executive director?		
4	39(j)(1)(D)	Have all significant changes or additions to the system (10% or 250 connections, whichever is smaller) been reported to the executive director in writing?		
5	39(j)(3)	If a Certificate of Convenience and Necessity (CCN) is required or must be amended due to changes or additions to the system, the CCN application is included with the plan notice to the Executive Director?		
		DISINFECTION		
6	39(j)(1) B & C	Have all changes in the process and type of disinfectant used to maintain a disinfectant residual in the distribution system been submitted in writing to the executive director?		
7	39(l)(1)	Are copies of approved exceptions for the above on file at the utility?		
		WELLS		
8	39(e)(4)	Copies of all fully executed sanitary control easements are recorded in the deed records and copies are submitted to the Executive Director prior to putting the well into service?		
9	*41(c)(1)(E)	All known abandoned or inoperative wells within one quarter mile of a proposed well site have been reported to the Commission along with any potential pollution hazards?		
10	* 41(c)(1)(F)	Are 150' easements secured and recorded for each well location?		
11	46(u)	Are all wells that are not in use, and are not deteriorated, inspected every 5 years or as required by the executive director, and are the test results submitted to the commission?		
12	46(n)(3)	Copies of well material setting data, geological log, sealing information, disinfection information, microbiological sample results and chemical analysis reports are on file for each well?		

		OTHER EXCEPTIONS AND WAIVERS		
15	* 43(d)(9)	If more than 3 pressure tanks are located at one site the system has received prior written approval from the Executive Director?		
16	45(g)	If using alternative capacity, prior written approval from the Executive Director has been received?		
18	46(f)(3)(C)-(D)	The public water system retains the records concerning a variance or exception for the system, Concentration Time studies and the results of microbiological analyses results of investigations for water storage, maintenance facilities & pressure filters for five years?		
		OPERATING REPORTS, RECORDS, PLANS, MAPS, PROGRAMS		
20	* 42(l)	The plant operations manual is detailed and up to date?		
21	44(h)(1)(B)(ii)	All backflow investigations and test results are maintained and are available for Commission review?		
22	44(h)(1)(B)(i)	Has the PWS established a cross connection control program?		
23	* 44(h)(4)(c)	Test Reports are prepared by a recognized backflow prevention assembly tester for each assembly tested and the original dated and signed report is submitted to the PWS for record keeping? *[testers follow 290.44(h) guidelines for equipment and reporting criteria]*		
24	45(b)(2)(H)	A log of emergency power use is kept on file with the system for at least 3 years and is available for Executive Director review?		
25	45(g)(5)(D)	The emergency response plan with contacts has been submitted?		
26	* 46(e)	The water system is being operated by a licensed operator at a level appropriate for the system ?		
27	* 46(f)	The public water system maintains a daily operating and maintenance activity record and operating reports are submitted as required?		
28	46(f)(1-2)	The public water systems records are accessible for review during investigation and are organized and kept on file or stored electronically?		
29	46(f)(3)(A)	The public water systems reports for chemical use, volume of treated water used each day, date, location, nature of water quality, pressure or outage complaints received, results of complaint investigations, dates dead end mains were flushed, date storage tanks and other facilities were cleaned, and maintenance records for equipment and facilities are kept on file for two years?		
30	46(f)(3)(B)	The public water system records for notices of violation and correction actions, public notices issued, turbidity disinfectant residual monitoring results and exception reports for individual filters, calibration records for laboratory equipment, flow meters, rate-of-flow controllers, on-line turbidimeters, on-line disinfectant residual analyzers and backflow prevention device programs are kept on file for three years?		
31	46(f)(3)(c)	The public water system records for variances or exemptions granted are kept for 5 years after they are no longer in effect.		

32	46(f)(3)(E)	The public water system retains records of Monthly Operating Reports, chemical analysis results, written reports, summaries or communication relating to sanitary surveys conducted by the system, private consultant or the Commission, and customer service investigations for ten years?		
33	46(f)(3)(F)	The public water system maintains records relating to special studies and pilot projects, special monitoring, and other system specific matters?		
34	46(f)(4)	The public water system submits all monthly and quarterly reports required in a complete and timely manner?		
35	* 46(m)	A maintenance program is in place to ensure reliability and general appearance of all facilities?		
36	* 46(n)(2)	Is there an up to date and accurate map of the distribution readily available?		
37	46(p)	Changes in system ownership are reported to the Commission 120 days prior to the sale, transfer, or merger and in accordance to TAC Chapter 291?		
38	46(q)	Notices for low pressure, water outages, microbiological samples unsafe, low chlorine residuals, high turbidity levels, or other conditions which indicate the potability of the drinking water has been compromised are issued in a timely manner and as specified in 290.47? "Boil Water Notice"		
39	121(a)	The systems chemical and microbiological monitoring plan is up to date and maintained at each plant and at a central location?		
		TARIFF		
40	291.21(a)	If the system is a person, corporation, cooperative corporation, affected county, or any combination of these persons or entities, tariffs (rates) charged are in accordance with a tariff signed and approved by the commission?		
41	291.21(b)(2)	The utility's tariff (rates) are not changed without approval from the Executive Director?		
42	291.71 to 291.76	The utility produces and maintains general reports, financial reports, annual reports, management audits, and regulatory assessment records according to this section?		
43	291.80 to 291.90	The utility follows the customer service and protection requirements in this section?		
		CERTIFICATE OF CONVENIENCE AND NECESSITY (CCN)		
44	291.91 to 291.95	If the system is a retail public utility required to possess a Certificate of Convenience and Necessity (CCN), is continuous and adequate service being supplied to every qualified applicant requesting service in the boundaries of the CCN?		
45	291.101	If the utility charges for water directly or indirectly, they possess a Certificate of Convenience and Necessity and only serve outside their certificated area with Commission approval?		

	290.	**MONITORING**	**Y/N**	**N/A**
46	106	The system reports the monitoring results of inorganic contaminants, and if applicable notifies the customers and the public drinking water program of any violations?		
47	107	The system reports the monitoring results of organic contaminants, and if applicable notifies the customers and the public drinking water program of any violations?		
48	108	The system reports the monitoring results of Radionuclides other than Radon, and if applicable notifies the customers and the public drinking water program of any violations?		
49	109	The system reports the monitoring results of microbial contaminants, and if applicable notifies the public of any violations?		
50	110	The system reports the monitoring results of disinfectant residuals, and if applicable notifies the people it serves and the public drinking water program of any violations?		
51	112	The system reports monitoring results of total organic carbon, and if applicable notifies the customers and the public drinking water program of any violations?		
52	113	The system reports the monitoring results of disinfection by-products (TTHM and HAA5), and if applicable notifies the customers and the public drinking water program of any violations?		
53	114	The system reports the monitoring results of other disinfection by-products (chlorite and bromate), and if applicable notifies the customers and the public drinking water program of any violations?		
55	117(a)(2)	The systems reports, monitors, and provides public education relating to the regulations of lead and/or copper?		
56	118	The system reports the monitoring results of secondary constituent levels, and if applicable notifies the public of any violations according to 290.122?		
57	121(a)	A copy of the monitoring plan is maintained at each water treatment plant and at a central location?		
58	122	*If applicable*, the PWS notifies people served by its system when acute violations occur as required by this section?		
59	271(b)	Has the water system provided an annual (CCR) report that contains all information required to its customers?		



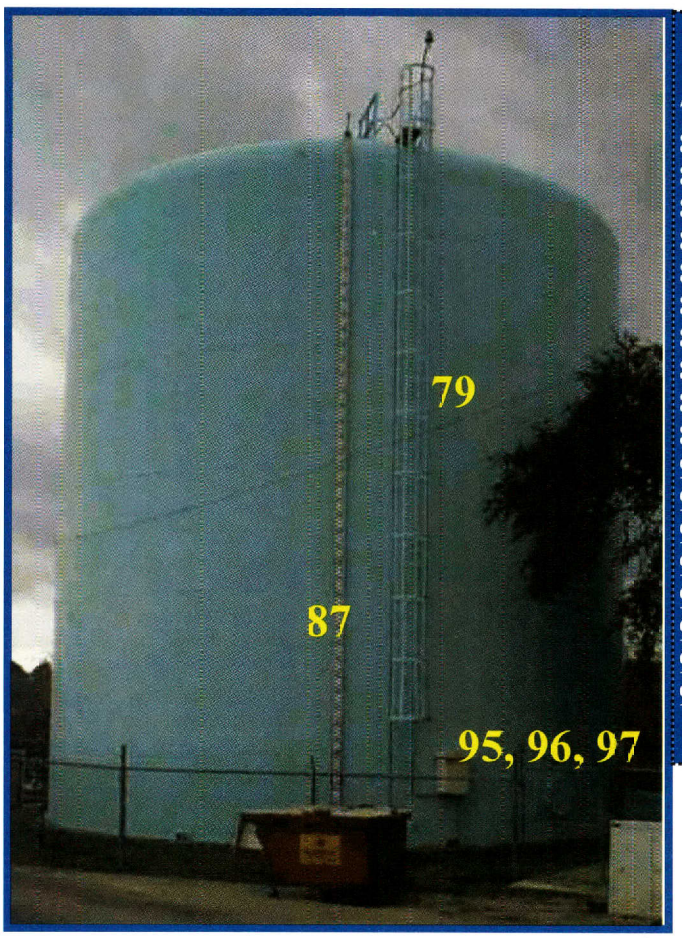
Inspection Points

8 Well casing elevation
9 Above ground elevation
10 Properly graded well site
11 Sealing block size
12 Sealing block thickness
13 Sealing block slope
14 Wellhead seal and vented
15 Casing vent
16 Wellhead and vent elevation
17 Well blowoff
18 Sampling cock
19 Flow neasuring device
20 Air release valve

		Activity 4 - WATER SOURCES - WELLS		
1	41(c)(1)(A)	The well site is 150 feet or more from a septic tank perforated drain field, areas of irrigation by an OSSF, absorption bed, evapotranspiration bed, improperly constructed water well or underground petroleum and chemical storage tank or liquid transmission pipeline?		
2	41(c)(1)(A)	The well is located at least 10 feet, but preferably 50 feet or more from sanitary or storm sewers constructed of ductile iron or PVC pipe meeting AWWA standards, and have a minimum working pressure of 150 psi or greater, and equipped with pressure type joints?		
3	* 41(c)(1)(B)	The well site is located 500 feet or more from a sewage treatment plant?		
4	* 41(c)(1)(B)	The well is located 300 feet or more from a sewage wet well, sewage pumping station or a drainage ditch which contains industrial waste discharges or the wastes from sewage treatment systems?		
5	* 41(c)(1)(c)	The water well is located 500 feet or more from an animal feed lot, solid waste disposal site, lands on which sewage plant or septic tank sludge is applied, or lands irrigated by sewage plant effluent?		
6	* 41(c)(1)(D)	Livestock has no accessibility within 50 feet of the water well?		
7	41(c)(1)(F)	Have all pollution hazards within 150' of the well location(s) been removed?		
8	* 41(c)(3)(B)	Does the well casing extend at least 18 inches above the elevation of the finished floor of the pump room or natural ground surface and a minimum one inch above the sealing block or pump motor foundation block if one is provided?		
9	* 41(c)(3)(H)	There are no below ground-level pump rooms and pump pits in connection with water supply installation?		
10	* 41(c)(3)(I)	Is the well site fine graded and free from depressions so that surface water drains away from well?		
11	* 41(c)(3)(J)	Does the concrete sealing block extend at least three feet from the well casing in all directions?		
12	* 39(c)(3)(J)	Is the concrete sealing block at least six inches thick?		
13	* 41(c)(3)(J)	Does the concrete sealing block slope at least .25 inches per foot to drain away from the wellhead?		
14	* 41(c)(3)(K)	The wellheads and pump bases are sealed by a gasket or sealing compound and properly vented to prevent possible contamination of the water well?		
15	* 41(c)(3)(K)	The well casing vent is in place and covered with 16-mesh or finer corrosion resistant screen, facing downward, elevated and located to minimize drawing contaminants into the well?		

16	41(c)(3)(K)	The wellheads and vents are two feet or more above the highest known watermark or 100 year flood elevation, or adequately protected from possible floods?		
17	* 41(c)(3)(L)	If there is a well blowoff line, its discharge(s) is terminated in a downward direction where it cannot be submerged by flood waters?		
18	* 41(c)(3)(M)	Is a suitable sampling cock located on the discharge pipe of each well pump prior to treatment?		
19	* 41(c)(3)(N)	Flow measuring devices are provided for each well and are located for ease of daily readings?		
20	* 41(c)(3)(Q)	If an air release device is provided on the discharge piping, is it elevated and located to avoid submergence and minimize drawing contaminants into the well, and all openings are covered with 16-mesh or finer corrosion resistant screen?		
21	41(c)(4)(A)	If pitless well units are supplied, are they are shop fabricated from the point of connection with the well casing to the unit cap or cover, threaded or welded to the well casing, watertight, and constructed of materials and weight comparable to the casing?		
22	41(c)(4)(A)	If pitless well units are supplied do they have field connections to the lateral discharge with threaded, flanged or mechanical joint connection?		
23	41(c)(4)(B)	If pitless well units are supplied are they designed with access to disinfect the well, a properly designed casing vent, a cover at the upper terminal of the well that will prevent the entrance of contamination, a sealed entrance connection for electrical cable, and at least one check valve in the well casing?		
24	41(c)(4)(B)	If pitless well units are supplied do they have a diameter as large as the well casing up to and including a well casing diameter of 12 inches?		
25	41(c)(4)(c)	If pitless well units are supplied and designed for field welding to the casing, is the shop assembled unit designed specifically for field welding?		
		WATER TREATMENT		
42	42(a)(1)	The total capacity of the PWS production and treatment facilities is greater than its anticipated maximum daily demand?		
		Groundwater Treatment		
43	42(b)(1)	A disinfection facility is provided for microbiological control and distribution protection and is in conformity with disinfection requirements?		
44	42(b)(2)	If the ground water doesn't meet drinking water standards, an acceptable treatment facility is provided? *Follow 290.42(b)(2)(A-C) and 290.42(b)(3) for specifics*		
45	42(b)(4)	Laboratory facilities are provided for controls and to check the effectiveness of disinfection and other treatment processes?		
46	42(b)(5)	All plant piping is constructed for minimal leakage?		
47	42(b)(6)	Sampling taps are provided for raw water, treated water, and at every point water enters the distribution system?		

48	42(b)(7)	Air release valves are installed so they cannot be submerged and contaminants cannot enter?		
		Activity 5 - DISINFECTION		
58	42(e)	All water is disinfected in accordance with 290.110?		
59	* 42(e)(2)	All groundwater is disinfected prior to distribution and, if storage is provided prior to distribution, the application point is prior to the storage tanks?		
60	42(e)(3)	Disinfection equipment is installed and provides continuous and effective disinfection at all times?		
61	* 42(e)(3)(A)	The disinfection equipment has a capacity 50% greater than the highest expected dosage to be applied at any given time?		
62	42(e)(3)(B)	Automatic proportioning equipment for disinfectant equipment is provided?		
63	* 42(e)(3)(D)	The system has facilities available to determine the amount of disinfectant used daily and the remaining amount for use?		
64	* 42(e)(4)(A)	If chlorine gas is used, a full face self-contained breathing apparatus or supplied air respirator is readily available outside the chlorine room?		
65	* 42(e)(4)(A)	A small bottle of fresh ammonia is available for testing for chlorine leaks?		
66	* 42(e)(5)	Hypochlorination solution containers and pumps are housed in secure enclosures to protect from adverse weather conditions & vandalism & the solution container top is completely covered & other contaminants from entering?		
67	* 42(e)(6)	Anhydrous ammonia fed equipment is stored in a secure, separately enclosed, and appropriately ventilated area?		
		FACILITIES		
68	* 41(c)(3)(O)	Are **all facilities** protected by intruder resistant fences, with gates that have locks and if applicable are enclosed in locked, ventilated structures to prevent intruder passage or damage to the facilities by trespassers and the gate or well house is locked when dark and when the plant is unattended?		
69	* 41(c)(3)(P)	Does each plant and well site have an all weather access road leading to it?		
70	* 42(h)	Appropriate toilets and hand washing facilities are provided in areas where employees frequent?		
		PERMITS		
71	* 42(i)	Wastewater permits have been obtained as necessary for water treatment processes?		
		CHEMICALS		



Inspection Points

79 Storage tank construction
80 Roof vent type
81 Roof vent screened
82 Screen mesh and fastening
83 Roof openings
84 Overflow pipes
85 Overflow discharges above ground
86 Overflow accessibility
87 Water level indicator
88 Inlet and outlet location
89 Tank baffling
90 Tank leak prevention
91 Pipe, valve & fitting leak prevention
92 Tank drains
93 Tank painting and disinfection
94 Tanks used only for potable water
95 Access entry ports
96 Entry port opening size
97 Entry port sealed openings

72	* 42(j)	All the chemicals and any additional or replacement process media used in treatment of water supplied conform to American National Standards Institute/National Sanitation Foundation Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives?		
		SAFETY		
73	42(k)(1)	All safety equipment meets OSHA standards?		
74	* 42(k)(2)	The system complies with the EPA requirements for Risk Management Plans?		
		Activity 6 - WATER STORAGE		
75	* 43(b)(1)	The elevated and/or ground storage tanks are located 500 feet or more away from any municipal or industrial sewage treatment plant or any land that is spray irrigated with treated sewage effluent or sludge disposal?		
76	* 43(b)(2)	The clearwells or treated water tanks are not located under any part of any building?		
77	* 43(b)(3)	If the clearwell or storage tank is located below ground level it is more than 50 feet from a sanitary sewer or septic tank? (unless the sanitary sewer is constructed of 150 psi pressure rated pipe with pressure tested, watertight joints then the distance is no closer than 10 feet)		
78	* 43(b)(4)	If the storage tank or clearwell is constructed below ground level is it at least 150 feet from a septic tank soil absorption system?		
79	* 43(c)	All facilities for potable water storage are covered and designed, fabricated, erected, tested and disinfected in strict accordance with current AWWA standards and provide the minimum number, size, and type of roof vents, manways, drains, sample connections, access ladders, overflows, liquid level indicators, and other appurtenances required?		
80	* 43(c)(1)	The roof vents are gooseneck or roof ventilator type and are designed for the maximum outflow from the tank and are installed according to AWWA standards?		
81	* 43(c)(1)	The roof vents have approved screens to prevent animals, birds, insects or heavy air contaminants from entering?		
82	43(c)(1)	The roof vent screen is 16 mesh or finer and is securely fastened with stainless or galvanized bands or wires?		
83	* 43(c)(2)	All the roof openings are designed in accordance to AWWA standards and roof openings are at least 30 inches in diameter, have a raised 4 inch curb with a lockable cover that overlaps the curbing at least two inches in a downward direction?		
84	* 43(c)(3)	All overflow pipes are equipped with a gravity-hinged and weighted cover, and the cover does not gap more than 1/16"?		
85	* 43(c)(3)	The overflow discharge sits above ground level and is not subject to submergence?		
86	* 43(c)(3)	The overflow is located close enough and at a position accessible from a ladder or the balcony for investigation purposes?		
87	* 43(c)(4)	All ground storage tanks have water level indicators at the tank site?		

88	* 43(c)(5)	All inlet and outlet connections are located to prevent short circuiting or stagnation of water?		
89	43(c)(5)	Any clearwells used for disinfectant contact time are appropriately baffled?		
90	* 43(c)(6)	The clearwells and potable water storage tanks are tight to prevent leakage and are located above ground level and have no common walls with any other part of the plant containing water in the process of being treated?		
91	* 43(c)(6)	All associated appurtenances including valves, pipes, and fittings are tight against leakage?		
92	* 43(c)(7)	All storage tanks have a means to remove accumulated silt and deposits at all low points in the bottom of the tank and the drains are not connected to a waste or sewage disposal system and cannot contaminate the stored water?		
93	43(c)(8)	All clearwells, ground storage tanks, standpipes, and elevated tanks are painted with no lead paint, disinfected, and maintained in strict accordance to AWWA standards?		
94	43(c)(9)	All used tanks put into operation have only been used for potable water storage, and a letter from the previous owner confirming this is on file with the commission?		
95	43(c)(10)	The access manways in the riser pipe, shell area, access tube, bowl area or any other location opening directly into the water compartment is located according to AWWA standards?		
96	43(c)(10)	The manways or other openings are not less than 24 inches in diameter? *(Some exceptions) 290.43(c)(10)*		
97	43(c)(10)	If there is an opening directly to the water compartment, is it sealed with a gasket to make a positive seal?		
		PRESSURE TANKS		
98	43(d)	Pressure (hydropneumatic) tanks are located above grade and are made from steel with welded seams? *(Some exceptions) 290.43(d)(8)*		
99	* 43(d)(1)	The pressure tank metal thickness is sufficient to withstand the highest expected working pressure with a four to one safety factor?		
100	43(d)(1)	Any pressure tanks 1,000 gallons or larger meet ASME standards and have an access port for investigations?		
101	43(d)(1)	Any pressure tank of 1,000 gallons or larger have a permanently affixed ASME name plate?		
102	* 43(d)(2)	All pressure tanks have a pressure release device?		
103	* 43(d)(2)	All pressure tanks have an easy-to-read pressure gauge?		
104	43(d)(3)	The pressure tanks provide facilities to maintain air-water volume at its design water level and working pressure?		
105	43(d)(3)	Pressure tanks larger than 1,000 gallons have a device readily available to determine the air-water volume?		

106	43(d)(3)	Air injection lines have filters or other devices to prevent compressor lubricants and other contaminants from entering the pressure tank?		
107	43(d)(4)	Protective paint or coating is applied to the inside portion of all pressure tanks?		
108	43(d)(5)	The pressure tanks have not been used to store anything but potable water?		
109	43(d)(6)	The pressure tanks are equipped with a slow closing valve and time delay pump controls?		
110	* 43(d)(7)	All associated pipe, valves, and fittings to the pressure tanks are tight against leaks?		
111	43(d)(8)	Any seamless fiberglass tanks used are smaller than 300 gallons?		
112	43(e)	Are the water storage tanks and pressure maintenance facilities installed in a lockable building that is intruder resistant or enclosed by an intruder resistant fence with lockable gates?		
113	43(f)	Any service pumps taking suction from storage tanks are provided with an automatic low water cutoff device, and the service pump circuitry will also resume pumping automatically once the minimum water level is reached in the tank?		
		WATER DISTRIBUTION		
114	* 44(a)(1)	Plastic pipes used in the PWS are installed according to ANSI/NSF standard 61 and are certified by ANSI?		
115	44(a)(2)	All of the plastic pipes used in the system have a ASTM design pressure rating of 150 psi or a standard dimension ratio of 26 or less?		
116	44(a)(3)	The pipes used in the water system have only been used for conveying drinking water?		
117	44(a)(4)	Water transmission/distribution lines are buried at least 24" below ground surface?		
118	44(a)(5)	The hydrostatic leakage rate does not exceed the amount allowed or recommended by AWWA formulas?		
119	44(b)(1)	Pipe and pipe fittings do not exceed 0.8 percent lead and solders and flux do not exceed 0.2 percent lead? *(Waived for repairs to cast iron pipe)*		
120	44(c)	All new pipes used in the system are at least 2 inches in diameter?		
121	* 44(d)	The water distribution system provides a minimum pressure of 35 psi at flow rates of 1.5 gpm at each outlet or connection at all times and maintains 20 psi during fire fighting events?		
122	* 44(d)(1)	All air release devices are installed in the distribution where topography or other factors may create air locks?		
123	* 44(d)(2)	If booster pumps are installed to take suction directly from the distribution system, a minimum residual pressure of 20 psi is maintained on the suction side at all times?		
124	* 44(d)(2)	Plan approval has been received for all service connections that require booster pumps taking suction from any area other than a storage tank in the public water system lines?		

125	* 44(d)(3)	The booster pumps are equipped with an automatic pressure cut off device?		
126	44(d)(4)	All service connections provide accurate metering devices?		
127	44(d)(5)	Sufficient valves and blowoffs are available for repairs and flushing to avoid large areas of interrupted service?		
128	* 44(d)(6)	All dead end mains have acceptable flush valves and discharge piping?		
129	* 44(d)(6)	Dead end mains are located and arranged for ultimately connecting them to provide circulation?		
130	* 44(e)	The requirements in this section regarding the placement of water distribution lines, wastewater collection lines, wastewater force mains, or other potential sources of contamination are followed?		
131	44(f)	Sanitary precautions including flushing, disinfection and bacteriological sampling are followed according to AWWA standards when disinfecting water mains and when laying water lines?		
		follow all guidelines in 290.44(e) to install new water lines		
132	44(h)(1)(A)	All connections, potential contamination or system hazards which have an actual or potential cross connection have an air gap separation or backflow prevention assembly installed?		
133	44(h)(2)	All water from condensing, cooling, or industrial processes are prohibited to return to the potable water supply?		
134	44(h)(3)	The overhead bulk water station provides for an air gap between the filing outlet hose and the receiving tank?		
135	44(h)(4)	All backflow prevention devices are inspected upon installation and are tested and certified annually by a recognized backflow prevention assembly tester?		
136	44(h)(4)(A)	All backflow prevention assembly testers have completed a Commission approved course on cross connection control and backflow prevention assembly testing and have passed an examination administered by TCEQ or its designated agent?		
137	44(i)(1)&(2)	If water is hauled, is it obtained from an approved source and transportation is approved by the Executive Director?		
		MINIMUM CAPACITY REQUIREMENTS		
		Groundwater systems with less than 50 connections and without ground storage		
138	45(b)(1)(A)(i)	The well capacity is 1.5 gallons per minute or greater?		
139	45(b)(1)(A)(ii)	The pressure tank capacity is 50 gallons per connection or greater?		
		Groundwater systems with less than 50 connections with ground storage		
140	45(b)(1)(B)(i)	The well capacity is 0.6 gallons per minute per connection or greater?		
141	45(b)(1)(B)(ii)	The total storage capacity is 200 gallons per connection or greater?		

142	45(b)(1)(B)(iii)	There are two or more service pumps having a total capacity of 2.0 gallons per minute per connections?		
143	45(b)(1)(B)(iv)	The pressure tank capacity is 20 gallons per connection or greater?		
		Groundwater systems with 50 to 250 connections		
144	45(b)(1)(C)(i)	The well capacity is 0.6 gpm per connection		
145	45(b)(1)(C)(ii)	The total storage capacity is 200 gallons per connection or greater?		
146	45(b)(1)(C)(iii)	Each pump station or pressure plane has two or more pumps with a total capacity of 2.0 gpm per connection, or if there is an elevated storage capacity of 200 per connection, there are two service pumps with a minimum combined capacity of 0.6 gpm per connection at each pump station or pressure plane?		
147	45(b)(1)(C)(iv)	There is an elevated storage capacity of 100 gallons per connection or a pressure tank capacity of 20 gallons per connection?		
		Groundwater systems with more than 250 connections		
148	45(b)(1)(D)(i)	There are two wells with a total capacity of 0.6 gpm per connection?		
149	45(b)(1)(D)(i)	Under emergency situations where an emergency interconnect exists, there is a supply of 0.35 gallons per minute per connection in the combined system?		
150	45(b)(1)(D)(ii)	There is a total storage capacity of 200 gallons per connection?		
151	45(b)(1)(D)(iii)	Each pump station or pressure plane has two or more pumps with a total capacity of 2.0 gpm per connection or a total capacity of 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service?		
152	45(b)(1)(D)(iii)	The systems with elevated storage capacity of 200 gallons per connection have two service pumps with a minimum combined capacity of 0.6 gpm per connection and are located at each pump station or pressure plane? (Except where wells and elevated storage are provided)		
153	45(b)(1)(D)(iv)	The elevated storage capacity is 100 gallons per connection or there is a pressure tank of 20 gallons per connection? (Some exceptions)		
154	45(b)(1)(D)(v)	If elevated storage requirements are not met, there is emergency power to the system with enough power to operate at 0.35 gpm per connection?		
		Mobile home parks with groundwater sources, 8 or more units per acre or apartments with 100 or less connections and no ground storage		
156	45(b)(1)(E)(i)	The well capacity is 1.0 gpm per connection or greater?		
157	45(b)(1)(E)(ii)	The pressure tank capacity is 50 gallons per connection with a maximum of 2,500 gallons required?		
		Mobile home parks and apartment complexes with groundwater sources, which supply 100 connections or more, or less than 100 connections and use ground storage		
158	45(b)(1)(F)(i)	The well capacity is 0.6 gpm per connection?		

159	45(b)(1)(F)(ii)	The total storage is 200 gallons per connection?		
160	45(b)(1)(F)(iii)	There are at least two service pumps with a total capacity of 2.0 gpm per connection?		
161	45(b)(1)(F)(iv)	The pressure tank capacity is 20 gallons per connection?		
		Mobile home parks and apartment complexes with groundwater sources, which supply 250 connections or more		
162	45(b)(1)(F)(i)	There are two wells or an approved interconnection which is capable of supplying at least 0.35 gpm for each connection in the combined system?		
		MINIMUM OPERATING PRACTICES		
163	* 46(d)	The system's disinfection is continuously maintained during treatment process and throughout the system?		
164	46(e)(3)(A)	If the water system serves less than 250 connections, does it have a Class "D" or higher licensed operator on staff?		
		Groundwater or Purchased Treated Water Users		
165	46(e)(3)(A) and (4)(A)	If the water system serves 250 or more connections, and only uses groundwater or purchased treated water does it have a Class "D" or higher licensed operator on staff?		
166	46(e)(3)(B) and (4)(B)	If the water system serves 250 to 1,000 connections and uses groundwater or purchased water, does it have a Class "C" or higher licensed operator on staff?		
167	46(e)(3)(c)) and (4)(c)	If the water system serves more than 1,000 connections and uses purchased water, does it have two Class "C" or higher licensed operators on staff?		
		All Systems		
174	* 46(g)	If the system installs or repairs lines, all disinfection work is performed under the supervision of the water system's personnel?		
175	* 46(h)	The system has calcium hypochlorite on hand for making repairs, setting meters, and disinfecting new mains?		
176	* 46(i)	Plumbing ordinances and service agreements prohibit potential cross connections and unacceptable plumbing practices?		
177	46(j)	Customer service investigations are performed when the water purveyor has reason to believe that a cross connection or other unacceptable plumbing practice exists or after any material improvements, corrections, or additions are made to the private water distribution facility?		
178	46(j)	Customer service investigation certificates are completed prior to providing continuous water service to new construction?		
179	46(j)(1)	Customer service investigations are performed by approved investigators?		
180	46(j)(2)	All potential contamination hazards discovered are eliminated or service is terminated?		

181	46(k)	The Executive Director has approved any connection between the distribution system and any other water supply?		
182	* 46(l)	All dead end mains are flushed monthly or more frequently to maintain water quality?		
183	46(m)(1)	The system's ground, elevated and pressure tanks are inspected annually and meet the requirements in 290.46(m)(1)(A-C)?		
184	46(m)(2)	If pressure filters are used, visual investigations are conducted annually to ensure good condition?		
185	46(m)(3)	If cartridge filters are used, they are changed according to manufacturer's specifications or more frequently?		
186	46(m)(4)	Water storage facilities, distribution system lines, and related appurtenances are in watertight condition and free of excess solids?		
187	46(m)(5)	The basins used for clarification are maintained free of excess solids?		
188	46(n)(1)	Accurate and up to date as-built plans and specifications for the treatment plant, pump station, and storage tanks are maintained at the PWS?		
189	46(s)	Accurate testing equipment or other means to monitor effectiveness of all chemical treatment processes is provided?		
190	46(s)(1)	Flow measuring devices are calibrated at least every 12 months, and well meters are calibrated at least once every three years?		
191	* 46(s)(2)	All laboratory equipment used for compliance testing is calibrated in accordance with 290.46(s)(2)?		
192	46(s)(2)(c)	All disinfectant residual analyzers are properly calibrated according to 290.46(s)(2)?		
193	* 46(t)	Legible signs showing the utility name and emergency contact number are located at each of the production, treatment, and storage facilities?		
194	46(u)	Are all abandoned wells owned by the system plugged or, if not deteriorated, they are tested every five years?		
195	* 46(v)	All electrical wiring is in a securely mounted conduit in compliance with local or national electrical code?		
196	* 47(a)	If the water system is recognized as an approved or superior water system, signs are properly displayed and maintained?		
197	104	The Maximum Contaminant levels (MCLs), maximum residual disinfectant levels (MRDLs), treatment techniques, and action levels in this section are met?		
198	106	The PWS monitors for inorganic contaminants as required?		
199	107	The PWS monitors for organic contaminants as required?		
200	108	The PWS monitors for radiological contaminants as required?		
201	109	The PWS monitors for microbial contaminants as required?		

202	* 110	Does the system disinfect the water and maintain an acceptable disinfectant residual within the distribution system as required?		
203	113	The PWS monitors for disinfection by-products TTHM an HAA5 as required?		
204	114	The PWS monitors for disinfection by-products other than TTHM and HAA5 as required?		
206	117	The PWS follows the monitoring and sampling requirements for Lead and Copper as required?		
207	118	The PWS follows the monitoring requirements for secondary constituent levels as required?		
208	119(a)	The PWS uses only acceptable laboratories to analyze its samples as required?		
209	119(b)	The PWS uses the acceptable analytical methods as described in this section?		

Appendix C
Common Violations

	Section in Chapter 290	Appendix C1. 12 Common Category A Violations	Y/N	N/A
1	39(j)	Have all changes or additions to the system been submitted in writing to the executive director? (those which resulted in an increase in production, treatment, storage, pressure maintenance, or distribution facilities)		
2	39(j)(1)(D)	Have all significant changes or additions to the system (10% or 250 connections, whichever is smaller) been reported in writing to the executive director?		
3	42(d)(1)	All surface water obtained is treated at a plant suitable for pretreatment disinfection, taste and odor control, continuous coagulation, sediment, filtration, covered clear well storage and terminal disinfection of the water with chlorine or suitable chlorine compounds?		
4	42(b)(1)	A disinfection facility is provided for microbiological control and distribution protection and is in conformity with disinfection requirements?		
5	42(c)(1)	The treatment process achieves minimum level standards?		
6	46(e)	The water system is operated by a licensed operator at a level appropriate for the system?		
7	46(f)(4)	The public water system submits all monthly and quarterly reports in a complete and timely manner?		
8	46(q)	Notices for low pressure, water outages, microbiological samples unsafe, low chlorine residuals, high turbidity levels, or other conditions which indicate the potability of the drinking water has been compromised are issued in a timely manner and as specified in 290.47? **"Boil Water Notice"**		
9	104	The maximum contaminant levels (MCLs), maximum residual disinfectant levels (MRDLs), treatment techniques, and action levels in this section are met?		
10	108	The PWS monitors for radiological contaminants as required in this section and in their monitoring plan?		
11	110	Does the system disinfect the water and maintain an acceptable disinfectant residual within the distribution system according to this section?		
12	122	*If applicable*, the PWS notifies people served by its system when acute violations occur as required by this section?		

This checklist contains the most common public water system (PWS) violations reported in TCEQ Regions 15 and 16. The list can be used as a quick reference guide when the longer, more comprehensive version of the checklist cannot be completed.

	Ch. 290	Appendix C2. Other Common Violations	Y/N	N/A
1	41(c)(1)(F)	Are there **sanitary control easements** covering all the land within 150 feet of the wells?		
2	41(e)(5)	Is the raw water pump station and all appurtenances installed in a **lockable building** to prevent intruder access or enclosed by an intruder resistant fence with lockable gates?		
3	41(c)(3)(J)	The concrete **sealing block** extends at least 3 feet from the well casing in all directions, with a minimum thickness of 6 inches and slopes to drain away from the wellhead?		
4	41(c)(3)(K)	The wellheads and pump bases are **sealed** by a gasket or sealing compound and properly vented to prevent contaminating the water well?		
5	42(a)	The **total capacity** of the PWS production and treatment facilities is always greater than the anticipated maximum daily demand?		
6	42(d)(5)	**Flow measuring devices** are provided to measure raw water supplied to the plant, the recycled decant water, the treated water used to backwash the filters, and the treated water discharged from the plant?		
7	42(d)(6)	The **chemical storage** facilities are designed to ensure reliable supply of chemicals to the feeders, minimize the possibility and impact of accidental spills, and facilitate good housekeeping?		
8	42(e)	All the water obtained from surface sources, groundwater sources under the influence of surface water and groundwater are **disinfected** in a manner consistent with the requirements of 290.110?		
9	42(d)(11)(B)	**Filtration facilities** are designed to operate at filtration rates which assure effective filtration at all times?		
10	43(c))(1)	The **roof vents** are installed in strict accordance with current AWWA standards and are equipped with approved screens to prevent entry of animals, birds and heavy air contaminants?		
11	43(c)(2)	All the **roof openings** are designed in accordance with current AWWA standards?		
12	43(c)(4)	The clearwells and storage tanks have a **liquid level indicator** located at the tank site?		
13	43(c))(6)	Clearwells and potable water storage tanks, and associated appurtenances are **tight against leakage**?		
14	43(c)(8)	The clearwells, ground storage tanks, standpipes and elevated tanks are **painted**?		
15	43(d)(4)	Protective **paint or coating** is applied to the **inside** portion of any pressure tank?		
16	43(e)	All the potable water storage tanks and pressure maintenance facilities are enclosed with an **intruder-resistant fence with lockable gates**?		
17	44(a)(5)	The hydrostatic **leakage rate** does not exceed the amount allowed or recommended by AWWA formulas?		

18	44(d)	The system is designed to maintain a **minimum pressure of 35 psi** at all times within the distribution network at a flow rate of at least **1.5 gallons per minute per connection**? *(see exception for fire flow)*		
19	44(h)(1)(A)	At residences or establishments where an actual or potential **contamination hazard** exists, is there **additional protection at the meter** in the form of an air gap or backflow prevention assembly?		
20	45(a)	The total capacities of the PWS and at individual pump stations and pressure planes are met according to this section? *(Review this section for capacity requirements based on the type/size of facility.)*		
21	45(f)(1)	The **water purchase contract** is available for commission review and contains the appropriate contents as required by this section?		
22	46(d)	A **disinfectant residual** is continuously maintained during the treatment process and throughout the distribution system?		
23	46(e)	The PWS is operated continuously by an adequately **trained and appropriately licensed water works operator**?		
24	46(j)	A **customer service investigation** certificate is completed prior to providing continuous and adequate service to new construction, on any existing service where a potential hazard exists or after material improvement, correction, or addition to the private water distribution facility occurs?		
25	46(m)(1)	Each ground, elevated and pressure tank is **inspected annually** by water system personnel or a contracted investigation service?		
26	46(m)(4)	All the water storage and pressure maintenance facilities, distribution system lines, and related appurtenances are maintained in a **watertight condition and free of excess solids**?		
27	46(n)	**Plan, specifications, maps** and other pertinent information is maintained to facilitate operation and maintenance of the system?		
28	46(s)	The following meters or devices are **calibrated** as required in this section?		
		Flow measuring device		
		pH meter		
		Turbidimeters		
		Disinfectant residual analyzers		

Activity 7. Exit Interview

Purpose: Students understand the purpose of the exit interview and their role.

The instructor conducts a mock exit interview using information that was learned during Activities 3-6 and/or the common deficiencies described on pages 49-51.

Appendix D. Example of a NOV Letter

November 17, 2004

CERTIFIED MAIL 7002 0860 0004 6482 2002
RETURN RECEIPT REQUESTED

Mr. Robert D. Waterman, President
Professional WSC
4325 Belmont Avenue
Dallas, TX 75204

Re: Notice of Violation for the Comprehensive Compliance Investigation at:
Professional WSC, 1/4 mile East of Hwy 75, Dallas (Dallas County), Texas
PWS ID No.: 0570002
Regulated Entity Number: RN100512295

Dear Mr. Waterman:

On November 3, 2004, Ms. Toni Palma of the Texas Commission on Environmental Quality (TCEQ) Austin Region Office conducted an investigation of the above-referenced facility to evaluate compliance with applicable requirements for public water systems. Enclosed is a summary which lists the investigation findings. During the investigation, certain outstanding alleged violations were identified for which compliance documentation is required. Please submit to this office by **January 18, 2005** a written description of corrective action taken and the required documentation demonstrating that compliance has been achieved for each of the outstanding alleged violations.

In the listing of alleged violations, we have cited applicable requirements, including TCEQ rules. If you would like to obtain a copy of the applicable TCEQ rules, you may contact any of the sources listed in the enclosed brochure entitled "Obtaining TCEQ Rules."

The Texas Commission on Environmental Quality appreciates your assistance in this matter. Please note that the Legislature has granted TCEQ enforcement powers which we may exercise to ensure compliance with environmental regulatory requirements. We anticipate that you will resolve the alleged violations as required in order to protect the State's environment. If you have additional information that we are unaware of, you have the opportunity to contest the violation(s) documented in this notice. Should you choose to do so, you must notify the Austin Region Office within 10 days from the date of this letter. At that time, we will schedule a violation review meeting to be conducted (*within 21 days from the date of this letter*). However, please be advised that if you decide to participate in the violation review process, the TCEQ may still require you to adhere to the compliance schedule included in the attached Summary of Investigation Findings until an official decision is made regarding the status of any or all of the contested violations.

If you or members of your staff have any questions, please feel free to contact Ms. Toni Palma in the Austin Region Office at (512)339-2929.

Sincerely,

Sample Response Letter to a Notice of Violation

(Date)

Ms. Toni Palma
Texas Commission on Environmental Quality
Region 11 – Austin
(Address from the bottom of their letter)

Re: (your system's name); Notice of Violation; Investigation Date: (date of investigation)

Dear Ms. Palma,

This is in response to your letter dated (date of TCEQ letter) providing us with a summary of the investigation findings for our water system and requesting that we provide you with documentation of our corrective actions.

Attached to this letter is our description of the actions we took to correct each violation. You will also find photographs of the corrected facilities.

If you require further information, please contact me at (your telephone number or e-mail address.)

Thank you for your assistance in helping us make our water system better and safer for our customers.

Sincerely,

(Your name and title or position)

cc: President of the Board, City Manager, etc.

Attachment – description of corrections w/ photos